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.

BY HENRY STEPHENS, F.R.S.E.,

AUTHOR OF "THE BOOK OF THE FARM," ETC., ETC., ETC.,

ASSISTED BY

JOHN P. NORTON, M.A.,

PROFESSOR OF SCIENTIFIC AGRICULTURE IN YALE COLLEGE, NEW HAVEN.

IN TWO VOLUMES—WITH NUMEROUS ILLUSTRATIONS.

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CONTENTS OF VOLUME I.

INITIATION.

PRACTICE—WINTER.

PRACTICE—SPRING.

LIST OF THE ILLUSTRATIONS IN VOL. I.

ENGRAVINGS ON STEEL.

ENGRAVINGS ON WOOD.

PREFACE.

BY HENRY STEPHENS.

THE call for another Edition of the *Book of the Farm*, so soon after the issue of the former one, and the gratifying reception of the work by agriculturists of the highest repute, both at home and abroad, justify me in believing that the object for which it was undertaken has been attained, and that the plan upon which it is arranged has met with general approval.

My chief object, in preparing the work, was to construct such a hand-book as should be of service in instructing young men who might desire to become farmers, in practical husbandry. Not that I ever supposed the mere perusal of a book could make any young man a practical farmer; but my own experience as an agricultural pupil, for some years, having convinced me that it is most difficult to acquire a knowledge of husbandry even on a farm, unless through an expenditure of time which few young men can afford to spare, I became assured that, with a work at hand containing clear explanations of the details of each farm-operation, and of its relation to that which preceded and followed it in the revolution of the agricultural year, a young man, residing on a farm in the capacity of pupil to an intelligent farmer, would much sooner and much better become acquainted with rural affairs than he possibly could do without the advantages of such reference. The farmer, who unquestionably is the proper agricultural instructor, cannot always be on the spot to answer inquiries, nor can a pupil always put his questions distinctly, or be aware of the proper time to put them, so as to elicit the information wanted. But the pupil can, in the intervals when direct information is impossible, peruse his hand-book, wherein he will find not only every detail of the particular operation proceeding in the field fully explained, but its relative position correctly indicated in

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Note by the American Publishers.—That portion of the Farmer's Guide written by Mr. Stephens is a reprint of the second edition of the *Book of the Farm.* The reader will see by Mr. Stephens's Preface, that this second edition is virtually a new book, embracing the more important features of the first edition and all the later discoveries in Agricultural Science. This improvement in the character of the work, together with the additions of Professor Norton. has induced the American Publishers to adopt a new title. The change is sanctioned by the British Publishers, who have an interest in the sale of the American Edition, and it meets the approbation of the American Public.

reference to the operations preceding and following it. To explain still more explicitly the nature of field-operations, I have first arranged each in the agricultural season in which it should be begun, and then continued it through those in which it should be carried on, down to that in which it ought to be brought to a conclusion; and I have, moreover, carefully preserved its relation to those operations which precede and follow it through all the seasons. I am satisfied that no better mode exists of teaching farming successfully, to pupils in agriculture, from books. Systematic works on agriculture, as hitherto written, are couched in too general terms to be practically useful, and the narrative is rarely so arranged as to give an adequate idea of the method which is really adopted in the fields. A work in the cyclopædiac form, besides this objection, presents a greater, by placing the operation in the midst of subjects which, as a matter of necessity, bear no relation whatsoever to its peculiar antecedents or progress.

The aim and plan of the former edition of the *Book of the Farm*, which the public approval has sanctioned in the most unequivocal manner, it is not my intention to disturb in the present edition. Still, with the view of conveying more instruction to the agricultural pupil, considerable alterations have been made in the arrangement of the subjects; and these have been so emended, enlarged, and in some instances curtailed—a large proportion having been also rewritten, to suit the altered influences under which husbandry, as an art, is now placed—as, I am persuaded, to make the work more useful to the agriculturist and the student.

The subjects treated of I have arranged under three prominent divisions, with the view of bringing them successively under the notice of the agricultural student. The First Division directs him to avail himself of the experience of some farmer who practises the species of husbandry he desires to acquire; it makes him acquainted with the various sorts of farming practised in this country; and it indicates the peculiar form of the ground, and the locality, which determine the adoption of each of those sorts of farming. He is then warned of the difficulties which he will have to encounter at the outset of his agricultural career, and apprised of the means by which he may overcome these, if he chooses to adopt them. The necessity of a good general education to agriculturists is dwelt on with peculiar earnestness, because every farm-operation clearly indicates its dependence for its right performance on some branch of physical science.

The work, I trust, may be consulted with as much advantage by the country gentleman, unacquainted with practical agriculture, as by the pupil; and I have endeavoured to explain my reasons for thinking so, by pointing out the particular evils which inevitably arise from inacquaintance with rural affairs by the proprietors of the soil. This First portion I have designated Initiation, because it indicates the sort of discipline which the agricultural pupil should voluntarily undergo, before his mind can become fitted to master the details of practical agriculture.

The Second Division explains the details, even to the most minute particular, of every farm-operation, from one end of the year to the other; and as the treatment of each is materially affected by the particular season in which it is undertaken, great care has been taken to treat of each in the manner peculiar to the season in which it is conducted. The seasons having a predominating influence over farm-operations, all the operations are necessarily classed under their respective seasons. The Winter commences the operations of the farm, when most of the preparations for the succeeding busy seasons are made. Upon the foundation laid in Winter, the Spring consigns every variety of seed used in husbandry to the ground, and witnesses the reproduction of every species of live stock. The Summer fosters the growth both of plants and animals. The Autumn reaps the fruits of all the labour that has been bestowed in the preceding seasons. To render the explanations of the operations more particular and explicit throughout the seasons, I have found it necessary, by way of practical example, to assume the working of one of the sorts of farming for twelve months; and have selected that which embraces the greatest variety of particulars—the Mixed Husbandry, which has for its subjects not only the cultivation of the plants raised in the field, but also the breeding, rearing, and fattening of live stock. This part necessarily occupies a large portion of the work, and is appropriately designated Practice.

In the Third Division, the agricultural pupil is regarded no longer as a mere student, but as a young farmer on the look-out for a farm. To assist him in this object, he is made acquainted with the best and worst physical conditions in which a farm can be placed, in the different sorts of farming, as regards variety of ground and locality. He is next shown the manner of judging of land; of computing its rent; of negotiating the covenants of a lease; of stocking the farm which was chosen as an example for his guidance; and of arbitrating on minor subjects with his predecessor before he leaves the farm.

This extent of instruction is quite sufficient for the young farmer in ordinary cases, where the farm is complete, and its farming has been long settled. Where the farm is incomplete, he may further require information on subjects that might never have been presented to his notice in the course of his stay on the educational farm, but which it is incumbent on him to know before he can become a thoroughly good farmer. The farm he is about to enter may require a new steading—the young tenant should become acquainted with plans, specifications, and expenses of buildings. To assist him, I have given these, based upon such principles as are applicable to all sizes of steadings, and all modes of farming. The ground may require enclosure :—he should know the principles upon which fields should be planned for convenience of work, and the method of constructing fences, whether of thorn or of stone. The land may require draining :—he ought to become acquainted with the principles upon which drainage depends, so far as these have been ascertained, and the method of applying them practically. There may be waste land to bring in :—its treatment, whether by trenching with the spade, or trenching and subsoiling after drainage with the plough, should be familiarised to him. The embankment of land against, and irrigating it with water may be requisite in some localities :—he ought to know the best method of effecting both. On all these subjects I have endeavoured to afford the young farmer the best intrinsic information in an easy shape for reference, and not clouded with unnecessary technicalities.

After the treatment of those important and fundamental topics, which have reference alone to the soil, the principles upon which the purity of blood and the symmetrical form of animals are secured and maintained, are then explained. The points of animals which illustrate those principles are fully indicated, and the portraits of some which possessed these in an eminent degree embellish the work. No farmer can understand the position of his affairs without keeping accurate accounts, so that a system of book-keeping must be of service to him, and the simple one I have given possesses the advantage of having been found practically useful. With a few precepts for the guidance of the young farmer, at the outset of life, in his conduct towards his dependents and equals, as well as his superiors, I conclude my task. These, I trust, will be accepted, or at least perused, in the same good spirit with which they are offered; my object being to inculcate that unity of feeling among agriculturists of every class, without which no pursuit can prosper, and which is not only a social but a sacred duty, seeing that our dependence lies with Him who holds the elements in His hands. Because the wishes of the young farmer are realised, more or less, by one and all of these means, I have designated this part REALISATION.

It may be proper for me to state, in a few words, the opportunities I have had of acquiring such an extent of knowledge in the various departments of practical agriculture, and the other subjects enumerated above, as to warrant me in assuming the part of monitor to the agricultural student. The following short narrative, I trust, may be sufficient to satisfy the reasonable inquirer.

After receiving what is commonly called a liberal education at the Parochial and Grammar Schools of Dundee, at the Academy there, under Mr Duncan, the Rector, now Professor of mathematics in St Salvador's College, St Andrews, and at the College of Edinburgh, I boarded myself with Mr George Brown, of Whitsome Hill, a farm in Berwickshire, of about 600 acres, with the view of learning agriculture. Mr Brown was universally esteemed one of the best farmers of that well-farmed county; and so high an opinion did the late Mr Robertson of Ladykirk, the most celebrated breeder of short-horns in Scotland of his day, entertain of his farming, both in stock and crop, that he gave him permission to send his cows to the bulls at Ladykirk—a singular favour which he extended, I believe, to no one else, with the exception of his old tenant and intimate friend, Mr Heriot of Fellowhills. I remained three years at Whitsome Hill, during the first two of which I laboured with my own hands at every species of work which the ploughman, the field-worker, and the shepherd must perform in the field, or the steward and the cattle-man at the steading: and even in the dairy and poultry house part of my time was spent. All this labour I undertook, not of necessity, but voluntarily and with cheerfulness, in the determination of acquiring a thoroughly practical knowledge of my profession. In my third year, when there happened to be no steward, Mr Brown permitted me to manage the farm under his own immediate superintendance.

I then travelled for nearly a twelvemonth, soon after peace was restored, through most of the countries of Europe, and in many places I happened to be the first Briton who had visited them since the outbreak of the Revolutionary war. This excursion gave me considerable insight into the methods of Continental farming.

Shortly after my return home, I took possession of a small farm on

Balmadies in Forfarshire, consisting of 300 acres. It was in such a state of dilapidation as to present an excellent subject for improvement. It had no farm-house—only the remains of a steading; the fields were nine-and-twenty in number, very irregular in shape, and fenced with broken down stone dykes and clumsy layers of boulders and turf; a rivulet every year inundated parts of the best land; the farm-roads were in a wretched condition; and above forty acres of waste land were covered with whins and broom. The heaviest description of soil was hazel loam, some of it deep, some shallow, and all resting on retentive clay; and the lightest kind was gravelly, resting on gravel. The farm contained a remarkable feature, not uncommon, however, in that part of the country—an isolated peat-bog, very deep, containing thick beds of shell marl, and enclosing a small lake, around whose margin grew aquatic plants in the utmost luxuriance. In a few years the farm possessed a mansion-house, offices, and steading, (an isometrical view and ground-plan of the last were figured in Plates I. and II. of the first edition, though enlarged to suit a larger farm;) the surface was laid off in twelve fields of equal size and rectangular shape, to suit the six-course shift with three years' grass; some of those fields were fenced with thorn hedges, and some with stone dykes; the impetuous rivulet, the Vinny, was embanked out; the land upon the retentive bottom was drained in the old mode with stones, but a few acres were tried with furrow-drains filled with small stones, several years before the Deanston plan was made public by the late lamented James Smith; after the draining, the soil was trench-ploughed with four horses; the farm-roads were extended and made serviceable, and all the waste land was brought into cultivation. I made the plans of the buildings myself, and also set off the form of the fields, and the lines of the fences and roads—not because I imagined that a professional man could not have done them better, but that my mind and hands might be familiarised with every variety of labour appertaining to rural affairs. The results each year were twenty-five acres of good turnips, instead of ten or twelve of bad, and fifty stacks of corn in the stackyard, instead of seventeen. The rent offered for the farm before I took possession of it was £150, and after I relinquished farming it was let for nearly £400. The fee-simple arising from this increase of rent represents a sum larger than what was expended in producing those results. I believe I was the first person to introduce into Forfarshire the feeding of cattle in small numbers in hammels, instead of large numbers in large courts; to show the advantage of building troughs around the walls of the courts to hold topped turnips, instead of spreading untopped ones upon the dung; to confine sheep upon turnips in winter with nets instead of hurdles—a plan which the late Mr Andrew Dalgairns of Ingliston readily adopted, at my suggestion, even with Black-faced sheep; and to grow the Swedish turnip in a larger proportion than the other sorts.

It will, I think, be admitted that the farmer who had the opportunities of learning the varieties of rural labour thus particularised, and who has bestowed all the powers of his faculties for years in acquiring them thoroughly, may, without presumption, consider himself sufficiently qualified to impart the results of his experience and observation to agricultural students. It is in the belief that a work of this comprehensive nature, compiled after the author exchanged the actual practice of farming for the onerous duties of conducting a portion of the agricultural press, may not only be of service to the rising generation, but also no small assistance to the numerous farmers who now receive young men into their houses for tuition in agriculture, that these volumes are offered to the public. So long as I was a pupil, no such book was in existence for me to consult, and having therefore personally experienced the inconvenience of being left to acquire what knowledge I could, chiefly by my own industry and perseverance, sympathy for the young pupil, placed in similar circumstances, has prompted me to endeavour to make his path smoother than I found my own.

It will be observed that the work is printed alternately in small and in large type. The information imparted by the large type has been chiefly derived from my own experience and observation; and wherever that has coincided with the dicta of previous writers, I have quoted them, for the double purpose of corroborating what I had to say by the experience of others, and of giving competent authorities, to direct the agricultural pupil to works descriptive of different branches of husbandry. The small type contains descriptions by myself, and quotations from writers of professional eminence, of the other kinds of farming beside the one adopted as the leading example; and also illustrations of each particular operation under discussion, derived from various works and documents, agricultural and scientific. As I had not space to raise discussions on the particular views broached on each subject, I have deemed it sufficient to direct the agricultural student to the sources where he would find the subjects more fully stated and discussed. Most of the illustrative passages alluded to have been derived from the pages of the *Journal of Agriculture*, and the *Transactions of the Highland and Agricultural Society of Scotland*.

I have always believed that a work on practical husbandry loses half its value, unless it be copiously illustrated with figures of the various subjects treated of; because it seems to me as impossible to convey in words every particular connected with any important farm-operation, without the assistance of figures, as to explain by words alone the component parts of a complicated machine. After much reflection, and different preliminary experiments, I arrived at the conclusion that a group of figures would best show the method of executing each principal operation.

Holding the opinion I have just expressed as to the manner in which an agricultural work ought to be illustrated, in order to make it really useful, the first edition of the *Book of the Farm* was necessarily an expensive undertaking. It was unquestionably desirable, and consonant with the wishes both of the author and publishers, that any subsequent edition which might appear should be offered at a lower price. But notwithstanding the rapid sale, the practicability of such a reduction was attended with unforeseen difficulty, because, since the first appearance of the work, agriculture had attracted so much public attention, and so many changes in its practice had been suggested by scientific men, who proffered their aid to the farmer by means of chemistry, and, besides this, so many experiments had been conducted by farmers, in consequence of those suggestions, that the large additions required to record the results obtained would tend rather to increase than to diminish the cost. To have left those results unnoticed, and issued a mere reprint, without commentary on what had taken place, would not only have detracted from the usefulness of the work by rendering it behind its time, but would have justly withdrawn from myself that confidence which many young agriculturists, at home and abroad, had been pleased to place in me, in consequence of their perusal of the first edition. No alternative, then, was left me but to render the work more complete by engrossing as many of the results of those experiments, and explaining so much of the views of the men of science, as seemed to affect particular portions of ordinary practice. The execution of this task, so as to bring it within moderate bounds, was attended with no small difficulty and labour on account of the large mass of materials with which it was necessary to deal.

I soon found that in the chemical branch I should have to confine myself to giving, from the ascertained results, the largest returns from the use of the special manures recommended by chemists, and the analyses of the mineral ingredients contained in the plants that had been examined for that purpose. From theory and science, I have selected the views of the most eminent physical writers as to the action of plants upon ordinary manures in general, and upon special manures in particular; because this subject of manures and their effects is of all others the most important for explaining the phenomena of the rotation of crops, the development of plants, and the fertility of soils; and a subject more interesting or more valuable cannot occupy the attention of the farmer in reference to the cultivation of the soil. Besides these contributions of science, the recent theory of the assimilation of the component parts of the food, by the different functions of the animal economy, has thrown a flood of light on the feeding of stock, and, as a consequence, on the treatment of manure heaps, which no farmer could have discovered by practice alone, and which is yet in all probability destined to effect a great change in the distribution of food to the domesticated animals. Chemistry, in my estimation, has done much more for the farmer in this than in any point relating to the cultivation of the cereal grains. These tasks I have endeavoured to perform, with a view to abate the over-sanguine expectations of the ardent pupil, and remove the reasonable doubts of the experienced farmer; as also to caution both parties against the adoption of many of the conclusions arrived at and promulgated by scientific and non-practical writers, until these shall have been sanctioned by experience. The labour necessary for comprehending these subjects in an abridged form, which is as much as should be expected in an essentially practical work, has occupied more time than I expected, and to that circumstance must be referred the otherwise inexcusable delay in the issue of the concluding part of this work.

To make room for so much additional matter, the work has been printed in a rather smaller type, and the lengthened details of the descriptions of the implements and machines have been omitted. Still it was necessary to retain all the implements, in a completed form, used in mixed husbandry, which has been done by giving their figures engraved on wood instead of retaining the copper-plates, and as much of Mr Slight's description of their general construction and use has been adopted as might enable the agricultural pupil to recognise and appreciate them, wherever he might meet with them, because I could not so well describe them as in Mr Slight's own appropriate words.

Some delineations of machinery, however, will be found not described by him, but specially referred to by myself.

Were I to close these general observations, and omit to mention my obligations to the eminent Publishers, who offered without hesitation to incur the entire responsibility and risk connected with the publication of this work, I would do much violence to my own feelings; and their offer seemed the more generous to me, as it was the more timely, because I am sure that the work would never have been published unless it had been undertaken on those terms. My idea was, that the necessarily high price of the work would render its publication a hazardous undertaking; and, although convinced that such a work was a desideratum in the agricultural literature of this country, I will own that my knowledge of the loss which must be sustained, should the work not receive the public approval, weighed somewhat heavily upon my mind. Fortunately these fears were soon dissipated. The *Book of the Farm* at its first appearance received, and has since uninterruptedly enjoyed, the public favour beyond the expectations both of Author and Publishers.

The groups illustrative of the principal field-operations have been much increased in number. They have been drawn, in the most graphic manner, by Gourlay Steell of Edinburgh, Associate of the Royal Scottish Academy, with a beauty in composition, accuracy of detail, and power of expression, which it would be difficult to excel. The figures of the implements, both those in the former edition and the additional ones in this, have been drawn from the best-constructed machines in the possession of farmers and implement-makers, by George Henry Slight of Abernethy, whose mechanical designs conjoin the correctness of the skilful mechanician with the accuracy in perspective of the experienced draughtsman. His drawings, indeed, are not easily distinguishable from plate engravings.

As, in this country, the attention and interest of the farmer is more engrossed by the rearing of animals than by the cultivation of plants, it was necessary, for illustration, to procure correct portraits of those animals which had attained pre-eminence in the various classes of the domesticated breeds. To have given portraits, however, of the males and females in all their varieties, of every breed reared in this country, would have very much increased the cost of the work; and it was therefore deemed sufficient to confine the selection to good examples from the most esteemed and favourite breeds. The portraits of these animals were painted in oil, partly by the late John Sheriff of Edinburgh, Associate to the Royal Scottish Academy, and partly by Gourlay Steell, the most eminent artist in that line in Scotland. None of them are fancy pictures, got up for artistic effect only, but faithful likenesses of the several individuals, exhibiting the points which characterise their particular breeds; and they were painted in different parts of the country under my own superintendence. I felt myself much indebted to their respective owners, not only for leave to take the likenesses, but also for the accommodation so much required in undertakings of that nature.

Skilful engravers have done justice to the paintings. The name of Thomas Landseer alone would give eclat to any work professing to contain the portraits of the domesticated animals. The numerous and varied subjects engraved on wood were executed by R. E. Branston of London, whose name is a sufficient guarantee for excellence in that graphic and delightful branch of the fine arts. I am persuaded that, by the originality, quality, and number of its illustrations—it may be even to profusion—this work has been rendered the more useful to the agricultural pupil; and, in this respect, I may be allowed to say, without any charge of egotism, that I know no work on practical agriculture, foreign or domestic, that possesses the same advantage, at least in the same degree.

REDBRAE COTTAGE, EDINBURGH,
February 1851.

THE FARMER'S GUIDE

TO

SCIENTIFIC AND PRACTICAL AGRICULTURE.

PART I.—INITIATION.

ON THE BEST OF THE EXISTING METHODS FOR ACQUIRING A THOROUGH KNOWLEDGE OF PRACTICAL HUSBANDRY.

1. No doubt exists, I believe, that the best way, among existing ones, for a young man to acquire a thorough knowledge of farming, is to become a pupil in the house of a good practical farmer. On a fine farm, and with a competent tutor, the pupil will not only live comfortably, but may thoroughly learn any system of husbandry he chooses. The choice of locality is so far limited, that he must take up his residence in a district in which the particular system he has chosen is practised in a superior manner.

2. Many farmers are to be found who accept pupils, amongst whom a proper selection should be made, as it would be injudicious to engage with one who is notoriously deficient in the requisite qualifications — and those qualifications are numerous. A tutor-farmer should possess a general reputation of being a good farmer—that is, a skilful cultivator of land, a successful breeder, and an excellent judge of stock. He should possess agreeable manners, and have the power of communicating his ideas with ease. He should occupy a good farm, consisting, if possible, of a variety of soils, and situate in a tolerably good climate,—neither on the top of a high hill nor on the confines of a large moor or bog, nor in a warm sheltered nook, but in the midst of a well cultivated country. Such circumstances of soil and locality should be requisites in a farm intended for the residence of *pupils*. The top of a hill, exposed to every wind that blows, or the vicinage of a bog overspread with damp vapour, would place the farm in a climate in which no kind of crop or stock could arrive at a state of perfection; while a very sheltered spot and a warm situation, would give the pupil no idea of the disappointments experienced in a precarious climate.

3. The inexperience of the pupil renders him unfit to select these requisites for himself in either a qualified farmer or a suitable farm: but monitors are never awanting to render assistance to their young friends in every emergency; and as their opinion should be formed on a knowledge of farming, and especially on an acquaintance with the farm, and the personal qualifications of the farmer they recommend, some confidence may be placed in their recommendations. For the pupil's personal comfort, I would advise him to choose a residence where are *no young* children.

4. A residence of one year must pass ere the pupil can witness the course of the annual operations of the farm. His first engagement should, therefore, be made for a period of *not less* than one year; and at the expiry of that period he will not be qualified to manage a farm. The time he

would require to spend on a farm must be determined by the competency of the knowledge acquired of his profession.

5. The pupil may enter on his pupilage at any time of the year; but since farming operations have a regular period for beginning and ending every year, it is evident that the *most* proper time to *begin* to view them is at the *opening of the agricultural year*—that is, *in the beginning of winter.* It may be incongenial to his feelings who has been accustomed to pass the winter in town, even to contemplate, and far more to participate, for the first time, in the labours of a farm on the eve of winter. He would naturally prefer the sunny days of summer. But the commencement of winter being the time at which all the great operations are *begun*, it is requisite to their being understood to *see them begun;* and to endeavour to become acquainted with complicated operations after the *principal arrangements* for their prosecution have been formed, is purposely to invite wrong impressions of them.

6. There is really nothing disagreeable to personal comfort in the business of a farm in winter. On the contrary, it is full of interest, inasmuch as the welfare of living animals is presented to the attention more forcibly than the cultivation of the soil. The well-marked individual characters of different animals engage the sympathy; and the more so, that animals seem more domesticated under confinement than when at liberty to roam in quest of food and shelter. In the evening, in winter, the hospitality of the social board awaits the pupil at home, after the labours of the day are over. Neighbours interchange visits in that social season, when topics of conversation common to society are varied by remarks on professional management, elicited by modified practice, and from which the attentive pupil may derive much useful information. Should society present no charms, the quieter companionship of books, or the severer task of study, is at his command. In a short time, however, the various objects peculiar to the season of winter cannot fail to interest him.

7. The first thing the pupil should become well acquainted with is the *physical geography* of the farm,—that is, its position, exposure, extent;—its fences, whether of wall or hedge;—its shelter, in relation to rising grounds and plantations;—its roads, public or private, whether conveniently directed to the different fields, or otherwise;—its fields, their number, names, sizes, relative positions, and supply of water;—the position of the farm-house and farm-offices. Familiar acquaintance with all these particulars will enable him to understand more readily the orders given by the farmer for the work to be performed in any field. It is like possessing a map of the ground on which certain operations are about to be undertaken. A plan of the farm would much facilitate its familiar acquaintance. The *tutor*-farmer should be provided with such a plan to give to each of his pupils; but if he has none, the pupil can construct one for himself, which will answer the purpose.

8. The usual fee for pupils is about £120 per annum for bed, board, and washing, with the use of a horse to occasional markets and shows. If the pupil desire a horse of his own, about £30 a-year more are demanded. On these moderate terms pupils are very comfortably situated.

9. I think it bad policy to allow the pupil a horse of his own at first. Constant attention to field-labour is not unattended with irksomeness, while exercise on horseback is a tempting recreation to young minds. The desire to possess a horse of one's own is so very natural in a young person living in the country, that, were the pupil's inclinations alone consulted, the horse would soon be in his possession; and when the choice is given to an indifferent pupil, he will certainly prefer pleasure to duty. The risk is, that the indulgence will confirm a habit that will lead him astray from attending to his business; such as following the hounds, forming acquaintances at a distance from home, and loitering about towns on market-days,—and the evil of this roving life is its being an easy introduction to one of dissipation and extravagance. This consideration should have its weight with parents and guardians, when they accede to the request of the pupil for the luxury of a horse, on placing him under the roof of a farmer. It is enough for a young man to feel a release from parental restraint,

without having the dangerous incentive of an idle life placed at his disposal. They should consider that upon young men arrived at the years when they become farming pupils, it is not in the power, and is certainly not the inclination, of the tutor-farmer to impose ungracious restraints. It is the duty of their parents and guardians to impose these; and the most effectual way I know of, in the circumstances, to avoid temptations, is the denial of a riding-horse. Attention to business in the first year will, most probably, excite a desire to pursue it with pleasure in the second, and then the indulgence of a horse may be granted to the pupil with impunity, as the reward of diligence. Until then, the conveyance occasionally afforded by the farmer to attend particular markets, or pay friendly visits to neighbours, should suffice; and then it is quite in the farmer's power to curb in his pupils any propensity to wander abroad too frequently, and thereby to support his own character as an exemplary tutor. Such precautions are, of course, only necessary against pupils who show lukewarmness in acquiring their profession. The diligent pupil, who desires to learn his profession in as short a time as practicable, will daily discover new sources of enjoyment at home, far more exhilarating, both to body and mind, than in jogging along the dirty or dusty highways, until the jaded brute he bestrides is ready to sink under its burden.

10. The pupil should provide himself with an ample stock of stout clothing and shoes, capable of repelling cold and rain, and so made as to answer at once for walking and riding.

11. Three years, in my opinion, are requisite to give a pupil an adequate knowledge of farming,—such as would impress him with the confidence of being able to manage a farm; and no young man should undertake its management until he feels sufficient confidence in himself. Three years may be considered as too long time to spend in learning *farming*; but it is much less time than is given to many other professions, whose period of apprenticeship extends to five or seven years; and however highly esteemed those professions may be, none should excite a deeper interest, in a national point of view, than that of agriculture. There is one condition attendant on the art of farming, which is common to it and gardening, but inapplicable to most other arts,—that a year must elapse before the same work is again performed. This circumstance, of itself, will cause the pupil to spend a year in merely observing current operations. This is the first year. As the operations of farming are all anticipatory, the second year will be fully employed in studying the progress of work in preparation of anticipated results. In the third year, when his mind has been stored with every mode of doing work, and the purposes for which it is performed, the pupil may put his knowledge into practice, under the correcting guidance of his tutor. Whatever may be the ability of the pupil to acquire farming, *time* must thus necessarily elapse before he can have the opportunity of again witnessing a bygone operation. No doubt, by natural capacity he might acquire in two years the art to manage a farm; but, the whole operations necessarily occupying a year in their performance, he is prevented acquiring the art in less time than three.

ON THE DIFFICULTIES THE PUPIL HAS TO ENCOUNTER IN LEARNING PRACTICAL HUSBANDRY, AND ON THE MEANS OF OVERCOMING THEM.

12. The pupil, if left to his own guidance, when beginning to learn his profession, would encounter many perplexing difficulties. The difficulty which at first most prominently obtrudes itself on his notice, consists in the *distribution* of the labour of the farm; and it presents itself, in this way:—He observes the teams employed one day in one field, at one kind of work; and perhaps the next day in another field at another work. He observes the persons employed as field-workers assisting the teams one day; and in the next perhaps working by themselves in another field, or elsewhere. He observes those changes with attention, considers their utility, but cannot discover the reasons for making so varied arrangements—not because he entertains the least doubt of their propriety, but, being as yet uninitiated in the art of farming, he cannot foresee the purpose for which those labours

are performed. The reason why he cannot at once foresee this is, that in all cases, excepting the finishing operations, the object of the work is unattained at the time of his observation.

13. The next difficulty the pupil encounters is in the *variety* of the labours performed. He not only sees arrangements made to execute the same sort, but various kinds of work. He discovers this difference on examining more closely into the nature of the work he sees performing. He observes one day the horses at work in the plough in one field, moving in a direction quite opposite, in regard to the ridges, to what they were in the plough in another field. On another day he observes the horses at work with quite a different implement from the plough. The field-workers, he perceives, have laid aside the implement with which they were working, and are performing the labour engaged in with the hand. He cannot comprehend why one sort of work should be prosecuted one day, and quite a different sort the next. This difficulty is inexplicable for the same reason as the former—because he cannot foresee the object for which those varieties of work are performed. No doubt he is aware that every kind and variety of work performed on a farm are preparatives to the attainment of certain crops; but what portion of any work is intended as a certain part of the preparation of a particular crop, is a knowledge which he cannot acquire by intuition. Every preparatory work is thus perplexing to a pupil

14. Field-work being thus chiefly *anticipatory*, is the circumstance which renders its object so perplexing to the learner. It is in the exercise of the faculty of anticipation that the experienced and careful farmer is contradistinguished from the ignorant and careless. Indeed, let the experience of farming be ever so extensive —or, in other words, let the knowledge of minutiæ be ever so intimate—unless the farmer guide his experience by foresight, he will never be enabled to conduct a farm aright. Both foresight and experience are acquired by observation, and though observation is open to all farmers, all do not profit by it. Every farmer may acquire, in time, sufficient *experience* to conduct a farm in a passable manner; but many farmers never acquire *foresight*, because they never reflect, and therefore never derive the greatest advantage from their experience. Conducting a farm by foresight is thus a higher acquirement than the most intimate knowledge of the minutiæ of labour. Nevertheless, as the elements of every art must first be acquired by observation, a knowledge of the minutiæ of labour should be first acquired by the pupil; and, by carefully tracing the connexion between combined operations and their ultimate ends, he will acquire foresight.

15. The necessity of possessing foresight in arranging the minutiæ of labour, before the pupil can with confidence undertake the direction of a farm, renders *farming* more difficult of acquirement, and a longer time of being acquired, than most other arts. This statement may seem incredible to those who are accustomed to hear of farming being easily and soon learned by the meanest capacity. No doubt it may be acquired in time, to a certain degree, by all who are capable of improvement by observation and experience; but, nevertheless, the ultimate ends for which the various kinds of field-work are prosecuted are involved in obscurity to every learner. In most other arts, no great time usually elapses between the commencement and completion of a piece of work, and every piece of work is continued in hand until finished. The beginner can thus soon perceive the connexion between the minutest portion of the work in which he is engaged, and the object for which the work is prosecuted. He is thus led, by degrees, from the simplest to the most complicated parts of his art, so that his mind is not bewildered at the outset by observing a multiplicity of operations at one time. He thus begins to acquire true experience, and even foresight, if he reflects, from the outset.

16. The pupil-farmer has no such advantages in his apprenticeship. There is no simple easy work, or one object only to engage his attention at first. On the contrary, many minutiæ connected with different operations in progress claim his attention at one and the same time, and if the requisite attention to any one of them be neglected for the time, no opportunity for observing it occurs for a twelvemonth.

It is a misfortune to a pupil, in such circumstances, to be retarded in his progress by a trifling neglect; for he cannot make up his leeway until after the revolution of a year; and though ever so attentive, he cannot possibly learn to anticipate operations in a shorter time, and therefore cannot possibly understand the object of a single operation in the first year of his pupilage. The first year is spent almost unprofitably, and certainly unsatisfactorily to an inquisitive mind. But attentive observation during the first year in storing up facts, will enable him, in the second, to anticipate the successive operations ere they arrive, and identify every minutia of labour as it is performed.

17. Let it not be supposed by those who have never passed through the perplexing ordeals incident to the first year of farming, that I have described them in too strong colours, in order to induce to the belief that farming is an art more difficult of attainment than it really is. So far is this from being the case, I may safely appeal to the experience of every person who had attained manhood before beginning to learn farming, whether I have not truly depicted his own condition at the outset of his professional career; so that every pupil must expect to meet with those difficulties.

18. But, formidable as they may seem, I encourage him with the assurance, that it is in his power to overcome them all. The most satisfactory way of overcoming them is to resolve to learn his business in a truly practical manner—that is, by attending to *every* operation *personally*. Merely being domiciled on a farm is not, of itself, a sufficient means of overcoming them; for the advantages of residence may be squandered away in idleness, by frequent absence, by spending the busy hours of work in the house on light reading, or by casual and capricious attendance on field operations. Such habits must be eschewed, before there can arise a true desire to become a *practical* farmer.

19. *Much* assistance in promoting attention should not be *expected* from the farmer. No doubt it is his *duty* to communicate all he knows to his pupils, and I believe most are willing to do so; but as efficient tuition implies constant attendance on work, the farmer himself cannot constantly attend to every operation, or even explain any, unless his attention is directed to it; and much less will he deliver extempore lectures at appointed times. Reservedness in him does not necessarily imply *unwillingness* to communicate his skill; because, being himself familiar with every operation that can arrest the attention of his pupils, any explanation by him of minutiæ at any other time than when the work is in the act of being performed, and when only it could be *understood* by them, would only serve to render the subject more perplexing. In these circumstances, the best plan for the pupil to follow is to *attend constantly* and *personally observe* every change that takes place in every piece of work. Should the farmer happen to be present, and be appealed to, he will, as a matter of course, immediately remove every difficulty in the most satisfactory way; but should he be absent, being otherwise engaged, then the steward, or ploughmen, or shepherd, as the nature of the work may be, will afford as much information on the spot as will serve to enlighten his mind until he associates with the farmer at the fireside.

20. To be enabled to discover that particular point in every operation, which, when explained, renders the whole intelligible, the pupil should put his hand to every kind of work, be it easy or difficult, irksome or pleasant. Experience acquired by himself, however slightly affecting the mind,—if desirous of becoming acquainted with every professional incident,—will solve difficulties much more *satisfactorily* than the most elaborate explanations given by others; and the larger the stock of personal experience he can accumulate, the sooner will the pupil understand the purport of every thing that occurs in his sight. Daily opportunities occur on a farm for joining in work, and acquiring such experience. For example, when the ploughs are employed, the pupil should walk from the one to the other, and observe which ploughman or pair of horses perform the work with the greatest apparent difficulty or ease. He should also mark the different styles of work executed by each plough. A considerate comparison of particulars will enable him to ascertain the

best and worst specimens of work. He should then endeavour to discover the cause why different styles of work are produced by apparently similar means, in order to rectify the worst and practise the best. The surest way of detecting error, and discovering the best method, is to take hold of each plough successively, and he will find in the endeavour to maintain each in a steady position, and perform the work evenly, that all require *considerable* labour —every muscle being awakened into energetic action, and the brow most probably moistened. As these symptoms of fatigue subside with repetitions of the exercise, he will eventually find one of the ploughs more easily guided than the rest. The reasons for this difference he must endeavour to discover by comparison, for its holder cannot inform him, as he professes to have, indeed can have, no knowledge of any other plough but his own. In prosecuting this system of comparative trials with the ploughs, he will find himself becoming a ploughman, as the difficulties of the art divulge themselves to his apprehension; but the reason why the plough of one of the men moves more easily, does better work, and oppresses the horses less than the rest, is not so obvious; for the land is in the same state to them all—there cannot be much difference in the strength of the pairs of horses, as each pair are generally pretty well matched—and in all probability the construction of the ploughs is the same, if they have been made by the same plough-wright. The inevitable conclusion is, that one ploughman understands his business better than the others. He shows this by trimming the irons of his plough to the state of the land, and the nature of the work he is about to begin, and by guiding his horses in accordance with their natural temperament. Having the shrewdness to acquire these accomplishments in a superior degree, the execution of superior work is an easier task to him than inferior work to the other ploughmen. The case I have thus selected for an example, is not altogether a suppositious one.

21. Having advanced thus far in the knowledge, practice, and capability of judging of work, the pupil begins to feel the importance of his acquisition, which fans the flame of his enthusiasm, and prompts him to greater acquirements. But even in regard to the plough, the pupil has much to learn. Though he has selected the best ploughman, and knows why he is so, he is himself still ignorant of how to trim a plough practically, and to drive the horses with judgment. The ploughman will be able to afford him ocular proof *how* he *tempers* all the irons of the plough to the state of the land, and *why* he yokes and drives the horses as he does in preference to any other plan. Illiterate and unmechanical as he is, and his language full of *technicalities*, his explanations will nevertheless give the pupil a clearer insight into the *minutiæ* of ploughing, than he could acquire by himself as a spectator in an indefinite length of time.

22. I have selected the plough, as being the most useful implement to illustrate the method which the pupil should follow, in all cases, to learn a *practical* knowledge of every operation in farming. In like manner, he may become acquainted with the particular mode of managing all the larger implements, which require the combined agency of man and horse to put into action; as well as become accustomed to use the simpler implements adapted to the hand, easily and ambidextrously—a large proportion of farm work being executed with simple tools. Frequent *personal* attendance at the farm-stead, during the winter months, to feed the corn in the sheaf into the thrashing-machine, and afterwards to work the winnowing-machine, in cleaning the thrashed grain for the market, will be amply repaid by the acquisition of the knowledge of the quality and value of the cereal and leguminous grains. There is no better method of acquiring knowledge of *all* the minor operations of the farm, than to superintend the labours of the field-workers, their work being methodical, almost always in requisition, and mostly consisting of minutiæ; and its general utility is shown, not only in its intrinsic worth, but in relation to the work performed by the teams.

23. The general introduction of sowing-machines, particularly those which sow broadcast, has nearly superseded the beautiful art of sowing corn by the hand. Still corn is sown by the hand, especially on small farms, on which large and expensive

machines are not found. In the art of hand-sowing, the pupil should excel; for, being difficult to perform in an easy and neat manner, its superior execution is regarded as an accomplishment, and in contributing to a manly and healthful exercise, establishes a robust frame and sound constitution.

24. The feeding of cattle in the farmstead, or of sheep in the fields, does not admit of much participation of labour with the cattleman or shepherd; but either practice forms an interesting subject of study to the pupil, and without strict attention to both he will never acquire a knowledge of fattening and computing the value of live stock.

25. By steadily pursuing tne course of observation I have indicated, and particularly in the first year, the pupil will soon acquire a *considerable* knowledge of the minutiæ of labour; and it is only in this way that the groundwork of a familiar acquaintance with them can be laid, and which requires years of experience. Indeed, observant farmers are learning new, or modifications of old, practices every day, and such new occurrences serve to sustain a regard for the most trivial incident that happens on a farm.

26. In urging upon the pupil the *necessity* of putting his hand to every kind of labour, I do not intend to say he should become a first-rate workman; for to become so would require a much longer time than he has in a period of pupilage. His acquaintance with every implement and operation should enable him to decide quickly, whether work is well or ill executed, and in a reasonable time. No doubt a knowledge of this kind may be acquired, *in time*, without the actual labour of the hands; but as it is the interest of the pupil to learn his profession in the shortest time, and in the best manner, and as that can be acquired sooner by the joint co-operation of the head and hands than by either member singly, it would seem an imperative duty on him to acquire his profession by labour.

27. Other considerations as regards the acquisition of practical knowledge deserve attention from the pupil. It is most conducive to his interest to learn his profession in youth, before the meridian of life has arrived, when labour of every kind becomes irksome. It is also much better to have a *thorough* knowledge of farming *before* engaging in it, than to acquire it in the course of a lease, when losses may be incurred by the commission of comparatively trivial errors at the early period of its tenure, when farms in all cases are most difficult to conduct. It is an undeniable fact, that the work of a farm never proceeds *so* smoothly and satisfactorily to all parties engaged in it, as when the farmer is thoroughly conversant with his business. His orders are then implicitly obeyed, not because pronounced more authoritatively, but because a skilful master's plans and directions inspire such a degree of confidence in the labourers as to be regarded as the best in the circumstances. Shame is acutely felt by servants on being detected in error, whether of the head or heart, by the discriminating judgment of a skilful master; and a rebuke from him irresistibly implies ignorance or negligence in those who receive it. The fear of ignorance or idleness being imputed to them, by a farmer acquainted with the capabilities of work-people by his own experience, and who can estimate their services as they deserve, powerfully urges labourers to perform a fair day's work in a workmanlike style.

28. Let the converse of this state of things be imagined; let the losses to which the ignorant farmer is a daily prey, by many ways—by the hypocrisy, negligence, idleness, and dishonesty of servants—be calculated, and it must be admitted that it is much safer for a farmer to trust to his own skill than to depend on that of his servants. No doubt a trustworthy steward may be found to manage for him; but, in such a position, the steward himself is in a state of temptation, in which he should never be placed; and as the inferior servants never regard him as a master, where the master himself is resident, his orders are never so punctually obeyed. I would, therefore, advise every young farmer to acquire a *competent* knowledge of his profession before undertaking to conduct a farm. I only say a competent knowledge; for the gift to excel is not imparted to all who select farming as their profession.

29. Experience will undoubtedly dissipate doubt, and remove perplexity; but though a sure and a safe, it is a slow teacher. A whole year, as I have already observed, must revolve ere the entire labours of a farm are completed in the field, and the pupil understand what he is about; and a whole year is too long time for him to be kept in a state of uncertainty. Could the pupil find a *monitor* to explain to him, during the first year of his pupilage, the purpose for which every operation is performed,—fortell him the results which every operation is intended to produce,—and indicate the relative progress which all the operations should make, from time to time, towards the attainment of their various ends, he would acquire far more professional information, and have greater confidence in its accuracy, than he could obtain for himself in that perplexing period of his novitiate. Such a monitor would certainly best be an experienced and intelligent farmer, were his whole time devoted to his pupil. A farmer, however, cannot bestow as much attention at all times as would be desired by a pupil; and lapses of time are occasioned by necessary engagements, which oblige the farmer to leave home; and thus inattention and absence combined constitute sad interruptions to tuition.

30. But a *book* might be made an efficient assistant-monitor. If expressly written for the purpose, it might not only corroborate what the farmer inculcated, but serve as a substitute in his temporary absence. In this way the tuition of the pupil might proceed uninterruptedly. The usual deprecations against the acquirement of practical farming from books, would not apply to such a one. I would give no such counsel to any pupil. Books on farming, to be really serviceable to the learner, ought not to constitute his sole study: the field being the best place for perceiving the fitness of labour to the purposes it is designed to attain, the book should only present itself as a monitor for indicating the best modes of farming, and showing the way of learning those modes most easily. *By it the practice of experienced farmers might be communicated to the pupil. By consulting that which had been purposely written for his guidance, while carefully observing the import of daily operations,—which are often intricate, always protracted over considerable portions of time, and necessarily separated from each other,—he would acquire that import in a much shorter time than if left to be discovered by his own sagacity.*

31. Such a book would be useful to every class of pupils—to him who, having finished his scholastic and academical education, directs his attention, for the first time, to the acquirement of practical farming; or who, though born on a farm, having spent the greater part of his life at school, determines, at length, on following his father's profession. For the latter class of pupils, tuition in farming, and information from books, are as requisite as for the former. Those, on the other hand, who have constantly resided on a farm from infancy, can never be said to have been pupils, as, by the time they are fit to act for themselves, they are proficients in farming. Having myself, for a time, been placed precisely in the position of the first description of pupils, I can bear sincere testimony to the truth of the difficulties to be encountered in the first year of pupilage. I felt that a guide-book would have been an invaluable monitor to me, but none such existed at the time. No doubt the farmer ought to possess the ability to instruct every pupil he receives under his charge. This is his bounden duty, which, if rightly performed, no guide-book would be required; but very few farmers undertake the onerous task of instruction. Practical farming they leave the pupils to acquire for themselves in the fields,—theoretical knowledge, very few, if any, are competent to impart. The pupils, being thus very much left to their own industry, can scarcely avoid being beset with difficulties, and losing much time. It must be acknowledged, however, that the practice gained by slow experience is, in the end, the most valuable and enduring. Still a book, expressly written to suit the circumstances of his case, might be a valuable instructor to the pupil, in imparting sound professional information.

32. Such a book, to be a useful instructor and correct guide, should, in my estimation, possess these qualifications. Its principal matter should consist of a clear narrative of all the labours of the farm as they occur in succession, including the reasons why each piece of work is undertaken. While

the principal operations are thus being narrated, the precise method of executing every kind of work, whether manual or implemental, should be minutely described. Such a narrative will show the pupil, that farming is really a systematic business, having a definite object in view, and possessing the means of attaining it; and the reasons for performing every piece of work in one way, rather than another, will convince him that it is an art founded on rational and known principles. By the perusal of such a narrative, with its reasons having a common object, will impart a more comprehensive and clear view of the management of a farm in a given time, than he could acquire by himself by witnessing ever so many isolated operations. The influence of the seasons on all the labours of the field is another consideration which should be attended to in such a book. In preparing the ground, and during the growth of the crops, the labour appropriated to each kind of crop terminates for a time, and is not resumed until a fit season arrives. These periodical cessations from labour form natural epochs in the progress of the crops towards maturity, and afford convenient opportunities for performing the work peculiarly adapted to each epoch; and, since every operation must conform with its season, these epochs correspond exactly with the *natural* seasons of the year. I say with the *natural* seasons, in contradistinction to the common annual seasons, which are entirely conventional. Such a necessary and opportune agreement between labour and the natural seasons, induces a corresponding division of labour into *four* great *seasons*, bearing the same names as the annual seasons. Each operation should therefore be described with particular reference to its appropriate season.

33. If, by a course of tuition from such a book, the pupil could be brought to anticipate results whilst watching the progress of passing operations, his pupilage might be shortened by one year; that is, could a *book* enable him to acquire the experience of the second year in the course of the first, a year of probationary trial would be saved him, and he would then learn in two years what at present requires three; and it shall be my endeavour to make *The Farmer's Guide* accomplish this.

ON THE DIFFERENT KINDS OF FARMING, AND ON SELECTING THE BEST.

34. Perhaps the pupil will be astonished to learn that there are many systems of farming, and that they all possess distinctive characteristics. There are no fewer than *six* kinds practised in Scotland, which though practised with some particulars common to all, and each is perhaps best adapted to the soil and situation in which it is practised; yet it is probable that one kind might apply, and be profitably followed, in all places of nearly similar soil and locality. Locality has apparently determined the kind of farming fully more than the soil, though the soil has no doubt determined it in peculiar situations. The comparative influence of locality and soil in determining the kind of farming will best be understood after shortly considering each kind.

35. One kind is wholly confined to *pastoral* districts, which are chiefly situated in the Highlands and Western Isles of Scotland,—in the Cheviot and Cumberland hills of England,—and very generally in Wales. In all these districts, farming is almost confined to the breeding of cattle and sheep; and, as natural pasture and hay form the principal food of live-stock in a pastoral country, very little arable culture is there practised for their behoof. Cattle and sheep are not always reared on the same farm. Cattle are reared in very large numbers in the Western Isles, and in the *pastoral valleys* among the mountain-ranges of England, Wales, and Scotland. Sheep are reared in still greater numbers in the *upper parts* of the mountain-ranges of Wales and of the Highlands of Scotland, and on the green round-backed mountains of the south of Scotland and the north of England. The cattle reared in pastoral districts are small-sized, chiefly black coloured, and horned. Those in the Western Isles, called "West Highlanders," or "Kyloes," are esteemed a beautifully symmetrical and valuable breed. Those in the valleys of the Highland mountains, called "North Highlanders," are considerably inferior in quality, and smaller in size. The Black-faced, mountain, or heath, horned sheep, are also bred and reared on these upper mountain-ranges, and fattened in the low country. The round-backed green

hills of the south are mostly stocked with the white-faced, hornless, Cheviot breed; though the best kind of the Black-faced is also reared in the same locality, but both breeds are seldom reared on the same farm. Thus cattle, sheep, and wool, are the staple products of pastoral farming.

36. *Pastoral farms* are chiefly appropriated to the rearing of one kind of sheep, or one kind of cattle; though both classes of stock are reared where valleys and mountain-tops meet on the same farm. The arable culture practised on them is confined to the raising of provisions for the support of the shepherds and cattle-herds, and of a few turnips, for the support of the stock during the severest weather in winter; but the principal winter food of the stock is hay, which is obtained by enclosing and mowing pieces of natural grass on spots of good land, which are generally found on the banks of a rivulet. All pastoral farms are large, some containing many thousands of acres.—nay, miles in extent; but from 1500 to 3000 acres is perhaps an ordinary size. Locality entirely determines this kind of farming.

37. The *stocking* of a pastoral farm consists of a breeding or flying stock of sheep, or a breeding stock of cattle, and a proportion of barren stock are reared, which, sold at a proper age, are fattened in the low country. A large capital is thus required to stock at first, and afterwards maintain, such a farm; for, although the quality of the land may support few heads of stock per acre, yet, as the farms are large, the number required to stock them is very considerable. The rent, when consisting of a fixed sum of money, would be of small amount per acre, but its amount must of course be fixed by the number of stock the land will maintain, and it is not unfrequently calculated at so much per head the land is expected to maintain.

38. A *pastoral farmer* should be well acquainted with the rearing and management of cattle or sheep, whichever his farm is best suited for. A knowledge of general field culture is of little use to him, though he should know how to raise turnips and make hay.

39. Another kind of farming is practised on *carse* land. A carse is a district of country consisting of deep horizontal depositions of alluvial or diluvial clay, on one or both sides of a considerable river, and generally comprehends a large tract of country. In almost all respects, a carse is quite the opposite to a pastoral district. Carse land implies a flat, rich, clay soil, capable of raising all sorts of grain to great perfection, and unsuited to the cultivation of the pasture grasses, and, of course, to the rearing of live-stock. A pastoral district, on the other hand, is always hilly, the soil generally thin, poor, various, and commonly of a light texture, much more suited to the growth of natural pasture grasses than of grain, and, of course, to the rearing of live-stock. Soil entirely decides carse farming.

40. Being all arable, a *carse farm* is mostly stocked with animals and implements of labour; and these, with seed-corn for the large proportion of the land under the plough, require a considerable outlay of capital. Carse land always maintains a high rent per acre, whether consisting solely of money or of money and corn valued at the fiars prices. A carse farm, requiring a large capital and much labour, is never of great extent, seldom exceeding 200 acres.

41. A *carse farmer* requires to be well acquainted with the cultivation of grain, and almost nothing else, as he can rear no live-stock; and all he requires of them are a few cows, to supply milk to his own household and farm-servants, and a number of cattle in the straw-yard in winter, to trample down the large quantity of straw into manure, and they are purchased when wanted. There are no sheep.

42. A third sort of farming is what is practised *in the neighbourhood of large towns*. In the immediate vicinity of London, farms are appropriated to the growth of garden vegetables for Covent-Garden market, and, of course, such culture can have nothing in common with either pastoral or carse farms. In the neighbourhood of most towns, garden vegetables, with the exception of potatoes, are not so much cultivated as green crops, such as turnips and grass, and dry fodder, such as straw and hay, for the use of cowfeeders and stable-keepers. In this kind of farm-

ing all the produce is disposed of, and manure received in return; and it constitutes a retail trade, in which articles are bought and sold in small quantities, mostly for ready money. When the town is not large enough to consume all the disposable produce, the farmer purchases cattle and sheep to eat the turnips and trample the straw into manure, in winter. Any pasture grass is mostly in paddocks for the accommodation of stock sent to the weekly market. Locality entirely decides this kind of farming.

43. The chief qualification of an *occupant of this kind of farm*, is a thorough acquaintance with the raising of green crops,—potatoes, clover, and turnips; and his particular study is raising the most prolific varieties, to have large quantities to dispose of, and most suitable to the wants of his customers.

44. The *capital required for a farm of this kind*, which is all arable, is as large as that for a carse one. The rent is always high per acre, and the extent of land not large, seldom exceeding 300 acres.

45. A fourth kind of farming is the *dairy*. It directs its attention to the making of butter and cheese, and the sale of milk, and the farms are laid out for this express purpose; but the sale of milk is frequently conjoined with the raising of green crops, in the neighbourhood of large towns, as in the preceding class of farms, (42,) and the cows are fed on cut grass in summer, and on boiled turnips and hay in winter. A true dairy-farm requires *old pasture*. Its chief business is the management of cows, and their produce; and whatever arable culture is practised, is made subservient to the maintenance and comfort of the dairy stock. The milk, where practicable, is sold; where beyond the reach of sale, it is partly churned into butter, which is sold either fresh or salted, and partly made into cheese, either sweet or skimmed. Stock are *reared* on dairy-farms only to a small extent, such as a few quey (heifer) calves, yearly to replenish the cow stock; no aged stock are fattened in winter, as on farms in the vicinity of towns; and the bull calves are frequently fed for veal, or sold to be reared. The principal stock reared are pigs, which are fattened on dairy refuse. Young horses are also successfully reared. Horse labour being comparatively little required—mares can rear their young, and work at the same time, while old pasture, spare milk, and whey, afford great facilities for nourishing young horses in a superior manner. Locality has established this kind of farming on the large scale, and large districts, both in England and Scotland, have long been appropriated to it.

46. The purchase of *cows* is the principal expense of *stocking* a *dairy-farm;* and as the purchase of live-stock in every state, especially breeding-stock, is always expensive, and cows are liable to many casualties, a dairy-farm requires a considerable capital. It is, however, seldom of large extent, seldom exceeding 150 acres. The arable portion of the farm, supplying the green crop for winter food and litter, does not incur much outlay, as hay—obtained chiefly from old grass—forms the principal food of the cows in winter. The rent of dairy-farms is high.

47. A *dairy-farmer* should be well acquainted with the properties and management of milk cows, the making of butter and cheese, the feeding of veal and pork, and the rearing of horses; and he should also possess as much knowledge of arable culture as to raise green crops and make good hay.

48. A fifth method of farming is that which is practised in *most arable districts*, consisting of every kind of soil not strictly carse land. This method consists of a regular system of cultivating grains and sown grasses, with partial rearing and purchasing, or wholly purchasing of cattle. No sheep are reared in this system, being purchased in autumn, to be fed on turnips in winter, and sold fat in spring. This system may be said to *combine the professions of the farmer, the cattle-dealer, and the sheep-dealer*.

49. A decided improvement on this system long ago originated, and has since been practised, in the counties of Berwick and Roxburgh, in Scotland; and of Northumberland in England. The farmer of this improved system combines all the

qualifications of the various kinds of farming enumerated. Rearing cattle and sheep, and having wool to dispose of, he is a stock-farmer. Cultivating grains and the sown grasses, he possesses the knowledge of the carse farmer. Converting milk into butter and cheese, after the calves are weaned, he passes the autumnal months as a dairy farmer. Feeding cattle and sheep in winter on turnips, he attends the markets of fat-stock as well the ordinary farmer in arable districts; and breeding and rearing *all* his stock, he avoids the precarious trade of the dealer in stock. Thus combining all the kinds of farming within the limits of his farm, he supplies the particular demand of each market, and thereby enlarges the sphere of his profits, which are every year more uniform and certain than any of his co-farmers.

50. This is called the *mixed husbandry*, because it embraces all the sorts of farming practised in the country. It is prosecuted in a different manner from that in localities where a particular branch is pursued as the only system of farming; because each branch must be conducted so as to contribute to the welfare of the rest, and in upholding a mutual dependence of parts, a harmonious whole is produced. Such a multiplicity of objects demand more than ordinary attention and skill. Doubtless the farmers of the other modes of farming are skilful in the practice of the locality in which they are placed, but the more varied practice of the mixed husbandry incites versatility of talent and quickness of judgment; and, accordingly, it has made its farmers the most skilful and intelligent in the country.

51. The Border counties are not only the most highly cultivated portion of the kingdom, but contain the most valuable breeds of live-stock; and as the mixed husbandry cannot be conducted within narrow limits, the *farms* are large, not less than 500 acres in extent. The capital required to furnish the live-stock and the means of arable culture is considerable, though perhaps less than for the last-named system, (48,) in which the entire stock are purchased and sold every year; and hence they are termed a *flying*-stock. The rents of both systems are about the same. Neither is determined by any peculiarity of soil and locality, like the other methods, but the *mixed* has a happy form of constitution in adapting itself to most circumstances.

52. Now, one of these systems the pupil must adopt for his profession; and which he should choose, depends on circumstances. If he succeed to a family inheritance, the kind of farming he will follow will depend on that pursued by his predecessor, which he will learn accordingly; but should he be free to choose for himself, I would advise him to adopt the mixed husbandry, as containing within itself all the varieties of farming requisite for a farmer to know.

53. My reason for recommending the mixed husbandry is that it practically possesses advantages over every other. Thus: In pastoral farming, the stock undergo minute examination, for certain purposes, only at distantly stated periods; and owing to the wide space over which they have to roam for food, comparatively little attention is bestowed on them by shepherds and cattle-herds. The pastoral farmer has thus no particular object to attract his attention at home between those long intervals; and in the mean while time is apt to become irksome in cultivating a limited space of arable land.—The carse farmer, after the spring work is finished, before the cows begin to calve, has nothing but hay-making and bare-fallowing in summer, to occupy his mind until the harvest.—Dairy-farming affords little occupation to the farmer.—The farmer near large towns has little to do in summer, from turnip-seed to harvest.—The farmer of mixed husbandry has abundant and regular employment at all seasons. Cattle and sheep feeding, and marketing grain, pleasantly occupy the short days of winter. Seed-sowing of all kinds affords abundant employment in spring. The rearing of young stock, sale of wool, and culture of green crops, fill up the time in summer until harvest; and autumn, in all circumstances, brings its own busy avocations in gathering the fruits of the earth. Strictly speaking, mixed husbandry does not afford one week of real leisure,—if the short period from assorting the lambs in the beginning of August, to putting the sickle to the corn be excepted,—and that period

is contracted or prolonged, according as the harvest is early or late.

54. There is another view to be taken of the mixed husbandry; it will not in any year entirely disappoint the hopes of the farmer. He will never have to bewail the almost total destruction of his stock by the rot, or the severe storms of winter, as the pastoral farmer sometimes has. He cannot suffer so serious a loss as the carse farmer, when his grain is blighted or burnt up with drought, or its price depressed for a succession of years. Should his stock be greatly injured, or much deteriorated in value by such casualties, he has the grain to rely on; and should the grain fail to a serious extent, the stock may still insure him a profitable return. It is scarcely within the bounds of probability that a total destruction of live-stock, wool, *and* grain, would occur in any year. One may fail, it is true, and the prices of all may continue depressed for years; but, on the other hand, reasonable profits have been realised from them *all* in the same year. Thus, safeguards exist against a total loss, and there is a greater certainty of a profitable return from capital invested in the *mixed* than in any *other* kind of husbandry known.

ON THE PERSONS REQUIRED TO CONDUCT AND EXECUTE THE LABOUR OF THE FARM.

55. The persons who labour a farm constitute the most important part of its staff. Their duties should therefore be well understood. They are the farmer himself, the steward or grieve, the ploughman, the hedger or labourer, the shepherd, the cattle-man, the field-worker, and the dairy-maid. These have each duties to perform which, in their respective spheres, should harmonise and never interfere with one another. Should any occurrence happen to disturb the harmony of their joint labour, it must arise from the misapprehension or ignorance of the interfering party, whose derelictions should be corrected by the presiding power. I shall enumerate the duties incumbent on these respective functionaries.

56. *Farmer.*—And first, those of the farmer. It is his province to originate the entire system of management,—to determine the period for commencing and pursuing every operation,—to issue general orders of management to the steward, when there is one, and when none, to give minute instructions to the ploughmen for the performance of every separate field operation,—to exercise a general superintendence over the field-workers,—to observe the general behaviour of all,—to see if the cattle are cared for,—to ascertain the condition of all the crops,—to guide the shepherd,—to direct the hedger or labourer,—to effect the sales of the surplus produce,—to conduct the purchases required for the progressive improvement of the farm,—to disburse the expenses of management,—to pay the rent to the landlord,—and to fulfil the obligations incumbent on him as a residenter of the parish. All these duties are common to the farmer and the independent steward who manages a farm. Such a steward and a farmer are thus far on a similar footing: but the farmer occupies a loftier station. He is his own master,—makes bargains to suit his own interests,—stands on an equal footing with the landlord on the lease,—has entire control over the servants, hiring and discharging them at any term he pleases,—and can grant favours to servants and friends. The farmer does not perform all those duties in any one day, but in the fulfilment of them in due order, so large a portion of his time is occupied, that he finds little leisure to go from home, and seldom does so to a distance, except in the season when few operations are performed on a farm, viz., the end of summer. Besides these professional duties, the farmer has to perform those of a domestic and social nature, like every other good member of society

57. *Steward or Grieve.*—The duty of the steward, or grieve, as he is called in some parts of Scotland, and *bailiff* in England, consists in receiving general instructions from his master the farmer, which he sees executed by the people under his charge. He exercises a direct control over the ploughmen and field-workers; and unreasonable disobedience to his commands, on their part, is reprehended as strongly by the farmer as if the affront had been offered to himself:

I say *unreasonable* disobedience, because the farmer is the sole judge of whether the steward has been reasonable in his orders. It is the duty of the steward to enforce the commands of his master, and to check every deviation from rectitude and tendency against his master's interests he may observe in the conduct of the servants. Although he should thus protect the interests of his master from the aggressions of any servant, it is not generally understood that he has control over the shepherd or hedger. The farmer reveals to the steward alone the plans of his management; intrusts him with the keys of the corn-barn, granaries, and provision-stores; delegates to him the power to act in his absence as his representative on the farm; and confides in his integrity, truth, and good behaviour. When a steward conducts himself with propriety in his master's absence, and exhibits at all times discretion, activity, and honesty, he is justly regarded as a valuable servant.

58. Personally, the farm-steward does not always labour with his own hands; verifying, by judicious superintendence, the truth of the adage, that "one head is better than two pair of hands." He should, however, never be idle. He should deliver the daily allowance of corn to the horses. He should be the first person out of bed in the morning, and the last in it at night. He should sow the seed-corn in spring, superintend the field-workers in summer, tend the harvest field and build the stacks in autumn, and thrash the corn with the mill, and clean it with the winnowing machine in winter. On very large farms he cannot perform all these duties, and selects one or another as suits the exigency of the case. On some farms he even works a pair of horses like a common ploughman; in which case he cannot personally sow the corn, superintend the workers, build the stacks, or thrash the corn, unless another person take the charge of his horses for the time. This is an objectionable mode of employing a steward; because the nicer operations,—such as sowing corn, &c., must be intrusted to another, and, most likely, inferior person. But in by far the greatest number of cases, the steward does not work horses: on the contrary, when a ploughman qualifies himself to become a steward, it is chiefly with the view of enjoying immunity from that species of drudgery. In any event, the steward should be able to keep an account of the work-people's time, and of the quantity of grain thrashed, consumed on the farm, and delivered to purchasers.

59. Stewards are not required on every sort of farm. On pastoral farms, his service is of no use, so that it is on arable farms alone that they are required. His services are the most valuable where the greatest multiplicity of subjects demand attention. Thus, he is a *more* useful servant on a farm of mixed husbandry than on one in the neighbourhood of a town, or on a carse farm. But even on some farms of mixed culture, the services of a steward are dispensed with altogether; in which case the farmer himself gives orders directly to the ploughmen, or indirectly through the hedger or cattle-man, as he may choose to appoint to receive his instructions. In such a case, the same person is also intrusted to corn the horses; for the ploughmen are never intrusted to do it, except in certain circumstances, as they are apt to abuse such a trust by giving too much corn, to the probable injury of the horses. The same person performs other parts of a steward's duty; such as sowing corn, superintending field-workers, and thrashing corn: or those duties may be divided betwixt the cattle-man and hedger. On the large farm in Berwickshire on which I learned farming, there was no steward, the cattle-man delivering the master's orders and corning the horses, and the hedger sowing the corn, building the stacks, and thrashing the corn. The object of this arrangement was to save the wages of a steward, since the farmer himself was able to undertake the general superintendence. I conducted my own farm for several years without a steward, the hedger acting as such.

60. *Ploughman.*—The duties of a ploughman are clearly defined. The principal duty is to take charge of a pair of horses, and work them at every kind of labour for which horses are employed on a farm. Horse-labour on a farm is various. It is connected with the plough, the cart, the sowing-machines, the roller, and the thrash-

ing-mill, when horse-power is employed. In the fulfilment of his duties, the ploughman has a long day's work to perform; for, besides expending the appointed hours in the fields with the horses, he must groom them before he goes to the field in the morning, and after he returns from it in the evening, as well as attend to them at mid-day. Notwithstanding this constant toil, he must do his work with alacrity and good-will; and when, from any cause, his horses are laid idle, he must not only groom them, but must himself work at any farm-work he is desired. There is seldom any exaction of labour from the ploughman beyond the usual daily hours of work, these occupying at least 12 hours a-day for 7 months of the year, which is sufficient work for any man's strength to endure. But occasions do arise which justify a greater sacrifice of his time, such as seed-time, hay-time, and harvest. For such encroachments upon his time at one season, many opportunities occur of repaying him with indulgence at another, such as a cessation from labour in bad weather. It is the duty of the ploughman to work his horses with discernment and good temper, not only for the sake of the horses, but of the work he executes. It is also his duty to keep his horses comfortably clean. Ploughmen are never placed in situations of trust; and having no responsibility beyond the care of their horses, there is no class of servants more independent. There should no partiality be shown by the master or steward to one ploughman over another, when all do their work alike well. An invidious and reprehensible practice exists, however, in some parts of the country, of setting ploughmen to work in an order of precedency, and which is maintained so strictly as to cause the men to go and return from work in the same order, one being appointed *foreman* or leader, whose movements guide those of the rest. Should the foreman prove a slow man, the rest must go not a single bout more than he does; and if active, they may follow as best they can. Thus, whilst his activity confers no superiority of work beyond his own, his dulness discourages the activity of the other ploughmen. This is sufficient ground for farmers to abolish the practice at once, and place the whole of their ploughmen on the same footing. I soon felt the evils attending the system, and put an end to it on my own farm. When one ploughman displays more skill than the rest, he is sufficiently honoured by being intrusted to execute the most difficult species of work, such as drilling; and such a preference gives no umbrage to the others, because they are as conscious of his superiority in work as the farmer himself. The services of ploughmen are required on all sorts of arable farms, from the carse-farm to the pastoral, on which the greatest and the least extent of arable land is cultivated.

61. *Hedger*, *Spade-hind*, or *Spadesman*. —The hedger, the spade-hind, the spadesman, as he is indifferently called, is a useful servant on a farm. He is strictly a labourer, but of a high grade. His principal duty is to take charge of the hedge-fences and ditches of the farm, and cut and clean them as they require in the course of the season. He also renews old fences, and makes new ones. He cuts channels across ridges with the spade, for the surface-water to find its way to the ditches. He is the drainer of the farm. He is dexterous in the use of the spade, the shovel, and the pick, and he handles the small cutting-axe and switching-knife with a force and neatness which a dragoon might envy. As the principal business of a hedger is performed in winter, he has leisure in the other seasons to assist at any work. He can sow corn and grass-seeds in spring; shear sheep and mow the hay in summer; and build and thatch stacks in autumn. He can also superintend the field-workers in summer, and especially in the weeding of the hedges. The hedger is a very proper person to superintend the making of drains, which, when done on a large scale, is generally executed by hired labourers on piece-work. It is thus obvious, that the hedger is an accomplished farm-servant.

62. Hedgers are not required on all sorts of farms. They would be of little use on pastoral farms, where fences are few, and most of them elevated beyond the growth of thorns; nor on farms whose fences are formed of stone-walls; nor on carse-farms, which are seldom fenced at all. On the last class of farms, they might be usefully employed as ditchers and makers of channels for surface-water; but on these, ploughmen are usually em-

ployed for those purposes when the land is too wet. The common practice on carse-farms of transforming ploughmen into spadesmen, and laying horses idle, I would say is one "more honoured in the breach than the observance," inasmuch as the labour of horses should always be more valuable than that of man. On this subject, Sir John Sinclair has a few just remarks. "In a considerable farm," he says, "it is of the utmost consequence to have servants specially appropriated for each of the most important departments of labour; for there is often a great loss of time, where persons are frequently changing their employments. Besides, where the division of labour is introduced, work is executed not only more expeditiously, but also much better, in consequence of the same hands being constantly employed in one particular department. For that purpose, the ploughmen ought never to be employed in manual labour, but regularly kept at work with their horses, when the weather will admit of it."* In the combination of arable with stock culture, the services of the hedger are indispensable. Still, the farm that would give him full employment must necessarily be of large extent. A *small* farm cannot maintain either a steward or a hedger. In selecting from these two classes of servants, for a small farm, I would recommend the hedger as the more useful servant of the two, provided the farmer himself understands his business thoroughly. I make this exception, because the hedger *may not* understand every department of husbandry, although he generally does, having most probably worked a pair of horses in his youth; while a steward must of necessity understand farming, otherwise he can have no pretension to the appellation; but he can in no case act as a substitute for a hedger.

63. *Shepherd.*—The services of a shepherd, properly so called, are only required where a flock of sheep are constantly kept. On carse-farms, and those in the neighbourhood of large towns, he is of no use; nor is he required on those farms where the only sheep kept are bought in to be fed off turnips in winter. On pastoral farms, on the other hand, as also those of the mixed husbandry, his services are so indispensable that they could not be conducted without him. His duty is to undertake the entire management of the sheep, and when he bestows the requisite pains on the flock, he has little leisure for any other work. His time is occupied from early dawn, when he should see the flock before they rise from their lair, during the whole day, to the evening, when they again lie down for the night. To inspect a large flock three times a-day over extensive bounds, implies the exercise of walking to fatigue. Together with this daily exercise, he has to attend to the feeding of the young sheep on turnips in winter, the lambing of the ewes in spring, the washing and shearing of the fleece in summer, and the bathing or smearing of the flock in autumn. And besides these major operations, he has the minor ones of weaning the lambs, milking the ewes, drafting the aged sheep, and marking the whole, at appointed times; not to omit the attention to be bestowed on the whole flock in summer, to keep them clean from the scour, and to repel the attacks of insects in autumn. It may thus be seen that the shepherd has little time to bestow beyond the care of his flock.

64. As no one but a shepherd, thoroughly bred, can attend to sheep in a proper manner, there must be one where a standing sheep-flock is kept, whatever may be the extent of the farm. On a *small* farm, his whole time may not be occupied in his profession, when he may be profitably engaged in mending and making nets, preparing stakes for them, and assisting the hedger (if there be one) to keep the fences in repair; or in acting as groom, and taking charge of a horse and gig, and going errands to the post-town; or in undertaking the duties of a steward. On *large* pastoral or mixed husbandry farms, more than one shepherd is required. The establishment then consists of a *head* shepherd, and one or more young men training to be shepherds, who are placed entirely under his control. The office of head shepherd is one of great trust. Sheep being individually valuable, and in most instances reared in large flocks, a misfortune happening to a number, from whatever cause,

* Sinclair's *Code of Agriculture*, p. 71.

must incur a great loss to the farmer. On the other hand, a careful and skilful shepherd conducts his flock in good health and full number throughout the year, and secures an extra return much beyond the value of his wages. The shepherd acts the part of butcher in slaughtering the animals used on the farm; and he also performs the part of the drover when any portion of the flock is taken to a market for sale. The only assistance he depends upon in personally managing his flock, is from his faithful dog, whose sagacity in many respects is little inferior to his own

65. *Cattle-man.*—The services of the cattle-man are most wanted at the steading in winter, when the cattle are all housed in it. He has the sole charge of them. It is his duty to clean out the cattle-houses, and supply the cattle with food, fodder, and litter, at appointed hours every day, and to make the food ready, when prepared food is given them. The business of tending cattle being chiefly matter of routine, the qualifications of a cattle-man are not of a high order. In summer and autumn, when the cows are at grass, it is his duty to bring them into the byre or to the gate of the field, as the custom may be, to be milked at their appointed times; and it is also his duty to ascertain that the cattle in the fields are plentifully supplied with water; the shepherd taking the charge of the state of the pastures. The cattle-man also sees the cows served by the bull in due time, and keeps an account of the reckonings of the time of the cows' calving. He should assist the shepherd at the important event of calving. As his time is thus only occasionally employed in summer, he is a suitable person to undertake the superintendence of the field-workers. In harvest, he is usefully employed in assisting to make and carry the food to the reapers, and lends a hand at the taking in of the corn. As cattle occupy the steading in winter on all kinds of farms, the services of the cattle-man appear generally indispensable; but all his duties may be performed by the shepherd, where only a small flock of sheep are kept. The office of the cattle-man is not one of trust, nor of much labour. An elderly person answers the purpose well, the labour being neither constant nor heavy, though well-timed and methodical. The cattle-man ought to exercise much patience and good temper towards the cattle under his charge, and a person in the decline of life is most likely to possess those virtues. He is generally under the control of the shepherd, where the latter has leisure to attend at all to the cattle, or under that of the dairy-maid in a large dairy-farm, and in other circumstances he is directly under the command of the farmer or steward.

66. *Field-worker.*—Field-workers are indispensable servants on every farm devoted to arable culture, and it is only on them they are employed. They mostly consist of young women in Scotland, but more frequently of men and boys in England; but most of the manual operations are better performed by women than men. In hand-picking stones and weeds, in hoeing turnips, and in barn-work, they are more expert and neat than men. The duties of field-workers, as their name implies, are to perform all the manual operations of the fields, as well as those with the smaller implements, which are not worked by horses. The *manual* operations consist chiefly of cutting and planting the sets of potatoes, gathering weeds, picking stones, collecting the potato crop, and filling drains with stones. The operations with the smaller implements are, pulling turnips and preparing them for storing, and for feeding stock in winter, performing barn-work, carrying seed-corn, spreading manure upon the land, hoeing potatoes and turnips, and weeding and reaping corn-crops. A considerable number of field-workers are required on a farm, and they are generally set to work in a band. They work most steadily under superintendence. The steward, the hedger, or cattle-man, superintends them when the band is large; but when small, one of themselves, a steady person, capable of taking the lead in work, may superintend them, provided she has a watch to mark the time of work and rest. But field-workers do not always work by themselves; being at times associated with the field-work of the horses, when they require no particular superintendence. Some farmers consider it economical to set the horses idle, and employ the ploughmen rather than engage field-workers. This may be a mode of avoiding a small outlay of money, but it is not true economy; and

ploughmen, besides, *cannot* perform light work so well as field-workers. In manufacturing districts field-workers are scarce; but were farmers generally to adopt the plan of employing a few constantly, and engage them for the purpose by the half year, instead of hiring them in large numbers at a time, young women would be induced to adopt field-labour as a profession, and of course would become very expert in it. In the neighbourhood of large towns, where labourers of every description are plentiful, there exists, it must be confessed, a great temptation to the farmer to engage a large number of workers at any time, to execute a given piece of work in the shortest space of time, though their work will certainly not be so well executed as if it had been done by field-workers constantly accustomed to the task. It is such steadiness of service, however, that has made the field-workers of the south of Scotland so superior to the same class in every other part of the country.

67. *Dairy-maid.*—The duties of the dairy-maid are well defined. She is a domestic servant, domiciliated in the farm-house. Her principal duty is, as her name implies, to milk the cows, to manage the milk in all its stages, bring up the calves, and make into butter and cheese the milk obtained from the cows after the weaning of the calves. The other domestics generally assist her in milking the cows and feeding the calves, when there is a large number of both. Should any lambs lose their mothers, the dairy-maid brings them up with cow's milk until the time of weaning, when they are returned to the flock. At the lambing season, should any of the ewes be scant of milk, the shepherd has his bottles replenished by the dairy-maid with warm new milk to give to the hungered lambs. The dairy-maid also milks the ewes after the weaning of the lambs, and makes cheese of the ewe-milk. She attends to the poultry, feeds them, sets the brooders, gathers the eggs daily, takes charge of the broods until able to provide for themselves, and sees them safely lodged in their respective apartments every evening, and sets them abroad every morning. It is generally the dairy-maid, where there is no housekeeper, who gives out the food for the reapers, and takes charge of their articles of bedding. The dairy-maid should therefore be an active, attentive, intelligent, and skilful person.

68. These are the duties of the respective classes of servants found on farms. They are not all required on the same farm. A pastoral-farm has no need of a steward, but a shepherd; a carse-farm no need of a shepherd, but a steward; a farm in the neighbourhood of a town no need of a hedger, but a cattle-man; and a dairy-farm no need of a shepherd, but a dairy-maid; but on a farm of mixed husbandry there is need for all these.

69. Now that the duties of all these servants are seen to be so multifarious, mixed husbandry will be perceived to be a very intricate system; and, being so, a farmer who undertakes it should be a well-informed man. This will appear the more evident, if we first conceive the quality and variety of the labour that passes through the hands of these different classes of work-people in the course of a year, and then imagine the clear-headedness of arrangement required by the farmer to make all these various labours coincide in every season, and under every circumstance, so as to produce the greatest results. It is in its greatest variety that labour is best acquired; and it is in the apportionment of varied labour that the greatest talent is displayed by the master, and the greatest skill acquired by the labourers. Vain would be the skill of any farmer to produce the results he does on any class of farm, were he not ably seconded by the general intelligence and admirable efficiency of his labourers; and in both these acquirements Scotland has cause to be proud of her farm-servants.

ON THE BRANCHES OF SCIENCE MOST APPLICABLE TO AGRICULTURE.

70. I believe I have said enough on the best means, in existing circumstances, of acquiring a thorough knowledge of practical agriculture: it is now incumbent on me to indicate those branches of science which will most enlighten the mind of the pupil for the most ready appreciation of agricultural practice; and I may, perhaps, excite general surprise, when I state that no art bears so close a relation to so many branches of science as agriculture.

71. Indeed agriculture may perhaps be considered one of the experimental sciences, as its principles are no doubt demonstrable by the test of experiment, although farmers have not yet attempted to deduce principles from practice. The necessity for such a deduction is, no doubt, the less urgent, that husbandry is usually pursued as a purely practical art; and the facility of thus pursuing it successfully, of course renders practical men indifferent to science, as they consider it unnecessary to burden their minds with scientific results, whilst practice is sufficient for their purpose. Could the man of practice, however, supply the man of science with a series of accurate observations on the leading operations of the farm, the principles of these might be truly evolved; but I conceive the greatest obstacle to the advancement of scientific agriculture is to be sought for in the unacquaintance of men of science with practical agriculture. Would the man of science become acquainted with practice, much greater advancement in scientific agriculture might be expected than if the practical man were to become a man of science; because men of science are best capable of conducting scientific research, and, being so qualified, could best understand the relation which their investigations bear to practice; and, until the relation betwixt principles and practice is well understood, scientific investigation, though important in itself, and interesting in its results, would tend to no practical utility in agriculture. In short, until the facts of husbandry are acquired by men of science, these will in vain endeavour to construct a satisfactory theory of agriculture on the principles of the inductive philosophy.

72. If the science of agriculture in its present position be thus correctly represented, it may be expected to remain in an incipient state until men of science become practical agriculturalists, or, what would still prolong such a state of lethargy, until farmers acquire scientific knowledge. It is certainly remarkable that so few scientific men were for a very long period induced to subject agricultural practice to scientific investigation; though of late many, both at home and abroad, have devoted a portion of their time to such a study, and which has already afforded abundant proof, that extensive as the field of research is, it has only to be occupied by numerous observers to produce results interesting alike to the man of science and the man of practice. The long neglect of agriculture by scientific men may perhaps have arisen from the circumstance of its having so intimate a relation to almost every physical science, so that until all its relations were first investigated, no sufficient data could be obtained for a satisfactory explanation of its practice. A short review of the actual relation which the physical sciences bear to agriculture will render this suggestion the more probable.

73. The sciences which agriculture most immediately affects are mathematics, natural philosophy, chemistry, natural history, comparative anatomy, and veterinary science. Of mathematics, the most useful parts are geometry and trigonometry, and the application of these to the measurement of surfaces and solids. Without a knowledge of mathematics no one can understand natural philosophy; because it is they alone which can demonstrate the powers of those laws which determine the motion of matter. Of natural philosophy, the most useful branches to the agriculturalist are *mechanics*—"the science of the laws of matter and motion, so far as it is accessary to the construction of machines which, acting under those laws, answer some purposes in the business of life," such as the culture and manufacture of crops; *pneumatics*, "that branch of physics which treats of air, and the laws according to which it is condensed, rarefied, or gravitates;" *hydraulics*, that branch of hydrodynamics which treats of fluids in motion, and in particular of the conveyance of water through pipes and channels; *electricity*, which endeavours to determine "the operations of a principle of very wide influence through nature; a cause which is, and perhaps can be no otherwise conceived, than as a highly attenuated form of matter existing in different substances, and passing from one to another with various effects, among such bodies as can be excited to give or to receive it;" *optics*, by which the laws of light, as affecting vegetation by the influence of colour, are investigated; and *heat*, which, by diffusing itself through neighbouring substances, gives to every object its existing form. By

the aid of chemistry, "the manufacture of manures may be expected to continue to improve, the supply of manure further augmented and cheapened, and the development of the resources of the soil thereby hastened and increased." Of the branches of natural history, the most useful to agriculturalists are *meteorology*, "the science of the atmosphere and its phenomena;" *botany*, "which treats of the structure, functions, properties, habits, and arrangement of plants;" and *zoology*, as restricted to the natural history of quadrupeds and insects. The branches of the medical science useful to agriculturalists are *comparative anatomy*, which treats of the structure of the bodies of animals as compared with that of the body of man; and *zootomy*, which treats of the structure, and explains the principles of the art of healing the diseases of the domesticated animals.

74. Viewing the general aspect of these sciences as presented to the agricultural pupil, in the definitions just given of them, he must at once observe the advantages he would derive by studying them. It is well observed by Sir John Herschell that, "between the physical sciences and the arts of life there subsists a constant mutual interchange of good offices, and no considerable progress can be made in the one, without of necessity giving rise to corresponding steps in the other. On the one hand, every art is in some measure, and many entirely, dependent on those very powers and qualities of the material world which it is the object of physical inquiry to investigate and explain." It is evident that most farming operations are much affected by external influences. The state of the weather, for example, regulates every field operation, local influences modify the climate very materially, and the nature of the soil generally determines the kind of crop that should be cultivated. Now the pupil should desire to become acquainted with the causes which give rise to those influences, by understanding the laws of nature which govern every natural phenomenon. The science which investigates those laws, is called *Natural Philosophy*, which is divided into as many branches as there are classes of phenomena occurring in the earth, air, water, and heavens. Those laws, being unerring in their operation, admit of absolute demonstration; and the science which affords the demonstration is called *Mathematics*. Again, every object, animate or inanimate, possesses an individual character, so that it can be identified, and the science which makes us acquainted with its characteristics, is termed *Natural History*. Farther, every object, animate or inanimate, is a compound body made up of certain elements, of which *Chemistry* makes us acquainted with their nature and combinations. The pupil thus sees how suitable those sciences are to the explication of the phenomena around him, and their utility will be the more apparent to him, the more minutely each science is investigated.

75. Mathematics.—These are both abstract and demonstrative. Abstract mathematics "treat of propositions which are immutable, absolute truth," not liable to be affected by subsequent discoveries, "but remain the unchangeable property of the mind in all its acquirements." Demonstrative mathematics are also strict, but are "interwoven with physical considerations;" that is, with subjects that exist independently of the mind's conceptions of them or of the human will; or, in other words still, with considerations in accordance with nature. Mathematics thus constitute the essential means of demonstrating the strictness of those laws which govern natural phenomena. They must, therefore, be first studied before those laws can be understood. Their study tends to expand the mind,—to enlarge its capacity for general principles,—and to improve its reasoning powers.

76. Natural Philosophy may be divided into five great parts. The *first* contains the fundamental truths which explain the constitution of the material masses which compose the universe, and the motions going on among them. This last is a department commonly called Dynamics, which relate to force or power. The two great forces of nature, attraction and repulsion, acting upon inert matter, produce the equable, accelerated, retarded, and curved motions which constitute the great phenomena of the universe. The *second* part explains the peculiarities of state and motion among *solid* bodies,—a department called Mechanics. The *third*

explains the peculiarities of state and motion among *fluid* bodies,—a department called Hydrodynamics, which embraces Hydrostatics or water at rest—Hydraulics, water in motion—Pneumatics, air phenomena—and Acoustics, phenomena of sound or hearing. The *fourth* part explains the more recondite phenomena of imponderable substances—such as Heat, Light, Electricity, Magnetism, and Galvanism. And the *fifth* part explains the phenomena of the heavens,—a department named Astronomy.

77. Mechanics—Of all the branches into which Natural Philosophy is divided, mechanics have proved the most useful to agriculture. No doubt any labourer may work any machine that answers the purpose it is constructed for; but without a knowledge of this science he cannot understand the *principles* upon which any machine is constructed, nor can any machine be properly constructed but in accordance with those principles. As implements may be characterised as the right hand of agriculture, mechanical science, in improving their form and construction, may be said to have given cunning to that right hand; for, testing the strength of materials, both relatively and absolutely, it employs no more material in implements than is sufficient to overcome the force of resistance, and it induces to the discovery of that form which overcomes resistance with the least power. Simplicity of construction, beauty of form of the constituent parts, mathematical adjustment, and symmetrical proportion of the whole machine, are now the characteristics of our implements; and it is the fault of the hand that guides them, if field-work is not now dexterously, neatly, and quickly performed. In saying thus much for the science that has improved our implements to the state they now are, when compared with their state some years ago, I do not aver that they are yet perfect; but they are so perfect as to be correct in mechanical principle, and light in operation, though some are not yet simple enough in construction. Many indeed may yet be much simplified in construction; and I consider the machinist who simplifies the action of any useful implement, thereby rendering it less liable to derangement, does as good service to agriculture as the inventor of a new one. Such a result may at all times be expected; for mathematical demonstration is strictly applicable to mechanics, whether to the principles on which every machine operates, or the form of which it is constructed.

78. Were mechanists to pay more attention to principles, and less to empirical art than they commonly do in several districts, implements would soon assume the form most consonant with the demonstrations of science. As it is, modifications of construction and unusual combinations of parts are frequently attempted by mechanists; and though many such attempts issue in failure, they nevertheless tend to divulge new combinations of mechanical action. It is desirable that every mechanist of implements should understand practical agriculture, and every farmer study the principles of mechanics and the construction of machines, so that their conjoined judgment and skill might be exercised in testing the practical utility of implements. When unacquainted with farming, mechanists are apt to construct implements obviously unsuited to the work they are intended to execute; so that having been put together after repeated alterations, and probably at considerable expense, the makers endeavour to induce those farmers who are no adepts at mechanics to purchase them, and after some unsatisfactory attempts they are put aside. Were farmers acquainted with the principles of mechanics, their discrimination would form a barrier against the spread of implements of questionable utility, and only those find circulation which were obviously simple, strong, and efficient. It is not easy to invent implements possessing all those desirable qualities; but, as they are always exposed to the weather, and the soil is ponderous and uncouth, it is necessary they should be of simple construction. Simplicity of construction, however, has its useful limits. Most farm operations being of themselves simple, they should be performed with simple implements; and all the *primary* operations, which are simple, requiring considerable power, the simple implements should also be *strong;* but complicated operations, though stationary, require to be performed with comparatively complicated machinery. Operations that are both complicated and locomotive should be performed with implements producing complicated action by

simple means, in order to avoid derangement of their constituent parts. The solution of this last is a difficult, if not impossible problem, in practical mechanics. The common plough approaches more nearly to its practical solution than any other implement; yet that wonderful implement, executing difficult work by simple means, should yet be so modified in construction, as to give the ploughman a greater command over its motions. These considerations tend to show, that the form and construction of implements, and the circumstances in which they may be used, are still subjects affording scope for mechanical contrivance.

79. In viewing the construction of all machines, an important circumstance to be considered by the pupil is, the resistance among moving parts which arises from *friction;* and in solid structures, generally, the forms and positions of parts have to be adjusted to the *strength of materials*, and the strain which the parts have to bear. This consideration should lead the pupil to become acquainted with the strength of materials; and, as a farmer, he will have much need to put such knowledge in practice when he comes to receive the work executed by the carpenter and smith.

80. On considering machines, he should also avoid the common error of supposing that any combination of machinery ever can increase the quantity of power applied. "What an infinity of vain schemes—yet some of them displaying great ingenuity—for perpetual motion, and new mechanical engines of power, &c.," exclaims Dr Arnott with reason, in his Elements of Physics, "would have been checked at once, had the great truth been generally understood, that no form or combination of machinery ever did, or ever can increase, in the slightest degree, the quantity of power applied. Ignorance of this is the hinge on which most of the dreams of mechanical projectors have turned. No year passes, even now, in which many patents are not taken out for such supposed discoveries, and the deluded individuals, after selling perhaps their household necessaries to obtain the means of securing the expected advantages, often sink into despair, when their attempts, instead of bringing riches and happiness to their families, end in disappointment and ruin. The frequency, eagerness, and obstinacy, with which even talented individuals, owing to their imperfect knowledge of the fundamental truths of mechanics, have engaged in such undertakings, is a remarkable phenomenon in human nature."

81. Pneumatics.—Next to mechanics, pneumatics is the branch of natural philosophy most useful to the farmer. It "treats of air, and the laws according to which it is condensed, rarified, and gravitates."

82. The atmospheric air surrounds the entire surface of our globe to a height not exceeding 50 miles. Dr Wollaston has shown that, at this elevation, the attraction of the earth upon any air particle is equal to the resistance of the repulsive power of the medium. This height, great as it may seem, only bears the same relation to the globe as dust of one-tenth of an inch in thickness upon a ball one foot in diameter.

83. The atmosphere presses with considerable force upon the surface of the earth, as well as on every object immersed in it. The weight of 100 cubic inches of air, at 60° Fahrenheit, and the barometer at 30 inches, has been computed, by various authorities, at from 30·199 to 31·10 grains, the average being 30·679. With this weight, and a height of 50 miles, the air exerts a pressure on every square inch of 15 lbs. At this rate its entire weight has been computed at 5,367,214,285,714,285 tons, or equal to that of a globe of lead 60 miles in diameter. The surface of an ordinary-sized man contains 2000 square inches, so that such a person sustains a pressure of 30,000 lbs., which, of course, would be sufficient to crush him to atoms in an instant, were it not that, in obedience to the laws of equal and contrary pressure, this effect is prevented.

84. The air consists in 100 parts of

	By Weight.		By Measure.
Nitrogen............	77·50	or	77·55
Oxygen..............	21·	—	23·32
Aqueous vapour...	1·42	—	1·03
Carbonic acid.......	·08	—	·10

These constituents are not chemically combined, but only mechanically mixed, and yet their proportions never vary. The powerful agency of the sun's heat and light evolve an abundant supply of oxygen from the luxuriant vegetation in the tropics, whilst the predominant existence of animals in the colder regions affords a large quantity of carbonic acid.

85. *Barometer.*—The gravity of the atmosphere is measured by the well-known instrument, the barometer. Its short column of mercury of 30 inches is as heavy as a column of air of the same diameter of about 50 miles, and of water of about 33 feet. This instrument is placed either in a fixed position or is portable. As the portable barometer is only used to measure altitudes, it need not be here described. The fixed one is made either upright or with a wheel. Whether it is that the long index of the wheel-barometer, being more easily observed than the variations of the column of mercury, makes it more popular among farmers, I know not; but were they to consider of the hindrance occasioned by the machinery required to put the long index in motion, the upright form would always be preferred for accuracy of indication. It is true that the tube of the upright is generally too small, perhaps to save mercury and make the instrument cheaper, to the disadvantage of increasing the friction of the mercury in its oscillations in the tube, which supports it above its proper level when falling, and depresses it below it when rising. To obviate this inconvenience, a tap of the hand against the instrument is required to bring the mercury to its proper position. But the objection also applies to the wheel-barometer.

86. The barometer has proved itself a useful instrument. It has proved that the density of the atmosphere decreases rapidly as we ascend. At 3 miles the density is only one-half of the air on the earth's surface, at 6 miles one-fourth, at 9 miles one-eighth, and at 15 miles one-thirtieth. So that the half of the atmosphere is confined to a height of 3 miles, and much the greatest part is always within 20 miles. The depression of the barometer has been found, by experiment, to be one-tenth of an inch for about every 88 feet of elevation; or, more correctly, as given in the table below, by which it will be seen that the density decreases in a geometrical while we ascend the air in an arithmetical progression. Thus, with the barometer, at the level of the sea, standing at 30 inches,

A depression of	·1 of an inch		gives an altitude of	87	feet above the surface of the earth.
– –	·2		– – – –	175	– – – –
– –	·3		– – – –	262	– – – –
– –	·4		– – – –	350	– – – –
– –	·5		– – – –	439	– – – –
– –	·6		– – – –	527	– – – –
– –	·7		– – – –	616	– – – –
– –	·8		– – – –	705	– – – –
– –	·9		– – – –	795	– – – –
– –	1 inch	=29 inch	– –	885	– – – –
– –	2 inches	=28 –	– –	1802	– – – –
– –	3 –	=27 –	– –	2752	– – – –
– –	4 –	=26	– –	3738	– – – –

This instrument is thus a correct measurer of the altitudes of places; and on whatever farm observations of the mean height of the mercury are taken, its height above the level of the sea may be correctly ascertained by reference to the above table.

87. No attention should be paid to the words fair, change, rain, commonly engraved on barometers, since the mean elevation of the mercury, in any place, indicates the usual state of the weather at that place, whatever be its relative elevation or depression to other places, so that the indications of the weather, as given by the barometer, are to be looked for in its *changes* and not in its actual *height*.

88. The cost of an upright barometer, of good workmanship, is from £1, 11s. 6d. to £2, 12s. 6d.; and that of a wheel-barometer from £2, 2s. to £5, 5s. The barometer was invented in Italy by Torricelli, a pupil of Galileo, in 1643.

89. *Sympiesometer.*—The sympiesometer was invented by Mr Adie, optician in Edinburgh, and answers a similar purpose to the barometer. Its effects are more delicate, being indicated on a longer scale. For the measurement of heights this instrument is convenient, its small size admitting its being carried in the coat-pocket, and not being subject to the same chances of accident as the portable barometer. The height is given in fathoms on the instrument, requiring only one correction, which is performed by a small table engraved on the case. It is stated to be delicately sensible of changes at sea, particularly of gales. Not being brought into general use, though Professor Forbes is of opinion it might be, I need not allude to it farther here.*

90. *Sucking-Pump.*—The pressure of the atmosphere explains the action of the common sucking-pump. The plunger, by its upward movement, withdraws the air from the chamber of the pump, and the air, pressing on the water in the well, causes it to rise and fill the chamber vacated by the air. The air cannot force the water higher than 33·87 feet. The force-pump acts both by the elasticity and pressure of the air. The pressure causes the water to be lifted to a height not exceeding 33 feet, but the elastic force of the air in the condenser of the force pump causes the water to rise from it to a very considerable height. It is on this principle that the fire-engine causes the water to rise to the roofs of houses.

91. *Stomach-Pump.* — The stomach-pump acts as a common pump in withdrawing any liquid from the stomach, and as a condensing syringe in injecting any liquid into it. This is a useful instrument in relieving some of the complaints of live stock.

92. *Siphon.*—The siphon operates by the pressure of the air, and is useful in withdrawing liquids in a quiescent state from one vessel into another. Water from a quarry may sometimes be removed better by the siphon than any other means. The efficiency of this instrument depends on the greater difference of length of its two limbs.

93. *Wind.*—Wind is occasioned by a change in the density of the atmosphere; the denser portion moving to occupy the space left by the rarefied. The density of the atmosphere is chiefly affected by the sun's heat raising the temperature of the earth in the tropics to a great degree, and the heated earth, in its turn, rarefies the air above it by radiation. The air, on being rarefied, rises, and is replaced by cold currents from either pole, and these currents being constant constitute the well-known and useful *trade-winds.* The great continent of Asia is heated in summer, and the cool air of the Indian seas moves north to occupy the displaced air above the continent. In winter, on the other hand, the water of this ocean, together with the land in the same latitude, are heated in like manner, and the cool currents from the great continent move south to replace the air rarefied by them, and these two currents constitute the half-yearly *monsoons.*

94. The air over the entire coasts and islands of the ocean is rarefied during the day, and condensed in the night, and these two different states of the air give rise to the daily *land* and *sea breezes.*

95. *Weather-cock.*—The direction of the wind is best indicated by the *wind-vane* or weather-cock, a very useful instrument to the farmer. It should be erected on a conspicuous part of the steading, that it may be readily observed from one of the windows of the farm-house. Its position on the steading may be seen in the isometrical elevation of that structure. The cardinal points of the compass should be marked with the letters N. E. S. W. The vane should be provided with a ball or box containing oil, which may be renewed when required. There is no neater or more appropriate form for a vane than an arrow, whose dart is always ready to pierce the wind, and whose butt serves as a governor to direct it into the wind's eye. The whole apparatus should be gilt, to prevent rusting.

96. Mr Forster had such a vane erected at his place of residence, which had a small bell suspended from the dart which

* See *Edinburgh Journal of Science*, vol. x. p. 334, for a description of this ingenious instrument; and New Series, vol. iv. pp. 91 and 329.

struck upon the arms bearing the letters of the compass, announcing every change of wind.* Such a contrivance may be considered a conceit, but it has the advantage of letting you know when the wind shifts much about; and when it does, there is as little chance of settled weather as in frequent changes of the barometer. A better contrivance would be to have a hammer suspended from the dart by a supple spring, and a bell of a different tone attached to each of the arms, indicating the cardinal points; and when different bells were struck, their tone would announce the direction in which the wind most prevailed. There is an ingenious contrivance for indicating the directions of the wind by an index on a vertical disc, like the dial-plate of a clock; a public example of which may be seen in the western tower of the Register-House in Edinburgh, and a private one in the entrance hall of Cassiobary House in Hertfordshire, belonging to the Earl of Essex. This latter method is a very convenient one of fitting up a weather-cock.

97. With regard to the origin of the name of *weather-cock*, Beckmann says, that vanes were originally cut out in the form of a cock, and placed on the tops of church spires, during the holy ages, as an emblem of clerical vigilance.† The Germans use the same term as we do, *wetter-hahn;* and the French have a somewhat analogous term in *coq de clocher.* As the vane turns round with every wind, so, in a moral sense, every man who is "unstable in his ways" is termed a weather-cock.

98. *Anemometer.*—The force of the wind is measured by an instrument called the anemometer, or measurer of the wind's intensity. Such an instrument is of little value to the farmer, who is more interested in knowing the direction than the intensity of the wind, as it has great effect on the weather. The intensity of the wind has, however, a material effect in modifying the climate of any locality, such as that of a farm elevated upon the gorge of a mountain pass. Still, even there its direction has more to do in fixing the character of the climate than the intensity; besides, the anemometer indicates no approach of wind, but only measures its force when it blows, and its strength can be sufficiently well appreciated by the senses. The mean force of the wind for the whole year at 9 A.M. is 0·855, at 3 P.M. 1·107, and 9 P.M. 0·605; so that the wind is most active in the day, when the temperature is highest, an effect which might be anticipated on knowing the cause of the air being moved in currents.

99. The best instrument of this class is Lind's anemometer, which, although considered an imperfect one, is not so imperfect, according to the opinion of Sir William Snow Harris of Plymouth, who has paid more attention to the movements of the wind than any one else in this country, as is generally supposed; but as it is an instrument of no use to the farmer, I need not describe it.‡

100. *Ventilation.*—The principle of ventilation, whether natural or artificial, lies in a change of the density of the air. "We may be filled with admiration," says Dr Arnott, "on discovering how perfectly the simple fact of a lighter fluid rising in a heavier, provides a constantly renewed supply of fresh air to our fires, which supply we should else have to furnish by the unremitted action of some expensive blowing apparatus; but the operation of the law is still more admirable as respects the supply of the same vital fluid to breathing creatures. The air which a man has once respired becomes poison to him; but because the temperature of his body is generally higher than that of the atmosphere around him, as soon as he has discharged any air from the lungs, it ascends away from him into the great purifying laboratory of the atmosphere, and new takes its place. No act or labour of his, as by using fans and punkas, could have done half so well what this simple law unceasingly and invisibly accomplishes, without effort or attention on his part, and in his sleeping as well as in his waking hours."§ This process of natural ventilation necessarily goes on in every stable and byre; and were the simple law allowed

* Forster's Researches into Atmospherical Phenomena, p. 203.
† Beckmann's *History of Inventions*, vol. i.
‡ A good account of it may be seen in the Edinburgh Encyclopædia, art. *Anemometer.*
§ Arnott's *Elements of Physics*, vol. i. p. 412—*Pneumatics.*

to take its course, by giving the heated and vitiated air an opportunity to escape by the roof, and the fresh air to enter by a lower point, the animals inhabiting those dwellings would be much more comfortably situated than they usually are.

101. "In proportion as air is higher removed above the surface of the earth," observes Mr Hugo Reid, "its *temperature* sinks. This is owing to the following peculiar relation which aëroids, in their degrees of density, bear to heat—namely, that more heat is required to warm an aëroid in proportion as it is rare. Hence, equal portions of heat produce more heating effect on air the denser it is, and the lower strata are therefore warm; while the temperature sinks as the elevation is greater, and at a certain height,—higher in proportion as we approach the equator,—perpetual frost reigns. It is said that the temperature sinks 1 degree Fahrenheit for every elevation of 352 feet. But this varies a little with the season, and very considerably with the latitude; it is near the proportion in the temperate zones." Hence elevation affects the local climate of every farm. In connexion with this subject, it is found that all liquids boil at a lower temperature according as the pressure upon them is less. "Water boils about 1 degree Fahrenheit lower for every 530 feet of ascent, or lower by 1·76 degree for every inch of the barometer."* Since it gives more trouble to carry fuel to a high farm, it thus appears it may be more economically used in cooking our food than at a lower one.

102. Hydrostatics.—These treat of the laws which govern the *weight* of fluids. The application of the physical pressure of fluids to the purposes of domestic economy and the wants of civilised life are extremely important, and afford some valuable objects of study to the mechanic and engineer, and with many of these it would be the interest of farmers to become acquainted.

103. Fluids are subject to the operation of gravity. A cubic foot of pure water weighs 1000 ounces, or $62\frac{1}{2}$ lbs., and an English pint about 1 lb.

104. Water in a vessel exerts a twofold pressure, on the base and on the sides of the vessel. The pressure on the *base* is in the direction of gravity. Suppose that the height of water is measured by 100 drops arranged one above the other, the lowest drop will exert on the base a pressure equal to the weight of the 100 drops. Of two vessels having the same base and height, the pressure of water on the base will be the same whatever quantity of water either may contain.

105. Every drop touching the *side* of a vessel presses laterally on the point of contact with a force equal to the weight of all the drops above it to the surface of the fluid. The lateral pressure of water thus varies as its depth.

106. Bodies immersed in water are pressed by it in all directions with a force increasing as the depth.

107. Water being almost incompressible, any pressure exerted against its upper surface is immediately communicated throughout the entire mass. Bramah's *hydraulic press*, for compressing hay and other elastic substances, and for uprooting trees, is a practical application of this principle. If the cylinder of the force-pump is half an inch in diameter, and that of the press 20 inches, the water will exert a pressure on the piston of the ram 40 times that on the force-pump. If the arms of the lever are as 1 to 50, and that of the force-pump is worked by a man with a force of 50 lbs., the piston of the pump will descend with a force of 2500 lbs., and the ram will rise with one of 100,000 lbs.

108. Hydraulics.—Hydraulics treat of the laws which govern the *motion* of fluids. If two vessels communicate with each other, and the height at which the water stands in the one exceeds the height of the other, then the water will overflow the second vessel until there remains as much water in the first as its height shall be equal to the height of the second. It is on this principle that water is supplied from reservoirs and cisterns to towns and villages, and farm-steads, and that it rises from springs at a higher level into wells, whether of the common or Artesian form.

* Reid's *Pneumatics*, p. 119 and p. 82.

109. The velocity of water issuing from an orifice is as the square root of its altitude. Thus, calling the velocity issuing 1 foot below the surface 1; that escaping from a similar orifice 4 feet below the level, will be 2; at 9 feet, 3; at 16 feet, 4; and so on. From this we learn, that of water issuing from two similar vessels, it will issue, from similar orifices, from the one kept constantly full, twice as fast as from the other. A *short* tube will assist the issue of water from an orifice to the extent of half as much more.

110. "The friction or resistance which fluids suffer in passing along *pipes*," says Dr Arnott, "is much greater than might be expected. It depends chiefly upon the particles near the outside being constantly driven from their true course by the irregularities in the surface of the pipe. An inch tube of 200 feet in length, placed horizontally, is found to discharge only a fourth part of the water which escapes by a simple aperture of an inch; and air passing along tubes is so much retarded, that a person who erected a great bellows at a waterfall, to blow a furnace two miles off, found that his apparatus was totally useless. Higher temperature in a liquid increases remarkably the quantity discharged by an orifice or pipe, apparently by diminishing that cohesion of the particles which exists in certain degrees in all liquids, and affects so much their internal movements." * The simplest way of ascertaining the discharge of water from an orifice, such as a pipe or duct of a drain, is to measure the quantity discharged in a given time.

111. *Water-ram.*—It has been long observed that, when a cock at the end of a pipe is suddenly stopped when water is issuing out of it, that a shock and noise are produced. A leaden pipe, even of great length, is often widened or burst in this way. Lately, the forward pressure of an arrested stream has been used as a force for raising water, and the apparatus has been called a *water-ram.* The ram may be described as a sloping-pipe in which the stream runs, having a valve at its lower end, to be shut at intervals, and a small tube rising from near that end towards a reservoir above, to receive a portion of the water at each interruption of the stream. Water allowed to run for one second in a pipe 10 yards long, 2 inches wide, and sloping 6 feet, acquires momentum enough to drive about half-a-pint, on the shutting of the cock, into a tube leading to a reservoir 40 feet high. Such an apparatus, therefore, with the valve shutting every second, raises about 60 half-pints or 4 gallons in a minute. The valve is ingeniously contrived so that the stream works it as desired. The action of the ram may be compared to the beating of an animal's pulse. The upright tube is usually made wider at the bottom, where it first receives the water, so as to constitute there an air-vessel, which, by the air's elasticity, converts the interrupted jets first received into nearly a uniform current towards the reservoir. The supply of air to this vessel is maintained by the contrivance called a *sniffing valve.*

112. The effect produced by moving water depends on the quantity of water that strikes in one minute of time against the surface of the opposing body, and on the velocity with which the collision takes place. If the collision happens in a direction vertical to the surface of the body, its effect is equal to the pressure of a column of water, having for its base the surface impinged on, and an altitude equal to that of the column which generates the velocity of the stream. If the water impinges obliquely on the surface, the force may be resolved into two others—one parallel to the side of the body, and the other perpendicular to it. The latter alone is effective, and is proportional to the square of the sine of the angle of incidence. From this law we learn to calculate the amount of resistance required in an embankment against the force of a stream.

113. *Water-wheels.*—The motive power of water is usefully applied to drive machinery by means of water-wheels. When water-power can be obtained to drive the thrashing machine, or other fixed machinery of a farm, an immense advantage is gained over the employment of horses. It is found that water-power, in the thrashing of grain alone, saves the work of one pair of horses out of every five pairs. Any form

* Arnott's *Elements of Physics*, vol. i. p. 433—*Hydraulics.*

of water-wheel, therefore, is more economical than horses. When a wheel with float-boards merely dips its lower part into the stream of water, and is driven by its momentum—that is, both by the bulk and velocity of the water—it is called an *undershot* wheel. This wheel is employed in low falls with large quantities of water. When the water reaches the wheel near the middle of its height, and turns it by falling on the float-boards of one side as they sweep downwards in a curved trough fitting them, the modification is called a *breast*-wheel. This form is employed in moderate falls commanding a large supply of water. When the float-boards are shut in by flat sides, so as to become the bottoms of a circle of cavities or buckets surrounding the wheel, into which the water is allowed to fall at the top of the wheel, and to act by its weight instead of its momentum; the modification is called the *overshot* wheel. This form requires a high fall, but comparatively a small supply of water, and is most desired when circumstances will permit its adoption. To have a maximum of effect from undershot wheels, they are generally made to turn with a velocity about one-third as great as that of the water; and overshot-wheels usually have their circumference turning with a velocity of about 3 feet per second.

114. The resistance between a meeting solid and fluid is nearly proportioned to the extent of surface opposed by it to the fluid; hence large bodies, because containing more matter in proportion to their surface, are less resisted, in proportion to their weight, than small bodies of similar form. This law explains how, by means of air or water, bodies of different specific gravities, although mixed ever so intimately, may be easily separated. Thus, when a mixture of corn and chaff, as it comes from the thrashing-machine, is showered down from the sieves in a current of air, the chaff, in being longer of falling, is carried further by the wind, while the heavier corn falls almost perpendicularly. The farmer, therefore, by *winnowing* in either a natural or artificial current of air, readily separates the chaff from the grain, and even divides the grain itself into portions of different quality.

115. *Friction of water.*—Friction affects the motion of streams of water very sensibly. The velocity of a stream is greater at the surface than at the bottom, in the middle than at the sides; and the water is higher along the middle than at the sides. But for the retarding power of friction, the water in open channels and ditches would acquire so great a momentum as to destroy their sides, and to overflow them at every bending. Rivers issuing from a high source, but for friction, and the effect of bending, would pour down their waters with irresistible velocity at the rate of many miles per hour. As it is, the ordinary flow of rivers is about 3 miles per hour, and their channels slope 3 or 4 feet per mile.

116. *Velocity of streams.*—To measure the velocity of a stream at the surface, hollow floating bodies are used, and the space they pass over in a given time—one minute—is observed by the watch. It is very difficult to ascertain the true velocity of an irregular stream. To learn what quantity of water flows in a stream, its breadth and depth are first measured at various places to obtain a mean of both; and the sum of these constituting the section of the stream is then multiplied by the velocity, and the product gives the number of cubic feet per minute.

117. *Horse-power of water.*—It may be useful to know the rule for calculating the number of horse-power any stream may exert if employed as a motive power. It is this:—multiply the specific gravity of a cubic foot of water, $62\frac{1}{2}$ lbs., by the number of cubic feet flowing in the stream per minute, as ascertained by the preceding process, and this product by the number of feet in the fall, and, cutting off the three figures on the right hand, divide by 44, and the product is the answer.

Thus,—Multiply the number of cubic feet flowing per minute in the stream, suppose— - - - - -	350
By the weight of a cubic foot of water, $62\frac{1}{2}$ lbs. - - - - - -	$62\frac{1}{2}$
	175
	700
	2100
	21,875
And then multiply the product by the number of feet of fall, available, suppose, - - - - - -	12
	262,500
Strike off the three figures on the right hand, - - - - - -	500
Divide the remainder by - -	44)262(6 { horse-power.
	264

And the quotient 6, gives the number of horse-power.

118. *Specific Gravity.*—The specific gravity of bodies is the proportion subsisting between their absolute weights in air having equal bulks, and their weights in water. It is consequently found by dividing the body's absolute weight by the weight it loses in water.

119. It may be useful to mention the specific gravities of a few common and useful things; distilled water being considered as 1·000:—

Of Rain-water			1.0013
Sea-water			1.027
Beef bones			1.656
Common earth			1.48
Rough sand			1.92
Earth and gravel			2.02
Moist sand			2.05
Gravelly sand			2.07
Clay			2.15
Clay and gravel			2.48
Flint, dark			2.542
Do. white			2.741
Lime, unslaked			1.842
Basalt, whinstone	2.8	to	3.1
Granite	2.5	—	2.66
Limestone	2.64	—	2.72
Porphyry	2.4	—	2.6
Quartz	2.56	—	2.75
Sandstones, (mean)	2.2	—	2.5
Stones for building	1.66	—	2.62
Brick	1.41	—	1.86
Iron, wrought	7.207	—	7.788
Lead, flattened	11.388		
Zinc, rolled	7.191		
Rock salt	2.257		

	Fresh-felled.	Dry.
Alder	0.8571	0.5001
Ash	0.9036	0.6440
Aspen	0.7654	0.4302
Birch	0.9012	0.6274
Elm	0.9476	0.5474
Horse-chestnut	0.8614	0.5749
Larch	0.9206	0.4735
Lime	0.8170	0.4390
Oak	1.0754	0.7075
—	1.0494	0.6777
Spruce	0.8699	0.4716
Scots fir	0.9121	0.5502
Poplar, Italian	0.7634	0.3931
Willow	0.7155	0.5289 *

120. Electricity.—The electric fluid, agency, or power, or, in one word, electricity, having so obvious an influence on external nature, necessarily arrests the attention of those whose occupation engages them chiefly in the open air. This mysterious because subtle agent is commonly spoken of as a fluid; but, as Dr Bird remarks, though frequently called so, it has little claim to the designation. In using it, therefore, let it be always understood in a conventional sense, not as expressing any theoretical view of the physical state of electric matter.

121. Electric matter is universally present in nature. This is proved not only by its being set free by friction, but by almost every form of mechanical change to which any substance can be submitted, mere pressure being quite sufficient for the purpose. It is in a latent state, in a state of quiescence and equilibrium; but this equilibrium is very easily disturbed, and then a series of actions supervenes, which continues until the equilibrium is restored.

122. It has been found that certain bodies possess the property of conducting electricity, whilst others are incapable of conducting this form of matter however subtle. On this account, bodies have been divided into two great groups—conductors and non-conductors of electricity; the former, such as metals, being termed *analectrics*, because they cannot produce sensible electricity; and the latter, such as wax or glass, are termed *idio-electric*, because they can.

123. Electricity, in its natural and compound state of positive and negative combined, appears to be diffused equally throughout any given mass of matter; but when decomposed and separated into its component elements, each of the fluids is confined to the surface of the substance in which it has been set free, in the form of an exceedingly thin layer, not penetrating sensibly into the substance of the mass.†

124. The atmosphere is the part in which the electricity, liberated by various processes, accumulates; it constitutes, in fact, the great reservoir of sensible electricity, our solid earth being rather the field in which this mighty power is again collected and neutralised. Sensibly, electricity is found in the atmosphere at all times and in every state, but varies both in kind and intensity. It owes its origin

* Peschel's *Elements of Physics*, vol. i. p. 151-187.
† Bird's *Elements of Natural Philosophy*, p. 162-177.

to many different causes, no perfect satisfactory explanation of which has yet been offered. The principal causes of electrical excitement with which we are acquainted are the friction and contact of heterogeneous substances, change of temperature, the vital process, the functions of the atmosphere, the pressure and rupture of bodies, magnetism — and philosophers are not unanimous as to whether chemical action, and a change in the aggregate form of matter, are capable of exciting electricity. The ordinary means of excitation employed are *friction*, *contact*, *heat*, and *magnetism*.

125. Two of the most natural sources of electricity seem to be vegetation and evaporation. Let us inquire how *vegetation* produces such a result. M. Pouillet has proved, by direct experiment, that the combination of oxygen with the materials of living plants is a constant source of electricity; and the amount thus disengaged may be learned from the fact that a surface of 100 square metres, (or rather more than 100 square yards,) in full vegetation, disengages, in the course of one day, as much vitreous electricity as would charge a powerful battery.

126. That some idea may be formed of the sort of action which takes place between the oxygen of the air and the materials of living plants, it is necessary to attend, in the first place, to the change produced on the air by the respiration of plants. Many conflicting opinions still prevail on this subject; but "there is no doubt, however, from the experiments of various philosophers," as Mr Hugo Reid observes, "that at times the leaves of plants produce the same effect on the atmosphere as the lungs of animals—namely, cause an increase in the quantity of carbonic acid, by giving out carbon in union with the oxygen of the air, which is thus converted into this gas; and it has been also established that at certain times the leaves of plants produce a very opposite effect—namely, that they decompose the carbonic acid of the air, retain the carbon, and give out the oxygen, thus adding to the quantity of the oxygen in the air. It has not yet been precisely ascertained which of these goes on to the greater extent; but the general opinion at present is, that the gross result of the action of plants on the atmosphere is the depriving it of carbonic acid, retaining the carbon, and giving out the oxygen, thus increasing the quantity of free oxygen in the air."*

127. It being thus admitted that both carbonic gas and oxygen are exhaled by plants during certain times of the day, it is important to ascertain, in the next place, whether electricity of the one kind or the other accompanies the disengagement of either gas. Towards this inquiry M. Pouillet instituted experiments with the gold-leaf electroscope, whilst the seeds of various plants were germinating in the soil; and he found it sensibly affected by the *negative* state of the ground. This result might have been anticipated during the evolution of carbonic gas; for it is known by experiment that carbonic gas, obtained from the combustion of charcoal, is, in its nascent state, electrified *positively*, and, of course, when carbonic gas is evolved from the plant, the ground should be in a state of negative electricity. M. Pouillet presumed, therefore, that when plants evolve oxygen, the ground should be in a positive state of electricity. He was thus led to the important conclusion, that vegetation is an abundant source of electricity; † but Peschel observes, that "the correctness of this assumption, on which the counter experiments of Pfaff have thrown a degree of doubt, requires a fuller investigation before it can be admitted to have been proved;" but elsewhere he considers that "Pouillet has rendered essential service to this branch of science, by discovering that positive electricity is given out from plants when germinating."

128. Another source of electricity is *evaporation*. The fact of a chemical change in water by heat inducing the disengagement of electricity, may be proved by simple experiment. It is well known that *mechanical* action will produce electricity sensibly from almost any substance. If any one of the most extensive series of resinous and siliceous substances, and of dry vegetable, animal, and mineral matters, is rubbed, electricity will be excited,

* Reid's *Chemistry of Nature*, p. 100.

† Leithead *on Electricity*, p. 150.

and the extent of excitation will be shown by the effect on the gold-leaf electroscope. Chemical action, in like manner, produces similar effects. If sulphur is fused and poured into a conical wine-glass, it will become electrical on cooling, and affect the electroscope in a manner similar to the other bodies mechanically excited. Chocolate on congealing after cooling, glacial phosphoric acid on congealing, and calomel when it fixes by sublimation to the upper part of a glass vessel, all give out electricity; so, in like manner, the condensation as well as the evaporation of water, though opposite processes, give out electricity. Some writers attribute these electrical effects to what they term a change of form or state; but it is obvious that they may, with propriety, be included under chemical action. This view is supported by the fact of the presence of oxygen being necessary to the development of electricity. De la Rive, in bringing zinc and copper in contact through moisture, found that the zinc became oxidised, and electricity was evolved. When he prevented the oxidation, by operating in an atmosphere of nitrogen, no electric excitement followed. When, again, he increased the chemical action by exposing zinc to acid, or by substituting a more oxidable metal, such as potassium, the electric effects were greatly increased. In fact, electrical excitation and chemical action were observed to be strictly proportional to each other. And this result is quite consistent with, and is corroborated by, the necessary agency of oxygen in evolving electricity from vegetation.* But more than all this, "electricity," as Dr Bird intimates, "is not only evolved during chemical decomposition, but during *chemical combination;* a fact first announced by Becquerel. The truth of this statement has been by many either altogether denied, or limited to the case of the combination of nitric acid with alkalies. But after repeating the experiments of Becquerel, as well as those of Pfaff, Mohr, Dalk, and Jacobi, I am convinced that an electric current, certainly of low tension, is really evolved during the combination of sulphuric, hydrochloric, nitric, phosphoric, and acetic acids, with the fixed alkalies, and even with ammonia." † On this subject Peschel observes, that "the indubitable evidences of sensible electricity which attend the different atmospheric deposits, are in favour of the aggregate conversion of aqueous vapours exerting a considerable influence on the generation of atmospheric electricity. Clarke has even tried to show that a connexion subsists between the variations in the quantity of vapours and electricity in the air." ‡ Evaporation being a process continually going on from the surface of the ocean, land, lakes, and rivers, at all degrees of temperature, the result of its action must be very extensive. But *how* the disengagement of electricity is produced—either by the action of oxygen on the structure of living plants, or by the action of heat on water—is unknown, and will perhaps ever remain a secret of nature. It is easy, however, to conceive how the electricity produced by these and other sources must vary in different climates, seasons, and localities, and at different heights of the atmosphere. §

129. The *force* of the electrical agency seems to be somewhat in proportion to the energy with which it is roused into action. Dr Faraday states, that *one grain* of water "will require an electric current to be continued for $3\frac{3}{4}$ minutes of time to effect its decomposition; which current must be strong enough to retain a platina wire $\frac{1}{104}$ of an inch in thickness red-hot in the air during the whole time. . . . It will not be too much to say, that this necessary quantity of electricity is equal to a very powerful flash of lightning." When it is remembered that the fermentation and putrefaction of bodies on the surface of the earth is attended with the decomposition of water, and to effect this, so large an amount of electric action must be excited, we can easily imagine that a very large amount of electric matter is required to support the constant wants of nature.

130. The brilliant discoveries of Faraday and Forbes have identified the galvanic and magnetic forces with that of electricity, by the extraction of the spark.

* Leithead on *Electricity*, p. 9 and 10.

† Bird's *Elements of Natural Philosophy*, p. 241.

‡ Peschel's *Elements of Physics*, iii. 173-5.

§ Forbes' *Report on Meteorology*, vi. 252.

It is extremely probable that one or all of these agencies are at work at once, or by turns, to produce the changes continually taking place in the atmosphere. It is hardly possible that the atmosphere surrounding the globe like a thin envelope, and carried round with it in its diurnal and annual revolutions, should exhibit so varied a series of phenomena every year, without a constantly operating disturbing cause; and none are so likely to produce a variety of phenomena as the subtle influences of all those agencies, whose nature and origin have hitherto baffled the closest scrutiny. It is quite possible that they all operate together, and contribute to maintain the atmosphere in a state of positive electricity, and the earth's surface in a state of negative electricity. As the air is a very bad conductor, Kämtz compares the atmosphere to a large electrical battery, whose negative coating is the earth's surface, and whose positive coating is formed by the upper stratum of the atmosphere.

131. Wheatstone announced his important discovery of measuring the velocity of the electric force, to the Royal Institution of London in 1835, and that it is 288,000 miles per second.

132. *Electrometer.*—The electrometer is an instrument of considerable utility to farmers; since it indicates, with a great degree of delicacy, the existence of free electricity in the air; and as electricity cannot exist in that state without producing some sort of action, it is satisfactory to have notice of its presence, that its effects, if possible, may be anticipated. The best sort of electrometer is the "*condensing electroscope:*" it consists of a hollow glass sphere on a stand, inclosing through its top a wide glass tube, on the top of which is affixed a flat brass cap, and from the under side of which are suspended two slips of gold-leaf. At the edge of the flat brass cap is screwed a circular brass plate; and another circular brass plate, so as to be parallel to the first, is inserted in a support fixed in a piece of wood moving in a groove of the stand which contains the whole apparatus. This is a very delicate instrument, and, to keep it in order, should be kept free of moisture and dust.

133. The very general distribution of the electric matter through every substance, the ease with which it can be excited into activity, and the state of activity it displays around plants in a state of healthy vegetation, have led to the belief that were means devised to direct a more than usual quantity of electric matter through plants when growing, their growth might be much promoted. It was conceived that metallic wires might be so placed as to convey this increased quantity; and accordingly experiments were made so as to direct it through given spaces of ground into the plants growing upon them; and this process has been named *electro-culture.* The results hitherto have been contradictory, and on the whole discouraging to future experiment.

134. "Electricity seems to play an important part in the various stages of the development of plants," says Peschel. "Thus flashes of light have been seen to be emitted from many plants in full flower soon after sunset in sultry days. It has further been ascertained, by means of galvanometric experiments, that electric currents are generated in the interior of their substance, although their activity is but small; and that an uninterrupted development of electricity is maintained by the exhalation of carbonic acid in the atmosphere, especially during the germination of the bud; and, indeed, through the entire process of vegetation. The luminous phenomena in plants have been most diligently noticed by Zawadski, who observed them to happen principally in orange-coloured flowers, (*Calendula officinalis*, *Tropæolum*, *Lilium bulbiferum*, *Tagetes patula* and *erecta*,) that they occurred most frequently in the months of July and August, and that the same flower discharged a number of flashes in succession. Dr Donné has performed a number of experiments in the course of his investigations into this subject. He has found that in many fruits the current runs from the stem to the eye, while in others it flows in an opposite direction. Blake, who has established the existence of these currents by similar experiments, thinks he has discovered that they run from the stem to the surface of the leaves; that he has verified their course to be as has been just said, by the chemical decomposition they effect; that lastly, the leaf itself is rendered posi-

tive, and the ambient air negative."* It thus appears undoubted that a connexion exists between a certain state of electricity and vegetation, but how best to promote the results of the connexion seems doubtful.

135. *Electric theory of vegetation.*—An anonymous author has recently promulgated a theory of vegetable physiology, based on electricity; and as that mysterious agent, without doubt, exercises a great influence in the phenomena of nature, it may be proper to state this theory shortly, to let the pupil reflect upon it, whether or not it is capable of explaining most of the phenomena connected with agriculture, and which the author is sanguine enough to believe that it does.

136. "Electricity," says this author, "has always been considered either as one or two fluids; but whether the former or the latter, great difference of opinion has always existed. Dr Franklin was the author of the former theory, and Dufay and Symmer, conjointly, the founders of the latter. I have adopted the two-fluid theory — not on account of its being, in any case, more simple; but, in my opinion, it is not only more in accordance with the laws and principles of the science, but also more consonant with established agricultural facts. Taking, therefore, the theory of two fluids called the positive and negative, they are found to pervade all matter; but, being generally in equal quantities, they are inactive, and therefore not recognised. They are, however, separated by various means, and then become sensible." The means of disturbing their equilibrium is by the presentation of points, vegetation, fermentation, putrefaction, combustion, &c., and, in short, by any case of simple decomposition.

137. "One undeviating law of free electric fluid," he goes on to say, "is its property of residing only on the surface of all matter. Each fluid is also self-repulsive, but attracts the other; therefore when a sphere, or other nearly round body, possesses either of the fluids, it is equally diffused over its surface, and if it contain an equal quantity of both, it is the same; but then they combine, and are latent or insensible. Some kinds of matter are also conductors of the fluid, and other kinds non-conductors—that is, it will move on the surface of some, and remain stationary on others; but with respect to this quality, much depends on the intensity of the fluid as well as peculiarity of matter. The earth is called a conductor, and also the great reservoir of the fluid; and, consequently, it is supposed to be the source whence it is all drawn. The atmosphere, or air which surrounds the earth, is of an opposite nature—it is a non-conductor of the fluids; but as it always holds moisture, which is a conductor, it changes its properties with its variation. Now it is evident, that when the air is positively electrified, and always contains more or less moisture, the fluid will be equally diffused among the particles of each; and therefore, when moisture descends to the earth, either in rain, dew, &c., it will carry the fluid along with it. The atmosphere and earth being in contact at all times, there will be a frequent interchange of moisture and fluid; it will be communicated from the former to the latter by induction, and the contrary, by vegetation and evaporation. . . . . If the earth be positive, the water it contains will be so likewise; and, when this is the case, I presume it will pass into the air by evaporation, and will thereby exhaust the soil at all times when the process of induction is not in operation; and it must be understood that this can only exist under certain favourable conditions,—viz., if the soil be so porous as to permit the air sufficiently to penetrate it, and when the weather is calm, and the air in a positive state: yet it is obvious that these requisites only sometimes exist, and then at others it is indisputable that positive fluid will escape, as evaporation goes on, perhaps, at all temperatures. But the most probable cause of the air being positive is vegetation — as it must receive, if correct, an amazing quantity by this means; and what makes the assumption still stronger, is its production of vegetation in its transit; as it is, therefore, not lost by the earth without being beneficial in its passage. There is a fact also which strengthens this view—viz., it is found that

* Peschel's *Elements of Physic*, vol. iii. p. 185—*Electricity*.

the air is more positive in winter than in summer; and this is the result we might expect, because it will have received all the fluid that has escaped through all the vegetables on the surface of the globe, and will only have returned the quantity that descended with dew and rain, and the latter in summer is sometimes not large. But during winter, again, the earth will receive abundant quantities, so that it will, to a great degree, be prepared to commence vegetation in the ensuing spring. There will be no obstacle, from crops, to the almost perpetual operation of induction; and therefore, as rapidly as the negative on the surface is saturated with the positive in the air, it will instantly be repelled, and again as quickly replaced; and thus it will go on without intermission, except when there is both a dry and a settled state of the atmosphere; so that the neutral air on the surface (which is known to be three or four feet) is neither circulated by the winds, to be replaced by the positive, nor will be a conductor from the air above it, if it be in a dry state. However, it is evident that in our climate this condition of the air seldom occurs; for in the night a fall of moisture, in one form or another, is almost invariable, and it is also very generally the case in the day."

138. After describing the structure of vegetables in a few words, the author proceeds to consider the electric condition of the organic and inorganic elements which compose plants.

139. *Oxygen* is in a negative state of electricity; and when it combines with alkalies and earths, it converts them into non-conductors, and is thereby of great service in retaining the fluid for vegetation; and the excitation of electricity is found to result from its union with all substances.

140. *Hydrogen* is in a positive state, since it unites with oxygen.

141. *Nitrogen* being an indifferent substance, its electric state is neutral, holding equal quantities of the two fluids.

142. *Carbon* readily unites with oxygen, and may, therefore, be regarded as in a positive state of electricity, and it is a non-conductor.

143. *Ammonia*, according to the experiments of Faraday, returns to either pole of the galvanic battery, and is therefore neutral like nitrogen.

144. *Humus* is valuable by its union with oxygen in supplying carbonic acid and the electric fluid to vegetables in all their stages. During the time it is in the soil, it is a great attractor and retainer of moisture, and therewith the electric fluid, being also a non-conductor.

145. All the *inorganic* substances of plants are non-conductors, and therefore valuable as retaining the electric fluid for the use of vegetation.

146. The author's views, in considering the utility of the inorganic materials, in so far as they may be regarded as ingredients for constructing the plant, are these:—"I assume that vegetables are a crystalline structure, and that their elements combine in a similar manner to other crystals. The grain, fruit, &c. are composed of different compounds of different proportions of the organic elements, with a small portion of the inorganic. The organic are gum, starch, sugar, &c. These are some of the proximate principles of vegetables; but they have again to be united in various manners and proportions before we can obtain grain, roots, &c.; and these may be called the final production.

147. "Now the organic elements cannot be united by art to form any of these compounds; but it is effected in the plant, and we conceive as follows:—Water is a compound of oxygen and hydrogen; carbonic acid is composed of oxygen and carbon; and ammonia is composed of hydrogen and nitrogen. Now these contain all the organic elements of vegetables, and they are all to be found in the air and the soil, and therefore within their reach. It is also known that water and ammonia can be decomposed by electricity; and we have no doubt but that these and carbonic acid can also be decomposed by the electricity of the plant: I therefore conclude, that the electric fluid issues from the earth through the vegetables during the day, and

decomposes those substances into their elements when in the extremity of the leaf, it being most intense when it escapes from the points. The elements then descend through the bark into the cells, where much of the water will be evaporated in the day; they will there remain until the cool of the night, and then, owing to the escape of the heat, and consequent contraction of the cells, together with the return of the electric fluid with the dew, their union is accomplished. It is here, I imagine, that a great benefit is derived from the inorganic ingredients; they unite with the acids formed in the plant, producing salts, and it is known that these are among the substances most prone to crystallisation.

148. "We have shown that the vegetable possesses all the requisites that contribute to effect crystallisation when attempted artificially: these are, the evaporation of the water of solution, the absence of motion, the absence of light, and frequently, in addition to these, a grain of sand is required before the process will commence. Thus, we see that the vegetable, at least in fine weather, has all that is necessary to enable its inorganic elements to crystallise, and thereby assist the organic to unite, besides the advantage of the fluid returning to the earth in a sort of current with the dew, and which is known to be able of itself to effect the process of crystallisation — being called slow electric action."

149. The author adduces a number of comparative results produced by vegetation and electricity, some of which bear a close resemblance to one another, and others analogically so. I shall content myself with one instance of comparison between the effects of electricity and vegetation:— "Most compounds," he says, "have been discovered to be decomposable by the electric fluid. Sir H. Davy immortalised his name by the decomposition of the alkalies and many of the earths; but the manner in which this is effected is differently explained by many eminent philosophers. Mr Faraday's I think the most plausible. He says that there is an internal corpuscular action in the decomposing mass, exerted according to the direction of the electric current; and that the elements, when liberated, pass to either pole, according to the affinity existing between them.

150. "The fact is now decidedly established that vegetables decompose compounds;—that water, carbonic acid, and ammonia, are all separated into their elements before being assimilated by the plant. What, then, can decompose them, if we reject electricity, except the vital principle? and this we have surely no right to call to our aid, when we are acquainted with an agent that can do its work."*

151. Galvanism.—The state of electrical quiescence in two different kinds of bodies which are good conductors of electricity, is destroyed by bringing them into contact with each other. It was Volta who first discovered this peculiar excitation of electricity in the metals. Before this, "Professor Galvani of Bologna observed, in 1797, that when he touched a nerve and muscle in the leg of a dead frog with two different metals, on bringing them into contact the leg moved convulsively. The author of this discovery considered this as the effect of a peculiar power exerted on the animal organisation; he therefore gave it the name of animal electricity; and even to the present day, out of respect to the discoverer, it is frequently called *galvanic electricity* or *galvanism.* Volta soon after proved, by means of the condenser he had lately invented, that this electricity by no means resided as an extraordinary agent in the animal organisation, but that it was the consequence of two metals being brought into contact; and that the nerves and muscles merely exhibited the sensible electricity, as any other delicate electroscope would. This theory led him to the most important discoveries, and, in the year 1800, to the construction of that valuable piece of apparatus known by the name of the *Voltaic pile.*"

152. With this apparatus Faraday adduced a variety of proofs, to establish the identity between electricity excited by contact and by friction. The important distinction between them is, that in a voltaic battery the exciting cause is perma-

* *A New Theory of Vegetable Physiology, based on Electricity,* p. 16, 22, 27, 35, 42.

nently at work—hence, after connexion is established with the ground, its electrical tension is excited and maintained; and, when the circuit is completed, the stream is emitted uninterruptedly so long as the circuit is not broken, and no change takes place—whereas in an electrical machine, when its conductor or a battery is charged, it loses its electrical tension immediately on a connexion being established by a good conductor between it and the ground.

153. Magnetism. — Magnetism is a force which exerts no immediate influence on any part of the nervous system. Substances endowed with it attract certain metals; display towards one another a force partly attractive and partly repulsive; and they exhibit a tendency to arrange their mass in a certain direction. "However simple these isolated fundamental effects may appear," observes Peschel, "yet the ultimate causes which produce them must remain shrouded in obscurity, unless we can discover the laws which regulate the mutual operations of this and the other physical agents on each other. Our knowledge of this subject has been greatly increased of late by the discovery of electro-magnetism and magneto-electricity; and the fact has been established beyond dispute that magnetic influences are affected by, and that they in their turn affect, light, heat, and electricity. We may, therefore, well hazard a conjecture, that magnetism has a far wider sphere of operation than the exertion of its attractive and repulsive forces would indicate; and that, probably, many a phenomenon is ultimately owing to magnetic influence, although the mode of its connexion with that force is unknown to us."

154. The spark obtained from the voltaic pile and from the magnet, evince a simultaneous exhibition of the electrical action with the voltaic and with the magnetic; and the insulated pile presents a striking analogy to the polarity of a bar magnet, in one half of which positive electricity resides, and negative electricity in the other; and its assuming, when suspended, the magnetic direction, also evinces a corresponding identity between voltaism and magnetism. Of the three forces, electricity seems to be most easily excited; for neither voltaic nor magnetic action are ever excited without an exhibition of the electrical.

155. The ground has been compared to a voltaic pile;—the particles of the different kinds of earths, which are just oxides of metals, being separated, and at the same time united together, by the moisture derived from the rain, and which holds in solution the alkalies and acids which may be present in the ground. The voltaic action amongst these materials is excited by the same circumstances as excite the action of the voltaic pile; and that action will be the greater the nearer the materials happen to be proportioned, and in a similar condition to those in the voltaic pile.

156. Terrestrial magnetism is supposed to arise from two fluids which are never singly combined with the particles of matter, but always both together; and if the relative proportions of which existing in any body be such that they mutually neutralise each other in the individual molecules composing it, that body would be said to be not magnetised. But if this condition of equilibrium be disturbed, then the magnetic state is induced; and the magnetism is invariably exhibited from both poles, and never from one only. Every body that has acquired this state of polarity is in its turn capable of disturbing the magnetic equilibrium of other similar bodies within certain limits. The derangement thus effected in the magnetic fluids is not sufficient to cause their passage from one particle of the body to another, still less from one body to another. "Hausbein is of opinion, that all bodies whatever on the earth's surface have a certain degree of magnetic polarity; he thought he had observed, that a needle held near to the ground on the north side of a tree, post, column, &c., made a greater number of vibrations in a given time than when held on the south side; but that the same needle, when presented to the upper end of the object, vibrated more rapidly on the south side than on the north side; whence he inferred, that all bodies had a less degree of polarity imparted to them by the earth's magnetism; that their lower end in the ground was a north pole, and their upper end a south pole."*

* Peschel's *Elements of Physics*, vol. ii. p. 265 and 316, and vol. iii. p. 70.

157. The subjects of voltaism and magnetism may not seem to be at all connected with the culture of the ground; but it is chiefly in the principles of these sciences that electro-culture has been recommended of late years to the notice of the farmer. The method of erecting the electrical apparatus for attaining the object of the recommendation, I shall have particularly to describe at the proper season. In the mean time, I would remark on the principle of the particular construction, that no doubt an electrical current may be established by the system of wires set up in the air, and continued under ground, *around* the space of ground included within the wires—and that such a current is put in motion is clearly shown by the active state of the magnetic needle. These electrical currents, to speak more properly, as a current will diverge in a contrary direction from each upright arm, will be accompanied by spiral magnetic currents revolving along with them, and the intensity of which will probably be in proportion to that of the electrical. The electrical currents will also give rise to a certain degree of voltaic excitation in the ground, but the action of these will be feeble and almost momentary. It seems to me improbable that any benefit can be derived from such an arrangement by any object placed within the space circumscribed by the wires; as the electricity, brought down the upright wires, has just as great a chance to be diffused into the ground from the horizontal wires in a downward or a lateral direction, away from the enclosure, as towards the interior of the enclosure. Nay, I should suppose that the wires under ground would be apt to convey away a quantity of the electricity that is naturally in the ground. If any sensible result is to be expected from such an experiment, every stem of a plant should be surrounded by a wire; and if the diffusion of the electricity is to do any good, it would then have a chance of being placed within the immediate reach of each plant. A better plan, in my opinion, would be to excite the ground itself to a voltaic action, which, although feeble at any given moment of time, might nevertheless produce sensible effects by its constancy during a lengthened period.

158. Heat.—Heat was ranked amongst chemical re-agents, until philosophers divided all the substances of nature into ponderable and imponderable, when it was classed among the latter, in common with electricity, magnetism, galvanism, and light.

159. Heat, as a general principle, may be regarded as the antagonistic force to gravity. Were gravity to act alone, every object would become a confirmed solid, and there would be no such existence as life.

160. It is the property of heat to part asunder the atoms of all bodies, and these remain or change into solids, liquids, and gases, as their atoms are more nearly or remotely placed from each other; the further they are separated, the weaker the attraction being between them. Thus bodies in these different states represent conditions which differ in regard to the quantity of heat in them.

161. Heat cannot be seen, and it has neither weight nor inertia, though it pervades all nature. It is only sensible when it displays a tendency to establish equilibrium, by diffusing itself equally in all surrounding bodies; and it is then in incessant motion, passing from one to another. The quantity of it at any moment in a particular body is said to be the *temperature* of that body. When its movement ceases, and it is in a temporary state of repose, intimately uniting itself with the atoms of matter, and not causing any change of aggregation, it is then said to be *latent*. With the same temperature, the latent heat of bodies increases as they change from solid to liquid, and from liquid to aëriform.

162. Whenever heat becomes sensible or free, it alters their form by dilation; and the measure of this increase has given rise to a class of useful instruments called *thermometers*.

163. *Thermometer.*—The common *mercurial* thermometer is nearly a perfect instrument, and has been the means of establishing important facts to science; but being a mere measurer of temperature, it is incapable of indicating changes of the atmosphere so clearly as the barometer, and is therefore a less useful instrument to the farmer. Indeed, it does not predict

changes at all, like the barometer. Regarding the ordinary temperature of the atmosphere, the feelings can judge sufficiently well; and as the state of the productions of the farm indicates pretty well whether the climate of the particular locality can bring them to perfection, the farmer seems independent of the use of the thermometer. Still, it is useful to know the lowest degree of temperature in winter to put him on his guard, as certain kinds of farm produce are injured by the effects of extreme cold, which the feelings are incapable, from want of habit, of estimating. For this purpose, a thermometer self-registering the lowest degree of cold will be found a useful instrument on a farm; and as great heat does no harm, a self-registering thermometer of the greatest degree of heat seems not so useful an instrument as the other.

164. "The thermometer, by which the temperature of our atmosphere is determined," says Mr John Adie of Edinburgh, "was invented by Sanctario in 1590. The instrument, in its first construction, was very imperfect, having no fixed scale, and air being the medium of expansion. It was soon shown, from the discovery of the barometer, that this instrument was acted upon by pressure as well as temperature. To separate these effects, alcohol was employed as the best fluid, from its great expansion by heat, but was afterwards found to expand unequally. Reaumur first proposed the use of mercury as the expansive medium for the thermometer.* This liquid metal has great advantages over every other medium; it has the power of indicating a great range of temperature, and expands very equally. After its introduction, the melting point of ice was taken as a fixed point, and the divisions of the scale were made to correspond to $\frac{1}{1000}$th parts of the capacity of the bulb. It was left for the ingenious Fahrenheit † to fix another standard point—that of boiling water under the mean pressure of the atmosphere, which is given on his scale at 212°; the melting point of ice at 32°. This scale of division has almost universally been adopted in Britain, but not at all generally on the Continent. The zero of this scale, though an arbitrary point adopted by Fahrenheit, from the erroneous idea that the greatest possible cold was produced by a mixture of common salt and snow, has particular advantages for a climate like ours: besides being generally known, the zero is so placed that any cold which occurs very rarely causes the mercury to fall below that point, so that no mistake can take place with regard to noting minus quantities. The only other divisions of the thermometer between the two fixed points in general use, are those of Reaumur and the centesimal; ‡ the former divides the space into 80 equal parts; the division of the latter, as indicated by its name, is into 100 parts. In both these scales the zero is placed at the melting point of ice, or 32° Fahrenheit."

165. The self-registering thermometers were the invention of the late Dr John Rutherfurd, and his are yet the best. The tube of the one for ascertaining the greatest degree of heat is inclined nearly in a horizontal position, and filled with mercury, upon the top of the column of which stands an index, which, on being pushed upwards, does not return until made to descend to the top of the mercury by elevating the upper end of the thermometer. This index was first made of metal, which became oxydised in the tube, and uncertain in its motions. Mr Adie, optician in Edinburgh, improved the instrument, by introducing a fluid above the mercury, in which is floated a glass index, which is free from any action, and is retained in its place by the fluid. "The other thermometer, for registering the lowest degree," says Mr John Adie, "is filled with alcohol, having an index of black glass immersed in the

* Peschel says that "Reaumur retained the use of the spirit of wine, and finding that its expansion between the points of boiling and freezing water equalled 0·08 of its volume, he divided the scale into eighty equal parts, on the supposition that the expansion of the spirit would be proportioned to the increase of the temperature. De Luc discovered and corrected this error, and substituted mercury for the spirit of wine, though he still retained his predecessor's system of graduation. Notwithstanding this important alteration, the thermometer still retained the name of Reaumur."—*Elements of Physics*, vol. ii. p. 151.

† A Danish philosopher who experimented in Iceland.

‡ Instituted by Celsius, a Swedish philosopher, whose system of graduation is rapidly supplanting Reaumur's on the Continent.

liquid. This index is always carried down to the lowest point to which the temperature falls; the spirit passes freely upwards without changing the place of the index, so that it remains at the lowest point. This instrument, like the other, turns upon a centre, to depress the upper end, and allow the index, by its own weight, to come into contact with the surface of the spirit, after the greatest cold has been observed, which is indicated by the upper end of the index, or that farthest from the bulb. In both cases, the instruments are to be left nearly horizontal, the bulb end being lowest. This angle is most easily fixed by placing the bulb about $\frac{3}{4}$ths of an inch under the horizontal line."*

166. Thermometers of all kinds, when fixed up for observation, should be placed out of the reach of the direct rays of the sun, or of any reflected heat. If at a window or against a wall, the thermometer should have a northern aspect, and be kept at a little distance from either; for it is surprising through what a space a sensible portion of heat is conveyed from soil and walls, or even from grass illuminated by the sun. The maxima of temperature, as indicated by thermometers, are thus generally too great; and from the near contact in which they are usually placed with large ill-conducting masses, such as walls, the temperature of the night is kept up, and the minima of temperature are also too high.

167. The price of a common thermometer is from 5s. 6d. to 14s.; and of Dr Rutherfurd's minimum self-registering, 10s. 6d.

168. Thermometers afford but limited information in regard to the state of heat in bodies. "It is evident," says Dr Arnott, "that the thermometer gives very limited information with respect to heat: it merely indicates, in fact, what may be called the tension of heat in bodies, or the strength of its tendency to spread from them. Thus, it does not discover that a pound of water takes thirty times as much heat to raise its temperature one degree as a pound of mercury; nor does it discover the caloric of fluidity absorbed when bodies change their form, and which indeed is called latent heat only because it is hidden from the thermometer; nor does it tell that there is more heat in a gallon of water than in a pint; and if an observer did not make allowance for the increasing rate of expansion in the substance used as a thermometer, as the temperature increases, he would believe the increase of heat to be greater than it is; and, lastly, when a fluid is used as a thermometer, the expansion observed is only the excess of the expansion in the fluid over that in the containing solid, and subject to all the irregularities of expansion in both instances: —all proving that the indications of the thermometer, unless interpreted by our knowledge of the general laws of heat, no more discloses the true relation of heat to bodies than the money accidentally in a man's pocket tells his rank and riches." †

169. Bodies, on receiving heat, expand generally more rapidly than the temperature increases; and the expansion is greater as the cohesion in the particles becomes weaker from increased distance—being considerably greater in liquids than in solids, and in airs than in liquids. Thus solids gain in bulk 1 part in from 100 to 400; liquids, in from 9 to 55; and all gases and vapours gain 1 part in 3, It is this dilating property of air which has prompted some persons to employ the force of expanding air as a motive power; the same quantity of heat that would produce one cubic foot of common steam would double the volume of five cubic feet of atmospheric air. Though the air-engine has hitherto not succeeded, by reason of the destructive effects of the heated air in the valves, yet the time may come when this inconvenience will be remedied; and it has already been proved that this power may be much more economically employed than steam.

170. *Steam-engine.*—In expanding on the reception of heat, bodies receive it in different quantities ere they exhibit a given increase of temperature; and this difference marks their different capacities for heat. It is this property which renders steam so powerful and economical a force to be employed in moving machinery; and, as a motive power, the steam-engine,

* *Quarterly Journal of Agriculture*, vol. iii. p. 5-7.

† Arnott's *Elements of Physics*, vol. ii. part 1st, p. 114—*Heat.*

at present, stands unrivalled. As it came from the hands of Watt, the steam-engine may almost be said to be endowed with human intelligence. I cannot resist quoting at length Dr Arnott's well-expressed encomium on this wonderfully simple machine. "It regulates with perfect accuracy and uniformity," he observes, "the *number of its strokes* in a given time—*counting* or *recording* them, moreover, to tell how much work it has done, as a clock records the beats of its pendulum;—it regulates the *quantity of steam* admitted to work—the *briskness of the fire*—the *supply of water* to the boiler—the *supply of coals* to the fire;—it *opens and shuts its valves* with absolute precision as to time and manner;—it *oils its joints;*—it *takes out any air* which may accidentally enter into parts which should be vacuous;—and when any thing goes wrong which it cannot of itself rectify, it *warns its attendants* by ringing a bell:—yet with all these talents and qualities, and even when exerting the powers of six hundred horses, it is obedient to the hand of a child;—its aliment is coal, wood, charcoal, or other combustible;—it consumes none while idle;—it never tires, and wants no sleep;—it is not subject to malady, when originally well made; and only refuses to work when worn out with age;—it is equally active in all climates, and will do work of any kind;—it is a water-pumper, a miner, a sailor, a cotton-spinner, a weaver, a blacksmith, a miller, &c.: and a steam-engine in the character of a *steam-pony* may be seen dragging after it, on a railroad, a hundred tons of merchandise, or a regiment of soldiers, with greater speed than that of our fleetest coaches. It is the king of machines, and a permanent realisation of the *genii* of eastern fable, whose supernatural powers were occasionally at the command of man."*

171. The steam-engine is becoming daily more useful to the farmer in working his stationary machines. Windmills, and even water-wheels, but scantily supplied with surface-water only, are being laid aside when worn out, and the steam-engine substituted in their stead. This power, at command at all times and in all seasons, to any extent, is also employed to cut straw and hay, and bruise corn, now that it is found better to support the horses on prepared food. The steam-engine has been suggested as a befitting motive power for the plough in the ordinary cultivation of the soil; and its powers were tested some years ago by Mr Heathcote, before the Highland and Agricultural Society, at Lochar Moss, near Dumfries; but the locomotive is yet too expensive a machine to be employed in all the varieties of ploughing in the various states of the ground incidental to a farm.

172. *Vapour.*—Though water remain ever so tranquil, a portion of it is constantly receiving heat from the air, and passing into it in the form of invisible vapour or steam. The weight of 1 cubic inch of distilled water (with the barometer at 30 inches, and the thermometer at 62° Fahrenheit) is 252·458 grains; that of 1 cubic inch of air is 0·3049 of a grain; and of steam at 212° 0·6325, taking atmospheric air as 1·000. Heat thus rendering water, in the form of vapour, lighter than the air, we see how readily vapour ascends in the atmosphere; and it is not improbable that it is electricity that maintains its elasticity after it has been carried beyond the influence of its generating heat, and keeps it in mixture with the air. The presence of vapour in the air is of essential service to the functions of plants and animals, as without it both would languish and die. Its quantity in the atmosphere is variable.

173. This table gives the weight in grains of a cubic foot of vapour, at different temperatures of 10°, from 0° to 90° Fahrenheit; and clearly shows that the higher the temperature of the air, the greater is the quantity of vapour held in solution in it.

Temperature in degrees.	Weight in grains.	Temperature in degrees.	Weight in grains.
0	0·856	50	4·535
10	1·208	60	6·222
20	1·688	70	8·392
30	2·361	80	11·333
40	3·239	90	15·005

174. *Clouds.*—When by any cause the temperature of the air is reduced, its par-

* Arnott's *Elements of Physics*, vol. i. p. 383—*Pneumatics.*

ticles approach nearer each other, and so do those of the vapour held suspended in the air; and as steam becomes visible when mixed with atmospheric air, so the vapour becomes visible when it occupies a lower position in condensation by a reduction of temperature. When vapour thus becomes visible in the atmosphere, it becomes *clouds.* These differ much in altitude, density, and extent. Their altitude is best observed in ascending mountains, when the traveller frequently passes one zone of clouds after another. Mountains thus form a scale by which to estimate the altitude of clouds. Mr Crossthwaite made these observations on the altitude and number of clouds in the course of five years:—

Altitude of Clouds.	Number of Clouds.
From 0 to 100 yards,	10
100 to 200 ...	42
200 to 300 ...	62
300 to 400 ...	179
400 to 500 ...	374
500 to 600 ...	486
600 to 700 ...	416
700 to 800 ...	367
800 to 900 ...	410
900 to 1000 ...	518
1000 to 1050 ...	419
	3283
Above 1050,	2098

Hence the number of clouds above 1050 yards was to that below as 2098 : 3283, or 10 : 16 nearly.

175. *Dew.*—Invisible evaporation sends a large quantity of vapour into the lower stratum of the atmosphere, which never ascends so high as to form clouds, but is deposited in dew, in drops, upon the points of objects having a rough surface, such as the blades of grass, and other suchlike plants.

176. *Theories* of the formation of dew have been proffered by many philosophers, from the days of Aristotle to the time of Dr Wells. "Dew, according to Aristotle," remarks Dr Wells, "is a species of rain formed in the lower atmosphere, in consequence of its moisture being condensed by the cold of the night into minute drops. Opinions of this kind, respecting the cause of dew, are still entertained by many persons, among whom is the very ingenious Mr Leslie of Edinburgh." This view is erroneous, because "bodies a little elevated in the air become moist with dew, while similar bodies lying on the ground remain dry, though necessarily, from their position, they are as liable to be wetted by whatever falls from the heavens as the former." Dufay concluded that dew is an electric phenomenon; but it leaves untouched bodies which conduct electricity, while it appears upon those which cannot transmit that influence. All the theories on dew, to the time of Dr Wells, omitted the important part, that the production of dew is attended with cold; and this is a very important omission, since no explanation of a natural phenomenon can be well founded which has been built without a knowledge of one of its principal circumstances. "It may seem strange to many," continues Dr Wells, "that neither Mr Wilson nor Mr Six applied the fact of the existence of cold to its production, to the improvement of the theory of dew. But, according to their view of the subject, no such use could have been made of it by them, as they held *the formation of that fluid* to be *the cause* of the cold observed with it. I had many years held the same opinion; but I began to see reason, not long after the regular course of my experiments commenced, to doubt its truth, as I found that bodies would sometimes become colder than the air without being dewed; and that, when dew was found, if different times were compared, its quantity, and the degree of cold which appeared with it, were very far from bearing always in the same proportion to each other. The frequent recurrence of such observations at length corrected the doubt of the justness of my ancient opinion into a conviction of its error; and at the same time occasioned me to conclude, that dew is the production of *a preceding cold in the substance* upon which it appears." Dr Wells' theory, therefore, is, "that the cold observed with dew is the previous occurrence, and, consequently, that the formation of this fluid has precisely the same immediate cause as the presence of moisture upon the outside of a glass or metallic vessel, where a liquid considerably colder than the air has been poured into it shortly before." As an obvious application of this theory, the experiments of Dr Wells, which led to its establishment, evince, that of all natural substances, grass

is peculiarly adapted to the exhibition of dew, inasmuch as it becomes, under ordinary circumstances, colder than the air above it, by the radiation of more heat towards the heavens than it receives in any way, and, accordingly, whenever the air is calm and serene, dew may be seen on grass when it may not be observed on other substances.

177. But it has been alleged by Dufay that dew is the condensation of vapour *rising* out of the earth upon the grass on it, because objects removed higher from the surface of the earth, as trees, are exempt from dew; and this is a very popular opinion, but it is an erroneous one, and the phenomenon can be explained on other principles—because the lower air in a clear and calm evening is colder than the upper, it is less liable to agitation than the upper, and it contains more moisture than the upper; and hence, on all these considerations, it will sooner deposit a part of its moisture. At the same time, it is true that vapour does rise from the earth, and it may be condensed as dew; for we find the grass first becoming moist with dew, then the substances raised above it, while both indicate an equal degree of cold; but all the quantity of dew from this cause can never be great, because, until the air be cooled by the substances, attractive of dew, with which it comes in contact below its point of repletion with moisture, it will always be in a condition to take up that which has been deposited upon grass or other low bodies by warm vapour emitted by the earth, just as the moisture formed on a mirror by our breath is, in temperate weather, almost immediately carried away by the surrounding air. Agreeably to another opinion, the dew found on growing vegetables is the condensed vapour of the very plants on which it appears; but this also is erroneous, because dew forms as copiously upon dead as upon living vegetable substances; and " if a plant," as Dr Wells observes, " has become, by radiating its heat to the heavens, so cold as to be enabled to bring the air in contact with it below the point of repletion with moisture, that which forms upon it from its own transpiration will not then indeed evaporate. But although moisture will at the same time be communicated to it by the atmosphere, and when the difference in the copiousness of these two sources is considered, it may, I think, be safely concluded, that almost the whole of the dew which will afterwards form upon the plant must be derived from the air; more especially when the coldness of a clear night, and the general inactivity of plants in the absence of light, both lessening their transpiration, are taken into account." " Hoar-frost is just frozen dew; but as it only appears when the surface of the earth is sealed with frost, the vapour of which it is formed cannot, of course, at the time perspire from the earth."*

178. *Hygrometers.* — Instruments intended to show the quantity and condition of the vapours contained in the atmosphere are called *hygrometers;* when they merely indicate the presence of aqueous vapour, without measuring its amount, they are called *hygroscopes.*

179. The measurement of the humidity of the atmosphere is a subject of greater importance to science than to practice; for however excellent the instrument may be for determining the degree of humidity, the atmosphere has assumed the humid state before an indication of its change is intimated by the instrument: and in this respect it is no better than the thermometer, which only tells the existing heat; and both are less useful on a farm than the barometer, which certainly indicates approaching changes.

180. Professor Leslie was the first to construct a useful instrument of this kind. It is of the form of the differential thermometer, having a little sulphuric acid in it; and the cold is produced by evaporation of water from one of the bulbs covered with black silk, which is kept wetted, and the degree of evaporation of the moisture from that bulb indicates the dryness of the air.

181. Another instrument is the dew-point hygrometer of Professor Daniells, which is considered rather difficult of management, except in expert hands.

182. The hygrometer of Dr Mason is

* Wells *On Dew*, p. 1-116, second edition, 1815.

an excellent one. It consists of two thermometers fastened upright to a stand, having a fountain of water in a glass tube placed betwixt them, and out of which the water is taken up to one of the bulbs by means of black floss silk. When the air is very dry, the difference between the two thermometers will be great; if moist, less in proportion; and when fully saturated, both will be alike. The silk that covers the wet bulb, and thread which conveys the water to it, require renewal about every month; and the fountain is filled when requisite with distilled water, or water that has been boiled and allowed to cool, by immersing it in a basin of the water till the aperture only is just upon the surface, and the water will flow into it. For ordinary purposes of observation, it is only necessary to place the instrument in a retired part of the room, away from the fire, and not exposed to weather, open doors, or passages; but for nice experiments, the observations should always be made in the open air and in the shade, taking especial care that the instrument be not influenced by the radiation of any heated bodies, or any currents of air. When the hygrometer is placed out of doors in frosty weather, the fountain had better be removed, as the freezing of the water within may cause it to break; in this case, a thin coating of ice may soon be formed on the wet bulb, which will last a considerable time wet, and be rewetted when required.

183. This instrument seems very similar to August's *psychrometer*, as described by Peschel. He says that "it consists of two very delicate mercurial thermometers, which exactly correspond, divided into fifths and even tenths of degrees, the scales ranging from —13° to 104° Fahrenheit; they are both fixed in a frame in a similar position, about three inches apart. One ball is surrounded with muslin, which is continually moistened by means of a thread of cotton attached to it, the other end hanging in a cup filled with distilled water; the other bulb is kept dry." The indications of this instrument are exactly similar to those of Mason's hygrometer.*

184. Simple hygrometers may be made of various substances — mostly of animal or vegetable origin — such as hair, fish-bone, ivory, animal membranes and intestines, the beard of wild oats, wood, &c. — to show whether the air is more or less humid at any given time. The awn of the Tartarian or wild oat, when fixed in a perpendicular position to a card, indicates, by its spiked inclined beard, the degree of humidity. A light hog's bristle split in the middle, and riding by the split upon the stem of the awn, forms a better index than the spike of the awn itself. To adjust this instrument, you have only to wet the awn and observe how far it carries round the index, and mark that as the lowest point of humidity; and then subject the awn to the heat of the fire for the highest point of dryness, which, when marked, will give betwixt the two points an arc of a circle, which may be divided into its degrees. I have used such an instrument for some time. When two or more are compared together, the mean humidity may be obtained. The awns can be renewed at pleasure. With regard to confiding in the truth of this simple hygrometer, the precaution of Dr Wells is worth attention. "Hygrometers formed of animal and vegetable substances," he remarks, "when exposed to a clear sky at night, will become colder than the atmosphere; and hence, by attracting dew, or, according to an observation of Saussure, by merely cooling the air contiguous to them, mark a degree of moisture beyond what the atmosphere actually contains. This serves to explain an observation made by M. de Luc, that in serene and calm weather, the humidity of the air, as determined by a hygrometer, increases about and after sunset with a greater rapidity than can be attributed to a diminution of the general heat of the atmosphere." †

185. *Boiling.* — It is the influence of external pressure that keeps the particles of water from being evaporated rapidly into the atmosphere. Even at 32°, the freezing point, if placed in a vacuum, water will assume the form of vapour, unless constrained by a pressure of 1½ ounce on each square inch of surface, and at higher temperatures the restraining force must be greater: at 100° it must be 13 ounces; at

* Peschel's *Elements of Physics*, vol. ii. p. 232—*Heat*.

† Wells *On Dew*, p. 64.

150° 4 lbs.; at 212° 15 lbs.; at 250° 30 lbs. Whenever the restraining force is much weaker than the expansive tendency, the formation of steam takes place so rapidly as to produce the bubbling and agitation called *boiling*. An atmosphere less heavy than our present one would have allowed water to burst into vapour at a lower temperature than 212°, and one more heavy would have had a contrary effect. Thus, the ebullition of water takes place at a lower temperature the higher we ascend mountains, and at a higher temperature the deeper we descend into mines. The boiling point may thus be made the measure of altitude of any place above the sea, or of one place above another. Dr Lardner has given a table of the medium temperature at which water boils at different places at various heights above the sea.* It appears that, at such an elevation as to cause the barometer to indicate 15 inches of atmospheric pressure, or at half the ordinary pressure of the atmosphère, water will boil at 180°. As a general rule, every tenth of an inch which the barometric column varies between the limits of 26 and 31 inches, the boiling temperature changes by one-sixth of a degree.

186. *Fuel.*—A few remarks on feul from Dr Arnott's valuable writings may not be out of place here, when we are considering the physical properties of various substances. The comparative value as fuel of different kinds of carbonaceous substances has been found by experiment to be thus:—

1 lb. of	charcoal of wood	melts	95 lb.	of ice.
—	good coal		90	—
—	coke		84	—
—	wood		32	—
—	peat		19	—

We thus see how valuable good coal, and how very inferior peat is, as a generator of heat—the latter not being much above half the value of wood. Good coal is thus the cheapest kind of fuel where it is abundant.

187. "A pound of coke," says Dr Arnott, "produces nearly as much heat as a pound of coal; but we must remember that a pound of coal gives only three quarters of a pound of coke, although the latter is more bulky than the former. It is wasteful to wet fuel, because the moisture, in being evaporated, carries off with it as latent, and therefore useless heat, a considerable proportion of what the combustion produces. It is a very common prejudice, that the wetting of coal, by making it last longer, is effecting a great saving; but while, in truth, it restrains the combustion, and, for a time, makes a bad fire, it also wastes the heat. Coal containing much hydrogen, as all flaming coal does, is used wastefully when any of the hydrogen escapes without burning; for, first, the great heat which the combustion of such hydrogen would produce is not obtained; and, secondly, the hydrogen, while becoming gas, absorbs still more heat into the latent state than an equal weight of water would. Now, the smoke of a fire is the hydrogen of the coal rising in combination with a portion of carbon. We see, therefore, that by destroying or burning smoke, we not only prevent a nuisance, but effect a great saving. The reason that common fires give out so much smoke is, either that the smoke, or what we shall call the vaporised pitch, is not sufficiently heated to burn, or that the air mixed with it, as it ascends in the chimney, has already, while passing through the fire, been deprived of its free oxygen. If the pitch be very much heated, its ingredients assume a new arrangement, becoming transparent, and constituting the common coal-gas of our lamps; but at lower temperature, the pitch is seen jetting as a dense smoke from cracks or openings in the coal—a smoke, however, which immediately becomes a brilliant flame if lighted by a piece of burning paper, or the approximation of the combustion. The alternate bursting out and extinction of these burning jets of pitchy vapour, contribute to render a common fire an object so lively and of such agreeable contemplation in the winter evenings. When coal is first thrown upon a fire, a great quantity of vaporised pitch escapes as a dense cold smoke, too cold to burn, and for a time the flame is smothered, or there is none; but as the fresh coal is heated, its vapour reproduces the flame as before. In close fire-places—viz. those of

* Lardner *On Heat*, p. 413.

great boilers, as of steam-engines, &c., all the air which enters after the furnace-door is shut, must pass through the grate and the burning fuel lying on it, and there its oxygen is consumed by the red-hot coal before it ascends to where the smoke is. The smoke, therefore, however hot, passes away unburnt, unless sometimes, as in iron foundery furnaces, where the heat is very great indeed; and it burns as a flame of a great lamp at the chimney-top, on reaching the oxygen of the open atmosphere. . . . . . A smoke-consuming fire would be constructed on a perfect principle, in which the fuel was made to burn only at the upper surface of its mass, and so that the pitch and gas disengaged from it, as the heat spread downward, might have to pass through the burning coals where fresh air was mixing with them; thus the gas and smoke, being the most inflammable parts, would burn first and be all consumed. . . . . Coal in a deep narrow trough, if lighted at its surface, burns with a lofty flame as if it were the wick of a large lamp; for all the gas given out from the coal below, as that is gradually heated, passes through the burning fuel and becomes a flame. Now, if we suppose many such troughs placed together, with intervals between them, in place of the fire-bars of a common grate or furnace, there would be a perfect no-smoking fire-place. . . . . . The reason of the vast saving of fuel by such a grate is, that the smoke, instead of stealing away latent heat—being yet itself the most combustible and precious part of the fuel, gives all its powers and worth to the purpose of the combustion." *

188. Light.—The science which treats of the properties and phenomena of light and vision is termed Optics.

189. The properties of light are, that "it is an emanation from the sun and other luminous bodies, becoming less intense as it spreads, and which, by falling on other bodies, and being reflected from them to the eye, renders them visible. It moves with great velocity, and in straight lines, where there is no obstacle, leaving shadows where it cannot fall. It passes readily through some bodies, which are therefore called transparent; but when it enters or leaves the surface obliquely, it suffers at times a degree of bending or refraction proportioned to the obliquity. And a beam of white light thus refracted or bent, under certain circumstances, is resolved into beams of all the elementary colours, which, however, in being again blended, become the white light as before."

190. "There have been two opinions respecting the nature of light: one, that it consists of extremely minute particles, darting all around from the luminous body; the other, that the phenomenon is altogether dependent on an undulation among the particles of a very subtile elastic fluid diffused through space—as sound is dependent on an undulation among air-particles. Now, if light be particles darting around, their minuteness must be wonderful, as a taper can fill with them for hours a space of four miles in diameter; and with the extreme velocity of light, if its particles possessed at all the property of matter called inertia, their momentum should be very remarkable; it being found, however, that even a large sunbeam collected by a burning-glass, and thrown upon the scale of a most delicate balance, has not the slightest effect upon the equilibrium. Such and many other facts lead to the opinion, that there is an undulation of an elastic fluid concerned in producing the phenomena of light."

191. There is no immediate relation between agriculture and the general propositions of optics; still the influence of light has so very powerful an effect upon vegetation, that to a mind desirous of tracing the causes and connexion of natural phenomena, the origin of colours must prove interesting. For an explanation of this remarkable phenomenon, I may quote the words of Dr Arnott:—"The most extraordinary fact connected with the bending of light is, that a pure ray of white light from the sun admitted into a darkened room by a hole in a window-shutter, and made to bend by passing through transparent surfaces which it meets obliquely, instead of bending altogether, and appearing still as the same

* Arnott's *Elements of Physics*, vol. ii. part 1, p. 149-153—*Heat.*

white ray, is divided into several rays, which, falling on the white wall, are seen to be of different most vivid colours. The original white ray is said thus to be analysed, or divided into elements. The solar spectrum, as it is called, formed upon the wall, consists, when the light is admitted by a narrow horizontal slit, of four coloured patches corresponding to the slit, and appearing in the order, from the bottom, of red, green, blue, and violet. If the slit be then made a little wider, the patches at their edges overlap each other, and, as a painter would say, produce by the mixture of their elementary colours various new tints. Then the spectrum consists of the seven colours commonly enumerated and seen in the rainbow, viz. red, orange, yellow, green, blue, indigo, and violet. Had red, yellow, blue, and violet been the four colours obtained in the first experiment, the occurrence of the others, viz.—of the orange, from the mixing of the edges of the red and yellow; of the green, from the mixture of the yellow and blue; and of the indigo, from the mixture of the blue and violet—would have been anticipated. But the true facts of the case not being such, proves that they are not yet well understood.

192. "When Newton first made known the phenomenon of the many-coloured spectrum, and the extraordinary conclusion to which it led, he excited universal astonishment; for the common idea of purity-the most unmixed was that of white light. In farther corroboration of the notion of the compound nature of light, he maintained that if the colours which appear on the spectrum be painted separately round the rim of a wheel, and the wheel be then turned rapidly, the individual colours cease to be distinguished, and a white beam only appears where they are whirling; also, that if the rays of the spectrum produced by a prism be again gathered together by a lens, they reproduce white light. The red is the kind of light which is least bent in refraction, and the violet that which is most bent. It was at one time said, as an explanation, that the differently coloured particles in light had different degrees of gravity or inertia, and were therefore not all equally bent. It is farther remarkable, with respect to the solar spectrum, that much of the heat in the ray is still less refracted than even the red light; for a thermometer held below the red light rises higher than in any part of the visible spectrum; and that there is an influence more refrangible than even the violet rays, producing powerful chemical and magnetical effects. The different spots of colour are not all of the same size, and there is a difference in this respect according to the refracting substance."*

193. The recent experiments on the influence of light in its various colours on vegetation, by Mr Hunt of the Museum of Economic Geology in London, have much increased the sphere of our knowledge; and as the results obtained by Mr Hunt are highly probable, I shall present them in the popular form they appeared in the *Gardeners' Chronicle.* "Yellow light *(luminosity)* impedes germination, and accelerates that decomposition of carbonic acid which produces wood and woody tissues. Under its influence leaves are small and wood short-jointed. Red light *(heat)* carries heat and is favourable to germination, if abundance of water is present, increases evaporation, (or perspiration,) supports the flowering quality and improves fruit. Under its influence colour is diminished and leaves are scorched. Blue light *(chemical action or actinism)* accelerates germination and causes rapid growth. Under its influence plants become weak and long-jointed."

194. In a lecture delivered by Mr Hunt to the Society of Arts, on the 16th February 1848, he stated that "experiments had proved that although light was injurious to the germinating seed, and actinism a most powerful accelerating agent in that process, when the first leaves were developed, the actinic principle as separated from light became too stimulating, and that the luminous principle was then demanded to effect in the plant the decomposition of the carbonic acid inhaled by the leaves and absorbed by the bark, and the secretion of carbon to form woody structure. The influence of heat and its necessity to vegetable life were well

* Arnott's *Elements of Physics*, p. 162 and 190.

known; but it had also been proved that as the calorific rays increased towards the autumnal season, the luminous and actinic relatively diminished. The scorching effects to be prevented were of course the result of some of the heat rays; and he had discovered to which class they belonged by spreading the expressed juice of Palm leaves over paper, and exposing it to the action of the spectrum. This class of ray had the power of acting partly by calorific force and partly by chemical agency—a phenomenon which had been previously detected by Sir John Herschell, and classed by him with others, to which he gave the name of Parathermic rays. It was important in adopting any tinted medium that no light should be intersected, no actinism extracted, and that the ordinary heat rays should not be interfered with. The experiments of Melloni had shown that a peculiar green glass, made in Italy, when washed with a solution of alum, would admit the free passage of light, but abstract a very large quantity of heat. The desideratum, therefore, to be obtained was a green glass which should of itself intercept the scorching rays without obstructing the others. Mr Hunt, with the assistance of Mr Turner, the contractor, procured from all parts of the kingdom green glasses of every variety of shade; but which, on examination, were all found to be objectionable. Mr Hunt then experimented with fluid media, diluting the colours to any degree, and examining the absorbing power of a great variety of chemical bodies. By this means he arrived at last at the discovery of a colour produced by oxide of copper in a very diluted state, which would effectually obstruct the scorching rays; and Messrs Chance, after many trials, succeeded in producing a glass which neither obstructed any light nor interfered with the colour of the most delicate white flowers, nor excluded the passage of the chemical rays, while it would completely prevent the permeation of the heat rays, which were found to have so remarkable a scorching property. In the manufacture of this glass the entire absence of manganese, though used in the ordinary construction of glass, had been insisted on; because that mineral, when used in the slightest excess, had the curious property, when under the influence of light, of imparting a pink tinge; and the slightest approach to redness would allow the free passage of those rays it was so important to obstruct.

195. "From the facility with which we were enabled," continued Mr Hunt, "to regulate by the use of coloured media the quantity of either light, heat, or actinism, which may be admitted to growing plants, we had at command the means of supplying the increased action of any of these forces. Germination might be quickened by the action of the actinic power, independently of light, and the full action of chemical rays was secured by the use of glasses stained blue by cobalt. In all cases the germination of seeds may be quickened by covering them with such blue glass as was used in making many finger-glasses; and since the striking of cuttings was dependent upon the exercising of an analogous force to that which quickened germination, similar glass shades would be found advantageous to effect this object. It must, however, be remembered that the excitement of that chemical agent must be withdrawn after germination had been effected, and the roots were formed, and an independent existence was given to the plant. When there was any tendency in plants to form too much stalk or leaves, and it was desired to produce more wood, it was done by admitting as much light as possible with the smallest possible quantity of actinic power. That might be effected by interposing glasses of a yellow tint, which obstructed the passage of the chemical rays, but would intercept very little light. It frequently occurred that, owing to some peculiar atmospheric condition, the flowers of plants did not develop themselves in a natural or healthy manner; the vegetative functions being too active, and interfering with the reproductive powers of the plant, often giving rise to leaves in the centre of the flower. All his experiments proved that the calorific radiations were the most active during the period in which the plant produced flowers, fruits, or seeds. The absence of the luminous rays in considerable quantities, and a diminished quantity of the chemical or actinic radiation, might be secured at will, without interfering with the heat-giving principle, by the use of glasses coloured red by the oxide of gold. Mr Hunt suggested, therefore, to horti-

culturists the occasional use of glasses coloured so as to secure the perfect formation of the flower."

196. "Experiments, however, are much wanted on this subject," as Dr Lindley properly observes; "for it is obvious, and by no means improbable, that unexpected difficulties may occur in applying the facts above mentioned to practice; and that although the luminous, heating, and chemical rays may be *separated*, there may be no means of *blending* them in such proportions as will render the artificial light thus created adapted to the purposes of vegetation. It is indeed improbable, to say the least of it, that any artificial light should be so well suited to plants as that which has been provided for them by the great Author of the universe." *

197. CHEMISTRY.—Chemistry is a branch of natural science useful to agriculture. Chemical action effects great and important changes in the structure of natural objects without the aid of motion, so that its operations are not cognisable by the senses; whereas the laws of natural philosophy operate in all cases by means of motion, and therefore present themselves directly to the notice of our senses. So universal is the extent of chemical action that, whenever different substances having affinity for each other are placed in contact, a sensible change takes place in the touching surfaces; and the effect of the change will continue unaltered as long as the separated surfaces remain in a similar condition; but the interference of certain agencies—such as heat, cold, moisture, drought, electricity, vitality, motion—will cause additional chemical changes to be effected in those surfaces as long as they are in contact. Thus the motion occasioned by the action of the agricultural implements amongst the particles of so complicated a material as the arable soil, causes a chemical change to take place in the varied substances composing the soil. A fall of rain causes another sort of change amongst the components of the same soil. The abstraction of substances in a state of solution by living plants from the soil and air, produces in the soil and air, as well as in the vegetable economy, great chemical changes. The removal of vegetable substances from the soil by animals, and the return of the same in their dung, also produce great changes in the soil and air, as well as in the animal economy. That electricity, or magnetism, or the voltaic action, has an intimate connexion with chemical changes there can be no doubt, since it has been well ascertained that no chemical action takes place without the evolution of electricity. Since one or more of these agencies are constantly in action, we must believe that chemical changes are as continually occurring in the earth, the air, or in the animal and vegetable kingdoms; and the importance of those changes is implied in the certainty of their results—changes in the same substances producing similar results under similar conditions.

198. *Organic matter.*—It is impossible to notice every minute change continually occurring in the chemical state of the numerous substances presented in nature; yet, in investigating the constituents of material objects, chemistry has discovered that plants consist of elements which may be classified under two heads: one in which the structure may be almost entirely dissipated by the action of heat in simple combustion; and another in which the parts resist combustion, and produce solid matter having very different properties. The class of substances entirely dissipated by combustion are called *organic,* because they "generally exhibit," observes Professor Johnston, "a kind of structure readily visible to the eye—as in the pores of wood and in the fibres of hemp, or of the lean of beef—and are thus readily distinguished from inorganic matters in which no such structure is observable; but, in many substances of organic origin also, no structure can be observed. Thus sugar, starch, and gum, are found in plants in great abundance, and yet do not present any pores or fibres; they have never been endowed with organs, yet, being produced by the *agency* of living organs, they are included under the general name of organic matter. So, when animals and plants die, their bodies undergo decay; but the substances of which they are composed, or which are formed during their

* *Gardeners' Chronicle,* for the 26th February and 4th March, 1848.

decay, are considered as of organic origin, not only as long as any traces of structure are observable, but even after all such traces have disappeared. Thus, coal is a substance of organic origin, though almost all traces of the vegetable matter from which it has been derived have been long ago obliterated. Again, heat chars and destroys wood, starch, and gum, forming black substances totally unlike the original matter acted upon. By distillation, wood yields tar and vinegar; and by fermentation, sugar is converted first into alcohol, and then into vinegar. All substances derived from vegetable or animal products, by these and similar processes, are included under the general designation of organic bodies."

199. The second class of substances are called *inorganic*, because they neither are, nor have been, the seat of life. "The solid rocks, the incombustible part of soils, the atmosphere, the waters of the seas and oceans, every thing which neither is nor has been the seat of life, may generally be included under the head of inorganic matter." *

200. *Inorganic matter.*—The existence of inorganic matter in plants has long been known to chemists, even prior to 1698; for in that year a list of the mineral ingredients of plants, by Redi, was published in the *Philosophical Transactions*. From that period until the publication of the researches of the younger Saussure, in 1804, the subject does not seem to have attracted the particular attention of chemists as one of paramount importance; and it was reserved for Professor Liebig of Giessen, so lately as 1840, to make the general impression that it is to their mineral ingredients alone that plants owe their peculiarities. The nutrition of plants was, before his time, a subject of much difficulty and doubt; but, by the adoption of his idea,—that plants find new nutritive materials only in inorganic substances—a clear view has been obtained of the great end of vegetable life being to generate matter adapted for the nutrition of animals, which are not otherwise fitted for the purpose; and the purport of his researches has been to elucidate the chemical processes engaged in the nutrition of vegetables.

201. During those researches Liebig has solved some chemical problems, which cannot fail to place the culture of plants and the fattening of animals on a more rational system of practice than has hitherto been pursued. Some of the most important of his demonstrations are these:—If certain "acids constantly exist in vegetables, and are necessary to their life, which is incontestable, it is equally certain that some alkaline base is also indispensable, in order to enter into combination with the acids; for these are always found in the state of neutral or acid salts. All plants yield by incineration ashes containing carbonic acid; all, therefore, must contain salts of an organic acid. Now, as we know the capacity of saturation of organic acids to be unchanging, it follows that the quantity of the bases united with them cannot vary; and, for this reason, the latter substances ought to be considered with the strictest attention, both by the agriculturist and physiologist. We have no reason to believe that a plant in a condition of free and unimpeded growth produces more of its peculiar acids than it requires for its own existence; hence a plant, in whatever soil it grows, must contain an invariable quantity of alkaline bases. Culture alone will be able to cause a deviation. In order to understand the subject clearly, it will be necessary to bear in mind that any one of many of the alkaline bases may be substituted for another, the action of all being the same. Our conclusion is, therefore, by no means endangered by the existence in one plant of a particular alkali, which may be absent in others of the same species. If this inference be correct, the absent alkali or earth must be supplied by one similar in its mode of action, or, in other words, by an equivalent of another base. The number of equivalents of these various bases, which may be combined with a certain portion of acid, must consequently be the same, and therefore the amount of oxygen contained in them must remain unchanged under all circumstances, and in whatever soil they grow."—"It has been distinctly shown by the analyses of

* Johnston's *Lectures on Agricultural Chemistry*, second edition, p. 22.

De Saussure and Berthier, that the nature of a soil exercises a decided influence on the quality of the different metallic oxides contained in the plants which grow on it. Hence it has been concluded (erroneously, I believe) that the presence of bases exercises no particular influence upon the growth of plants: but even were this view correct, it must be considered as a most remarkable accident that these same analyses furnish proof for the very opposite opinion. For although the composition of the ashes of the pine-trees at Mont Breven and from Mont La Salle was so very different, they contained, according to the analyses of De Saussure, an equal number of equivalents of metallic oxides, or what is the same thing, the quantity of oxygen contained in all the bases was in both cases the same."

202. "It is not known in what form manganese and oxide of iron are contained in plants; but we are certain that potash, soda, and magnesia can be extracted by means of water from all parts of their structure, in the form of salts of organic acids. The same is the case with lime, when not present as insoluble oxalate of lime. The potash in grapes is always found as an acid salt, viz., cream of tartar, (bitartarate of potash,) and never in the form of a neutral compound. As these acids and bases are never absent from plants, and as even the form in which they present themselves is not subject to change, it may be affirmed that they exercise an important influence on the development of the fruits and seeds, and also in many other functions, of the nature of which we are at present ignorant."—"The existence of vegetable alkalies, in combination with organic acids, gives great weight to the opinion that alkaline bases in general are connected with the development of plants."—"If it be found, as appears to be the case in the juice of poppies, that an organic acid may be replaced by an inorganic, without impeding the growth of a plant, we must admit the probability of this substitution taking place in a much higher degree in the case of the inorganic bases. When roots find their more appropriate base in sufficient quantity, they will take up less of another. These phenomena do not show themselves so frequently in cultivated plants, because they are subjected to special external conditions, for the purpose of the production of particular constituents or of particular organs."—"Plants have the power of returning to the soil all substances unnecessary to their existence; and the conclusion to which all the foregoing facts lead us, when their real value and bearing are apprehended, is, that the alkaline bases, assisting in the action of plants, must be necessary to their growth, since, if this were not the case, they would not be retained. The perfect development of a plant, according to this view, is dependent on the presence of alkalies or alkaline matter; for when these substances are totally wanting its growth will be arrested, and when they are only deficient it must be impeded. In order to apply these remarks, let us compare two kinds of trees, the wood of which contains unequal quantities of alkaline bases, and we shall find that one of these may grow luxuriantly in several soils upon which the other is scarcely able to vegetate. For example, 10,000 parts of oak-wood yield 250 parts of ashes, the same quantity of fir-wood only 83, of linden-wood 500, of rye 440, and of the herb of the tobacco plant 1500 parts. Firs and pines find a sufficient quantity of alkalies in granitic and barren sandy soils, in which oaks will not grow, and which thrive in soils favourable for the linden tree, because the bases necessary to bring it to complete maturity exist there in sufficient quantity. The accuracy of these conclusions, so highly important to agriculture and to the cultivation of forests, can be proved by the most evident facts."—"The ashes of the tobacco plant, of the vine, of pease, and of clover, contain a large quantity of lime. Such plants do not flourish in soils devoid of lime. By the addition of the salts of lime to such soils, they become fitted for the growth of these plants; for we have every reason to believe that their development essentially depends upon the presence of lime. The presence of magnesia is equally essential, there being many plants, such as the different varieties of beet and potatoes, from which it is never absent. The supposition that alkalies, metallic oxides, or inorganic matter in general, may be produced by plants, is entirely refuted by these well-authenticated facts." The general conclusion of the value of these propositions, as regards the culture of plants

and trees, is expressed in these terms:—"From these considerations we must perceive that exact and trustworthy examinations of the ashes of plants of the same kind, growing upon different soils, would be of the greatest importance to vegetable physiology, and would decide whether the facts above mentioned are the results of an unchanging law for each family of plants, and whether an invariable number can be found to express the quantity of oxygen which each species of plants contains in the bases united with organic acids. In all probability such inquiries will lead to most important results; for it is clear that if the production of a certain unchanging quantity of an organic acid is required by the peculiar nature of the organs of a plant, and is necessary to its existence, then potash or lime must be taken up by it in order to form salts with this acid; and if these do not exist in sufficient quantity in the soil, other alkaline bases, of equal value, must supply their place; and that the progress of a plant must be wholly arrested when none are present."*

203. The mineral ingredients of a plant bear but a small proportion to its entire weight. The extreme quantities of these ingredients in cultivated plants may perhaps be stated at from $\frac{1}{500}$ to $\frac{1}{6}$ of the weight, and the average may perhaps be stated near the truth at $\frac{1}{20}$ or 5 per cent of the weight. Saussure, who devoted so much of his attention to the analysis of the mineral ingredients of plants, would seem to fear that the smallness of their proportions might render them unimportant in the estimation of agriculturists and others. "Many authors," he says, as quoted by Liebig, "consider that the mineral ingredients of plants are merely accidentally present, and are not at all necessary to their existence, because the quantity of such substances is exceedingly small. This opinion may be true as far as regards those matters which are not always found in plants of the same kind; but there is certainly no evidence of its truth with those invariably present. Their small quantity does not indicate their inutility. The phosphate of lime existing in the animal body does not amount to a fifth part of its weight, yet it cannot be affirmed that this salt is unnecessary to the formation of its bones. I have detected the same compound in the ashes of all plants submitted to examination, and we have no right to suppose that they could exist without it." To show the important effects of the most minute proportion of ingredients, Liebig has given a few interesting illustrations. "In a comprehensive view of the phenomena of nature," he remarks, "we have no scale for that which we are accustomed to name, small or great—all our ideas are proportioned to what we see around us; but how insignificant are they in comparison with the whole mass of the globe! that which is scarcely observable in a confined district, appears inconceivably large when regarded in its extension through unlimited space. The atmosphere contains only a thousandth part of its weight of carbonic acid; and yet, small as this proportion appears, it is quite sufficient to supply the whole of the present generation of living beings with carbon for a thousand years, even if it were not renewed. Sea-water contains $\frac{1}{12400}$ of its weight of carbonate of lime; and this quantity, although scarcely appreciable in a pound, is the source from which myriads of marine mollusca and corals are supplied with materials for their habitations."—"The air hanging over the sea always contains enough of common salt to render turbid a solution of nitrate of silver, and every breeze must carry this away. Now, as thousands of tons of sea-water annually evaporate into the atmosphere, a corresponding quantity of the salts dissolved in it,—viz., of common salt, chloride of potassium, magnesia, and the remaining constituents of sea-water—will be conveyed by wind to the land."—"The roots of plants are constantly engaged in collecting from the rain those alkalies which formed part of the sea-water, and also those of the water of the springs penetrating the soil. Without alkalies and alkaline bases most plants could not exist, and without plants the alkalies would disappear gradually from the surface of the earth. When it is considered that sea-water contains less than one-millionth of its own weight of iodine, and that all combinations of iodine with the metallic bases of alkalies are highly soluble in water, some provision must necessarily be supposed to exist in

* Liebig's *Chemistry of Agriculture and Physiology*, 3d edition, p. 67-78.

the organisation of sea-weed and the different kinds of fuci, by which they are enabled, during their life, to extract iodine in the form of a soluble salt from sea-water, and to assimilate it in such a manner that it is not again restored to the surrounding medium. These plants are collectors of iodine just as land plants are of alkalies; and they yield us this element in quantities such as we could not otherwise obtain from the water, without the evaporation of whole seas. We take it for granted that the sea plants require metallic iodines for their growth, and that their existence is dependent on the presence of these substances. With equal justice, then, we conclude that the alkalies and alkaline earths, always found in the ashes of land plants, are likewise necessary for their development."*

204. *Specific manures.*—On the demonstration of such propositions as these, and many of a similar character, Professor Liebig arrived at the conclusion that, to promote the healthy growth of plants, it was not only necessary to supply them with such food as would support their general structure, as indicated by the composition of their organic parts, but also food of such a specific nature as would support their peculiar properties, as indicated by their inorganic ingredients; and as regards the rearing and fattening of animals, such food should be provided them as to supply the materials of flesh and bones to young animals, and of flesh and fat to those which are to be fattened. Hence the use of specific manures and of specific food, for the rearing of plants and animals to the best advantage to the farmer. Could all the operations of agriculture be thus conducted so as to ensure certain results, experience in the art would be abandoned, and science alone guide the way. This is a consummation as yet to be desiderated, and will be only attainable, if attainable at all, after the composition of all the plants in cultivation, of all the manures in use, and of all the soils bearing plants and animals, shall be made known by the researches of chemistry. Until that knowledge shall have been acquired, chemists will have a wide and extensive field to explore; and then, after all the labour has been accomplished, it will remain to be determined by practice how to use the vast fund of knowledge to the best advantage.

205. While Liebig, a foreigner, has obtained the credit of being the first to present the subjects of specific manures, and the mineral ingredients of plants, before the British farmers in a practicable shape, and which he did so lately as 1840, there were persons in our own country whose attention had been devoted to those particular subjects. Mr Grisenthwaite of Nottingham, in 1818, published the doctrine of specific manures, and of the existence of saline ingredients in plants, at one of the annual meetings at Holkham under the late Mr Coke; and in 1830, in the second edition of his *New Theory of Agriculture*, he devotes an entire chapter to the exposition of his views on specific manures. In describing the particular ingredients of some plants, he says, "Let us recur once more to the grain of wheat. In that grain there always exists, as has been stated, a portion of phosphate of lime. It is the constancy of its presence that proves, beyond reasonable doubt, that it answers some important purpose in the economy of the seed. It is never found in the straw of the plant: it does not exist in barley, or oats, or peas, although grown upon the same land and under the same circumstances, but, as has just been observed, *always* in wheat. Now, to regard this unvarying discrimination as accidental, or to consider it as useless, is to set at defiance the soundest principles of reasoning that philosophy ever bruited. If phosphate of lime had sometimes only been found in wheat, or if it had been discovered in barley or clover, then we might have concluded that the whole was accidental, that it in no way whatever assisted the formation of the perfect grain, nor contributed to promote the general design of it. They who can oppose these conclusions, will depart from a method of reasoning long established in every department of human knowledge,—a method to which the Baconian philosophy directs us, and to which we must have recourse whenever we are desirous to explain the causes of physical effects. As little attention," he

* Liebig's *Chemistry of Agriculture and Physiology*, 3d edition, p. 82.

continues, "has hitherto been paid to these saline bodies, at least as they regard the subject of vegetation, and much as they respect the operations of husbandry, I have, for the sake of distinction, called them *specific manures*. Hereafter, when a more complete analysis of vegetables shall be made, it is probable that a nomenclature, founded on their specific substances, may at least classify, if not particularise, every kind of plant. Already we know that there are several vegetables which exercise the power of selection; and it is reasonable to infer, that when investigation shall have more fully laid open the secrets of physiology, that then the uses and design of this selection will be rendered apparent, and the propriety of regarding it in practical husbandry completely established." This reasoning was sound then, is sound at the present day, and could not be better expressed by even Liebig himself.

206. On the beneficial effects of the employment of specific manures to agriculture, Liebig himself does not in any of his works express himself more clearly and firmly than did Mr Grisenthwaite in 1830; and it should be borne in mind that it was he so long ago that applied the term *specific* to this class of manures. "The subject of specific manures," he observes, "has never been regarded by practical men, nor ever been considered by writers on the theory of agriculture, though some practices have been recommended, and some opinions formed, even from the earliest ages, which are only explicable upon the principle here laid down. And yet, when viewed in its relation to the whole economy of agriculture, it forms, perhaps, one of the most important, as it is certainly one of the most interesting, objects connected with it. Upon the clear understanding of it depends the successful business of the farmer. It is calculated to raise the operations of the agriculturist to a level with those of the manufacturer; and instead of committing the cultivation of the soil to accident, as if nothing were understood respecting it more than the mechanical preparations of it for the seed, it will serve to explain upon what causes growth and production, and, consequently, their opposites, abortion and nonproduction, fundamentally depend; and of course will enable him to provide against both. Agriculture, may be considered a system of operations designed to convert manure into certain vegetable matters; and the land or soil performs the office of an instrument in the process; that all the care employed in its preparation is only intended to render the conversion more certain and complete; that it accomplishes these desirable ends by facilitating the action of air, heat, light, &c., upon the substances committed to it, and by giving to water a freedom of motion through it. This view of the business of agriculture will open to us many objects which have hitherto escaped observation, and which have never excited reflection; perhaps because the whole operation has been thought beyond the reach of the human mind. What is done spontaneously, and without any co-operation of man, is called natural; what is done by his exertions is called artificial—as if the same laws did not govern the result in both; whereas man, under any circumstances, can only bring the laws of nature into action; he cannot create new laws, nor modify those which already exist. But to distinguish between those which are in action without his care, and those which he calls into play by his own labour, has placed a great impediment in the path of science, and stopped for a long time the career of discovery. It has repressed inquiry by pronouncing it to be vain, and called off exertion by declaring it to be unavailing."

207. Upon these general principles our author endeavours to test the correctness of ordinary practice. "It is only within the last few years," he continues, "that the elements of bodies have been discovered. Before that time, the nature of compounds was but little understood, and the transmutation of matter, if not openly acknowledged, was only tacitly denied. The sun of chemistry has at length risen above our horizon, and dispersed much of the darkness of ignorance which covered former ages, and shed an illuminating ray over the various phenomena of nature. Elements, as the very term implies, are now known to be incapable of being changed into each other. They admit, when considered *per se*, of no alteration but as regards magnitude and figure; and all the variety of matter discoverable in the world is produced by

combinations of these elements in different proportions. From this fact we are led to deduce the following important conclusion, —that when out of one substance another is to be formed, as alcohol or acetic acid by fermentation out of sugar—or, to confine our views to agriculture, grain out of manure, it is obvious that the elements of the first must be contained in the second; as, if they be not, that conversion cannot possibly take place. This is a truth which applies with peculiar force to the doctrine of manures, and renders it imperatively incumbent upon the agriculturist to investigate the constituents both of the crops he grows, and of the manures he employs to make that growth successful. It is very reasonably to be feared, that many failures, quite inexplicable to the farmer, may be explained upon these principles. He has very frequently, perhaps, sown grain upon land which has not contained the elements necessary to the production of the crop, and therefore the crop has failed; and he continues to suffer a recurrence of the same loss, year after year, because he is unacquainted with the causes upon which it depends. If all crops were composed of the same elements, this reasoning, this discrimination among manures, could not apply, nor be necessary to be regarded by the agriculturist; and it is upon such a supposition that the practices of husbandry have been uniformly conducted, and are at the present day conducted with disadvantage."

208. To descend to particulars, our author shows that of the various kinds of plants cultivated in the field, each contains its peculiar base. Thus, the grain of wheat, besides its characteristic gluten, contains the phosphate of lime. "In barley there is no phosphate of lime, but a small portion of nitrate of soda or potash." — "The straw of the bean always yields, after maceration, a considerable quantity of sub-carbonate of potash."—"In the pea crop has been discovered a considerable quantity of superoxalate of lime, a salt also known to exist in the root of rhubarb." — "Sainfoin, clover, and lucerne have long been known to contain a notable quantity of gypsum (sulphate of lime.)" — "If we examine a turnip chemically, we shall always find in it a considerable quantity of a hydrosulphuret or a hydroguretted sulphuret—compounds not discernible in any of the crops heretofore considered, and therefore constituting the specific saline substance of the turnip. The existence of this substance is manifested also by the tarnish which boiled turnips impart to silver, and by the fetid effluvium attendant on a turnip field, where they are undergoing decomposition." In enumerating these particular substances, Mr Grisenthwaite indicates the different manures which will yield them to their respective crops; and as some stress may be laid on the minuteness of the quantities of these salts to perform so important purposes in the economy of plants, he points to the analogy between plants and animals, as organised bodies governed by a vital principle, as affording a satisfactory explanation of the results. "Thus, in the animal system, there are many salts and minute quantities of matter indispensably necessary for the production or the healthy action of various solids and fluids, the absence of which occasions disease, and, if long continued, death also. The bile *must* have *soda*, or the secretion of the largest and one of the most important glands in the animal system could not produce those effects required for the conservation of health. This soda does not amount to the one - hundred - thousandth part of the whole animal mass. The blood, according to those physiologists who explain its redness by the sub - oxy - phosphate of iron, must somehow acquire that salt, or the business of this vital fluid will, probably, be interrupted. All the cartilages, fibrine, nails, hair, &c., contain sulphur, as well as the albumen of the blood; and shall we venture to say that all this regular discrimination, these undeviating laws, contribute nothing to the vigorous existence and healthy action of the several parts over which they exercise so constant a control, because the quantities are minute? Would not such a supposition ascribe to nature, who is ever frugal of her means, never in excess, a work of supererogation? And if these one-hundred-thousandth parts be absolutely required for animal existence, would it not be presumptuous and quite unphilosophical to suppose that their presence in vegetables is accidental and useless? Would it not oppose the soundest reasoning?"

Our author pursues the subject of specific manures as affording a satisfactory explanation of the rotation of crops; the maintenance of the fertility of the soil; the improved growth of forest-trees; the selection of fruit-trees for particular soils; the admixture of soils; and, finally, the extermination of weeds. On all these subjects the observations of even Liebig himself seem but amplifications of our author's sentiments; and, so satisfied is he of their correctness, that he expresses his belief, "in another generation all this will be well understood." — "It is true that this is not the day when such a system can be acted upon," as he regrettingly remarks; "but to-morrow may, if sufficient encouragement shall be offered to stimulate inquiry, and practice should adopt its results." *

209. In a former work I spoke somewhat disparagingly of the power of chemistry to benefit agriculture. In the circumstances in which I wrote, the opinions I expressed were not altogether irrelevant; for no movement had been publicly made, to my knowledge, by a single chemist, from 1809, when Sir Humphry Davy published the celebrated lectures he had delivered before the Board of Agriculture, to the time my strictures were written and even printed; and, during this long blank period of nearly thirty years, no one seemed to me to be sanguine enough to expect any beneficial aid to be afforded to agriculture by chemistry, until Dr Henry Madden, when a medical student at the university of Edinburgh, introduced the subject of agricultural chemistry to the notice of the landed interest of the kingdom, in the pages of the *Journal of Agriculture*, for June 1838. Until that time I had not had the good fortune to see Mr Grisenthwaite's *New Theory of Agriculture*, and not until its author kindly sent me a copy, after the appearance of Dr Madden's early papers. Knowing what has since been done by chemists in analysing plants and manures employed in agriculture, as also the suggestions in improved practice which they since have made, and observing the results of the numerous experiments which have in consequence been conducted by farmers in all parts of the kingdom, my sentiments in regard to the assistance chemistry may afford to agriculture have been considerably modified, and cannot be better expressed than in the following words of a report issued by the *Chemistry Association of Scotland*, in 1846. Under the head of the "*Benefits which the Association is capable of rendering,*" the report observes—"'Chemical analyses of soils and plants throw much light upon the arcana of nature in the departments of her kingdom to which they respectively belong; they illustrate the relation which subsists between them, as regards the processes of vegetation; and they afford essential aid in ascertaining the kind and quality of substances that are required by given soils for the production of specific crops. The known principles, too, of chemical action, in resolution and composition, serve to explain facts which experience establishes in practical husbandry; while they elucidate the causes of the diversified, and more rarely opposite, effects which sometimes follow similar applications, and which, without the explanation that chemistry furnishes, would be likely to issue in discouragement and perplexity. The advantages of chemical analyses have been extensively experienced in the prevention of imposition, and in the right appreciation to which analytical investigations have led, with respect to different articles offered for sale as potent manures; and they have likewise been conspicuous in showing the absolute and comparative value of divers descriptions of food for use in rearing and fattening cattle. *It ought, however, never to be forgotten*, that the researches of the laboratory alone will not yield sufficient data for the formation of a sound theory, either of agricultural management or of feeding stock. There must, in addition, be an accumulation of carefully observed and accurately recorded facts, derived from experience, of the actual occurrences which take place in the conduct of the farm, and of the feeding house. It is from the combined results of practical observation and scientific research that just systems of practice may eventually be deduced; and the realisation of this desirable consummation will largely depend upon the assis-

* Grisenthwaite's *New Theory of Agriculture*, 2d edition, 1830, p. 159-210.

tance which able and scientific men shall receive from intelligent men of practice."*

210. Now, the spirit of these observations accords very much with what I have always held of the ability of chemists to instruct farmers. I have always maintained that farmers ought to know something of chemistry, and chemists something of agriculture. All the knowledge of chemistry required by farmers is of the affinity of bodies of different natures for one another, and a more particular knowledge of the properties of those bodies which are most frequently met with in the plants, animals, and earths, with which farmers have most to do, and these do not amount to above thirteen in number. The chemist ought to know all the common rules which have long been established by experience, in the culture of the soil and the treatment of live stock. With a proper understanding on the common ground which both chemist and farmer should occupy, it may reasonably be expected that a higher tone would be given to agriculture, and certainly an extended usefulness to chemistry would be thereby promoted. Let chemistry not attempt to take the lead of agriculture, but only re-recommend suggestions for experiment which may reasonably be expected to end in favourable results. Let chemists beware of drawing conclusions until practice has first established their soundness; and let farmers at all times be ready to undertake every experiment, how troublesome soever they may be, and there cannot be a doubt that, in the course of a few years, so large a stock of valuable facts will have been obtained, as to enable farmers to pursue a much more eminently enlightened system of husbandry than has yet been seen.

211. Besides the information afforded of the chemical composition of the subjects of nature, with which agriculture has particularly to do, the study of chemistry is useful to the farmer in affording him interesting information on the properties of all the natural objects around him, and on those numerons phenomena occurring on the surface of the earth, by which the general system of nature is daily sustained. In acquiring this knowledge, chemistry ascertains the chemical properties of the air, water, minerals, and of vegetable and animal bodies.

212. *Air.*— As regards its chemical properties — "The air," Mr Hugo Reid observes, "is of a blue colour, but very faint, so that the colour is perceptible only when a very large body of air is presented to the eye. The air is a compound body, consisting, in 1000 parts by weight, of 756 parts of nitrogen, a gas which cannot support combustion or respiration, 233 parts of oxygen, a gas which causes these processes to go on with too great activity, 10 parts of watery vapour, and 1 part of carbonic acid gas. The air is continually undergoing various changes, which more or less alter its chemical composition. By the breathing of animals, carbonic acid gas and watery vapour are added to the atmosphere, and oxygen removed. Plants, during germination, remove oxygen and replace it with carbonic acid; at times they produce the same effect by their leaves, while these same organs at other times remove carbonic acid from the air, and replace it with oxygen; they also add watery vapour to the atmosphere. Fermentation adds carbonic acid and watery vapour to the air, frequently diminishing the proportion of oxygen. Combustion, or burning, in general, converts the oxygen into carbonic acid and watery vapour. The air is essential to the existence of the animal and vegetable creation in a great number of ways. The oxygen serves to remove carbon from the body, by converting it into carbonic acid gas in the lungs, combines with combustible bodies, thus producing heat and light, and plays an important part in many other operations, as fermentation, germination, &c. The nitrogen dilutes and weakens the action of the oxygen. The carbonic acid and watery vapour, though not so directly essential to animal life as the oxygen and nitrogen, the removal of either of which, for a very short time, would be attended with fatal consequences, have still important offices allotted to them in the general economy of nature. The total mass of air being so immense, and all its different parts being so thoroughly raised by

* *Report of the Chemistry Association of Scotland,* for 1846, p. 9.

the winds, as well as by the diffusive process, the changes effected on the air by the various processes just mentioned, would not make a *perceptible* difference in many hundred years, and it would even be thousands of years before the air would be at all unfitted for any of the purposes for which it has been formed, this being still further (if not altogether) retarded by the action of vegetables, which seem to counteract the effects of the various processes which would unfit it for the support of combustion, respiration, &c. The various ingredients of the air, being each required for so many different operations in which the others are not concerned, are not bound to each other by chemical attraction, which would prevent each being readily supplied separately to that body which requires it: they are in a state of mere mechanical mixture, so that they are easily separated from each other by substances which have any attraction for them—being, nevertheless, diffused through each other in the same proportions every where, according to the law pointed out by Dr Dalton."

213. *Water.*—The chemical properties of water are thus described by Mr Reid. "Water exists every where, and is capable of assuming a great variety of forms. As commonly met with, water is a very compound substance, but consists chiefly of two ingredients, the others existing in it in a very small proportion. Water is composed chiefly of two substances, which assume the gaseous form when separated from each other—*hydrogen*, an inflammable body, but which cannot support the combustion of other bodies; and *oxygen*, which has the latter property, but cannot itself be made to burn, as discovered by Cavendish. Estimated by weight, these elements exist in water in the proportion of 8 of oxygen to 1 of hydrogen; estimated by measure of the exact quantities of the gases required to produce a certain quantity of watery vapour, without either gas being in excess and remaining in the unembodied state, 2 of hydrogen with 1 of oxygen; and, in becoming watery vapour, these become condensed into. two-thirds of the bulk they occupy separately—the bulk of the hydrogen. Water is a true chemical compound, not a mere mixture of its elements. Water is turned into vapour by heat, and into a solid (ice) when much heat is removed from it. Water can combine with a vast number of bodies, solids or gases, and make them pass to the liquid state. By its dissolving power, it separates the particles of bodies from each other, reduces them to a minute state of division; and, by bringing these particles in close contact with each other, enables them to exert their chemical affinities for other bodies. Water also unites with solid bodies, itself becoming solid; and it enters into the composition of crystals, and of animals and vegetables. All the water on the earth arises, in the first instance, from the ocean, in the form of vapour, which becomes deposited on the land as snow, rain, or dew; and, according to the nature of the ground on which it falls, gives rise to springs, rivers, or lakes. In different situations, water has different properties, from the various matters which it meets and dissolves being different in different places. The leading varieties are—sea-water, containing common salt, &c., rain and snow water, spring and well water, hard water, (this property arising from the presence of sulphate or carbonate of lime,) rain water, water of pools and marshes. Pure water is obtained by boiling common water to expel the gases, and distilling it, to separate the pure watery part from the earthy matters, the former arising in vapour, and being collected in a receiver. From the absence of the gases and earthy matters, pure or distilled water is insipid and mawkish, unfit to be used as drink. Waters become in some places so strongly impregnated with various matters which they dissolve, that their taste, colour, and chemical properties are affected in a marked degree, and they acquire at the same time medicinal properties. Of these there are four kinds—the carbonated, which contains carbonic acid as their most characteristic ingredient, as the waters of Selter, Spa, Pyrmont, and Carlsbad; the sulphureous, which contain sulphuretted hydrogen, as the waters of Aix-la-Chapelle, Harrogate, and Moffat; the chalybeate, which are distinguished by containing iron, such as the waters at Tunbridge, Brighton, and Cheltenham; and the saline, which are characterised chiefly by the presence of common salt, Epsom salt, glauber salt, muriate of lime—the

most noted of these are the waters of Bath, Bristol, Buxton, Epsom, Cheltenham, Pitcaithly, Dunblane, Seidlitz, Wiesbaden, Hombourg."

214. *Earths.*—The chemical composition of minerals is thus recapitulated by Mr Reid. "The mineral kingdom consists of *rocks* and *stones*, which are hard, heavy, and brittle, incombustible, and insoluble in water, exemplified by sandstone, whinstone, slate, flint: *sand, earth*, which are loose and powdery: *native metals*, mineral bodies which are rarely met with, and are characterised by being heavy, tough, or tenacious, malleable, and ductile, opaque, and perfectly insoluble in water: *native salts*, of a regular or crystalline form, not nearly so hard as rocks and stones, soluble in water, and consisting of some acid in union with a compound of a metal with oxygen: and *combustible minerals*. These six divisions include all the various kinds of mineral bodies; but rocks and stones are not to be considered as essentially different from earth, sand and earth being merely pulverised rocks; and then, rocks, stones, sand, earth, (*earthy matters*) form the main bulk of the mineral constituents of the earth, the quantity of metallic ores, metals, salts, and combustible minerals, is trifling when compared with these. Earthy matter consists, in general, of some substance of a metallic nature in chemical combination with oxygen, forming an oxide; this oxide being in some cases in chemical union with some body of an acid nature, first discovered by Sir Humphry Davy, with potassa and afterwards with lime, clay, &c., these being analogous to the common metallic oxides (as red lead) in their general composition. The leading earths are—*silica*, the mineral ingredient of sand and flint, and the most abundant of the earths, distinguished by its hardness, durability, and insolubility in water and all acids, except the fluoric:—*alumina*, or earth of clays, distinguished by the softness and plasticity which it possesses when mixed with water; this earth is next to silica in abundance:—*lime*, slightly soluble in water, caustic, and always found in nature in union with an acid (chiefly the carbonic,) with some other earthy matter:—and *magnesia, baryta, strontian*, &c. Earthy matter also contains considerable quantities of the *oxide of iron* and of potass, and the oxide of manganese and soda are also occasionally found among rocks and earth. The rocky masses in the crust of the earth are arranged in two great divisions, stratified and unstratified, and are composed of certain simple minerals, which are chiefly composed of silica and alumina, with smaller quantities of oxide of iron, lime, and magnesia, and minute portions of other ingredients. The chemical composition of earth and soils is similar to that of rocks, the former being composed of the latter broken down and reduced to fragments or to powder, by the chemical and mechanical action of air and water in the materials of the rock. The principal ingredients in the rock which are acted on, are the potash, lime, and oxide of iron. These, which to a certain extent act the part of cements to the various parts of the mineral in which they exist, when they enter into new states of combination, or are renewed, no longer perform their office for the renewal, and it speedily crumbles to pieces; hence the decay of monuments and buildings, and the formation of loose earthy soils from firm hard rocks. These soils soon give support to various kinds of plants, and become mixed with decayed vegetable matter, and thus form the common soil of the agriculturist."*

215. Natural History.—But the mechanical and chemical properties of matter do not afford us all the information that may be obtained of the objects of nature. These have external forms which undergo changes that have to be described, and the science that undertakes their description is called Natural History. If every object in nature admits of a description of its origin, growth, maturity, uses, and habits, it is evident that natural history must be more extensive than any of the other sciences, since it occupies itself with all the objects scrutinised by both mechanical and chemical philosophy. The treatment of the same subjects by these various sciences produces no tautology, and no object can be said to be perfectly known until its properties have been ascertained and described

* Reid's *Chemistry of Nature*, p. 139, 213, 282.

in every particular. The kingdoms of nature which form the subjects of natural history are the air,—the description of the apparent visible phenomena of which constitutes the science of *Meteorology;*—the water, the description of the nature and origin of which, in its different forms of sea, rivers, lakes, and springs, constitutes the science of *Hydrography;*—the earth, the description of the component parts forming the crust of our globe, constitutes the science of *Geology;*—the forms and functions of plants are described to us by *Botany;* — and the structure and habits of animals are made known to us by the descriptive science of *Zoology.*

216. Meteorology. — The changes which the atmosphere daily undergoes being occurrences of necessary observation to the farmer,—and these changes in fact constitute the weather, upon whose character the results of his labour so much depend,—renders meteorology one of the most important studies that can occupy his attention. "Indeed, the germ of meteorology is, as it were, innate in the mind of an Englishman; the weather is proverbially his first thought after any salutation; it comes to him instinctively; and is so a part of him that we can scarcely imagine him to meet his friend without giving utterance to the usual truism of 'fine day,' 'rainy weather,' 'very cold!' And who of us does not pride himself on the possession of a few weather axioms, by which we think to foresee the coming changes? Some of these axioms are sound; others are essentially true, but are often misapplied; while a large portion are false. That the latter should be a large class is obvious; because the casual observer is too apt to draw general rules from particular cases, without taking into account, or, perhaps, without being able to take into account, all the accidental circumstances that may be present. The only means we possess of eliminating these sources of error, and arriving at the general laws which govern atmospheric phenomena, is a course of faithful and unwearied observation, followed by sound and accurate deduction. The scientific world have, within the last few years, been awakened to the importance of this course; and very efficient means are in progress, and very plain instructions have been published, toward the attainment of the object in view. In the meantime, we must be reminded that many stumbling stones have been already removed; and that the path of meteorology has been trodden very effectually to a considerable extent." Such are the observations on this subject by Mr C. V. Walker, in the preface to his translation of Kaemtz's Meteorology, a work which had not come under my notice until my *Book of the Farm* had appeared, but which contains so complete a course of that interesting science, as to render it well suited for the study of the agricultural student.

217. In treating the subject of meteorology, on the present occasion, I wish to arrange its various departments in a different manner from what I did in the *Book of the Farm.* There, the whole subject of meteorology is embraced in one chapter, under the head of Weather; and although the weather is that part of the natural history of the atmosphere which most affects the operations, and comes nearest home to the feelings of the farmer, yet the subject, I now conceive, would be more clearly treated, because more naturally so, were the observations applicable to that part of the subject which treats of general principles, kept separate from those which are more immediately connected with the seasons; and when the operations of each season come to be explained in their natural order, the atmospherical phenomena prevalent in each would be most appropriately explained. Following this arrangement, I shall here describe only those phenomena of the atmosphere having no peculiarity in any particular season, confining my observations, of course, to those phenomena most cognisant to the farmer; reserving the relation of peculiar phenomena until we come to treat of those of each season in succession.

218. *Weather.*—As the weather, at all seasons, has undeniably a sensible power to expedite or retard the field operations of the farm, it becomes an incumbent duty on pupils of agriculture, to ascertain the principles which regulate its phenomena, in order to be enabled to anticipate their changes and avoid their injurious effects. It is, no doubt, difficult to acquire an accurate knowledge of the laws which govern the subtile elements of nature; and it is

especially difficult to trace those which affect the phenomena of the atmosphere; but experience has proved that *accurate observation of atmospherical phenomena* is the chief means we possess of becoming acquainted with the laws which govern them.

219. In saying that the weather has power to alter the operations of the farm, I do not assert that it can entirely change any great plan of operations that may have been determined on, for that may be prosecuted even in spite of the weather; but the weather, no doubt, can oblige the farmer to pursue a different and much less efficient treatment of the land than he desires, and the amount and quality of its produce may very seriously be affected by a change in its treatment. For example, the heavy and continued rain in autumn 1839 made the land so very wet, that not only that under the summer-fallow, but the potato-land, could not be seed-furrowed; and the inevitable consequence was, the postponement of sowing of the wheat until the spring of 1840; and in many cases the farmers were obliged to sow barley instead of wheat. The immediate effect of this remarkable interference of the weather was the restriction of the breadth of the land appropriated to autumnal wheat, and the consequent extension of that for barley and spring wheat,—a change that caused so much additional work in spring 1840 as to have the effect of prolonging the harvest of that year beyond the wished-for period, and of otherwise deranging the calculations of farmers.

220. Now, when such a change is, and may in any season be, imposed upon the farmer, it is a matter of prudence to be as much acquainted with ordinary atmospherical phenomena as to be able to anticipate the nature of the ensuing weather. If he could anticipate particular changes of weather by observation of particular phenomena, he might arrange his operations accordingly. But is anticipation in regard to weather attainable? Doubtless it is; for, although it is not as yet to be expected that minute changes of the atmosphere can be anticipated, yet the *kind* of weather which is to follow—whether rainy or frosty, snowy or fresh—may be predicted. We all know the prescience actually attained by people whose occupations oblige them to be much in the open air and to observe the weather. Shepherds and sailors, in their respective situations, have long been famed for such a knowledge of atmospherical phenomena as to be able to predict the advent of important changes in the atmosphere; but although the knowledge acquired by these two classes of observers is in accordance with the phenomena observed, great difference of acuteness exists amongst the same class in foretelling the true cause from the observed effect. For example. A friend of mine, a commander of one of the ships of the East India Company, became so noted, by observation alone—for his education was not of a high order—for anticipating the probable effects of atmospherical phenomena in the Indian seas, that his vessel often rode out the storm, under bare poles, unscathed, while most of the ships in the same convoy were more or less damaged. As an instance of superior sagacity in a shepherd, I remember in the wet season of 1817, when rain was predicted as inevitable, by every one engaged in the afternoon of a very busy day of leading in the corn, the shepherd interpreted the apprehended phenomena—those of the sun—as indicative of wind and not of rain, and the event justified his prediction.

221. I conceive that greater accuracy of knowledge in regard to the changes of the weather may be attained on land than at sea, because the effects of weather upon the sea itself imposes another element into the question. It is generally believed, however, that seamen are more proficient than landsmen in foretelling the weather; and, no doubt, when the imminent danger to which the lives of seamen are jeopardised is considered, that circumstance alone may reasonably be supposed to render them peculiarly alive to *certain* atmospherical changes. To men under constant command, as seamen are, it is, I conceive, questionable whether the *ordinary* changes of the atmosphere are matters of much interest. In every thing that affects the safety of the ship,—the weather among the rest—every confidence is placed by the crew in the commanding officer, and it is he alone that has the power to exercise his

weather wisdom. On the other hand, every shepherd has to exercise his own skill in regard to the weather, to save himself, perhaps, much unnecessary personal trouble, especially on a hill-farm. Even the young apprentice-shepherd soon learns to look out for himself. The great difference between the sea-captain and the farmer, in regard to a knowledge of the weather, consists in the captain having to look out for himself, whereas the farmer has his shepherd to look out for him: the captain himself, knowing the weather, directs his men accordingly; whilst the farmer does not know it nearly so well as his shepherd, and probably even as his ploughmen. And the effects of such difference of acquirement is easily told. The captain causes the approaching change to be met by prompt and proper appliances; whereas the farmer is frequently overtaken in his operations from a want, perhaps, of a knowledge most probably possessed by his shepherd or ploughmen. *The necessity of farmers acquiring a knowledge of the weather is thus evident.*

222. It being admitted that prescience of the state of the weather is essential to the farmer, the question is, how the pupil of agriculture is to acquire it? Doubtless it can best be attained by observation in the field; but as that method implies the institution of a series of observations extending over a period of time, the greater part of the engagement of the pupil may pass away ere he could acquire a sufficiency of knowledge from his own experience. This being the case, he should become acquainted with the experience of others. This I shall endeavour to communicate to him, premising that he must confirm every thing, by observation, for himself, whenever opportunity occurs.

223. *Atmospherical phenomena being the great signs by which to judge of the weather*, instruments are used to detect certain changes which cannot be detected by the senses. Some of these instruments I have already described, and they all possess great ingenuity of construction, and indicate pretty accurately the effects they are intended to recognise; and although they tell us nothing but the truth, such is the minute diversity of atmospherical phenomena, they do not tell us all the truth. Other means for discovering the truth must be used; and the most available within our reach is the converting of the phenomena themselves into indicators of subsequent changes. In adopting this rule, we may use the transient states of the atmosphere, in regard to clearness and obscurity, dampness or dryness, as they affect our senses of sight and feeling, the shapes and evolutions of the clouds, and the peculiar state of the wind, to predicate the changes of the weather. But such knowledge can only be acquired by long observation of natural phenomena.

224. *Barometer.*—The general indications of the barometer are few, and may easily be remembered. A high and stationary mercury indicates steady good weather. A slow and regular fall indicates rain; and if during an E. wind, the rain will be abundant. A sudden fall indicates a gale of wind in the course of 24 hours, especially if the wind is in the W. Good steady weather must not be expected in sudden depressions and elevations of the mercury: a fine day may intervene, but the general state of the weather may be expected to be unsteady. An E. or NE. wind keeps up the mercury against all other indications of a change: a W. or SW. one causes a fall when it changes from E. or NE.; but should no fall take place, the maintenance of the elevation is equivalent to a rise, and the reverse is equivalent to a fall. The quantity of range effected by these particular causes may be estimated at $\frac{2}{10}$ of an inch.* The barometer, at sea, is a good indicator of wind but not of rain. The actual height of the mercury is not so much a matter of importance as its oscillations. A convex form of the top of the column of mercury indicates a rise, and a concave one a fall.

225. Among the variable causes which affect the barometer is the direction of the wind. The maximum of pressure is when the wind is NE., decreasing in both directions of the azimuth till it reaches the minimum between S. and SW. This difference amounts to above $\frac{3}{10}$ of an inch at London. The rise occasioned by this wind

* *Quarterly Journal of Agriculture*, vol. iii. p. 2.

may be owing to the cold, which, always accompanying the E. winds in spring—connected as these probably are with the melting of the snow in Norway—causes a condensation; but it is not unlikely to be owing, as Mr Meikle suggests, to its opposition to the direction of the rotation of the earth causing atmospherical accumulation and pressure, by diminishing the centrifugal force of the aërial particles.*

226. The accidental variations of barometric pressure are greatly influenced by latitude. At the equator it may be said to be nothing, hurricanes alone causing any exception. The variability increases towards the poles, owing probably to the irregularity of the winds beyond the tropics. The mean variation at the equator is 2 lines—a line being the twelfth part of an inch—in France 10 lines, and in Scotland 15 lines throughout the year, the quantity having its monthly oscillations. These do not appear to follow the parallels of latitude, but, like the isothermal lines, undergo inflections, which are said to have a striking similarity to the isoclinal magnetic lines of Hansteen. If so, it is probably by the medium of temperature that these two are connected. More lately, M. Kaemtz has pointed out the connexion of the winds with such changes, and he has illustrated the influence of the prevalent aërial currents which traverse Europe, though not with apparent regularity, yet, at least, in subjection to some general laws.†

227. *Thermometer.*—Many interesting results have been obtained by the use of the thermometer, and among the most interesting are those regarding the mean temperature of different localities. In ascertaining these, it was found that a diurnal oscillation took place in the temperature as well as the pressure of the atmosphere, and that this again varies with the seasons. Nothing but frequent observations during the day could ascertain the mean temperature of different places; and in so prosecuting the subject, it was discovered that there were hours of the day, the mean temperature of which, for the whole year, was equal to the mean of the whole 24 hours, which, when established, renders all future observations less difficult. The results exhibit an extraordinary coincidence in different years.

Thus the mean temperature of 1824 gave	13	minutes past 9 A.M. and	26	minutes past	8 P.M.
... ... 1825 ...	13	... 9 ...	... 28	...	8 ...
Giving the mean of the 2 years	13	... 9 ...	... 27	...	8 ...

These results were obtained from a series of observations made at Leith Fort in the years 1824 and 1825 by the Royal Society of Edinburgh.‡ Some of the other consequences deducible from these observations are, "that the mean hour of the day of minimum temperature for the year is 5 A.M., and that of the maximum temperature 40′ past 2 P.M.: that the deviation of any pair of hours of the same name from the mean of the day is less than half a degree of Fahrenheit, and of all pairs of hours, 4 A.M. and P.M., are the most accurate: that the mean annual temperature of any hour never differs more than 3°·2 from the mean of the day for the whole year: that the mean daily range is a minimum at the winter solstice, and a maximum in April: and that the mean daily range in this climate is 6°·065."§ The mean temperature at Leith Fort for the mean of two years, at an elevation of 25 feet above the mean level of the sea, was found to be 48°·36. The mean, taken near Edinburgh, at an altitude of 390 feet above the mean level of the sea, at 10 A.M. and P.M., with a common thermometer, and with the maximum and minimum results of self-registering thermometers, gave these results when reduced to the mean level of the sea:—with the self-registering thermometers, 48°·413, and with two observations a-day with the common thermometer, 48°·352, which correspond remarkably with the observations at Leith Fort. These observations were taken at 10 A.M. and 10 P.M., which were found to be the particular hours which gave a near approximation to the mean temperature of the day; but had they been made at the more correct

* *Edinburgh New Phil. Jour.* vol. iv. p. 108.
† Forbes's *Report on Meteorology*, vol. i. p. 235-6.
‡ *Edinburgh Phil. Trans.* vol. x.
§ Forbes's *Report on Meteorology*, vol. i. p. 212.

periods of 13′ past 9 A.M. and 27′ past 8 P.M., it is probable that the results with those at Leith Fort would have corresponded exactly.* The mean temperature of any place may be ascertained pretty nearly by observing the mean temperature of deep-seated springs, or that of deep wells. Thus the Crawley Springs, in the Pentland Hills, which supply Edinburgh with abundance of water, situated at an elevation of 564 feet above the level of the sea, give a mean temperature of 46°·3, according to observations made in 1811 by Mr Jardine, civil-engineer, Edinburgh; and the Black Spring, which is 882 feet above the level of the sea, gave a mean temperature of 44°·9, by observations made in the course of 1810–11–15–18–19. A well in the Cowgate of Edinburgh gave a mean temperature of 49°·3, by observations made every month in the year 1794, of which the temperature of the month of June approached nearest to the mean temperature of the year, being 49°·5.†

228. *Vapour.*—At all temperatures, at all seasons, water is converted into vapour and carried up into the atmosphere; and when the air has acquired as much vapour as it can unite with at the temperature it then possesses, it is then said to be saturated with vapour. The quantity of vapour attains its *minimum* throughout the year, in the morning before sunrise. At the same time, on account of the low degree of temperature, the humidity is at its *maximum*. In proportion as the sun rises above the horizon, the evaporation increases, and the air receives every moment a greater quantity of vapour. But as the air increases in its capacity for vapour as the temperature rises, it becomes farther and farther 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*.

229. When evaporation commences in the morning with the increase of temperature, the vapour, by virtue of the resistance of the air, accumulates at the surface of the soil. This stratum of vapour does not attain a great thickness; but as soon as the ascending current commences, the vapour is drawn away to the upper part of the atmosphere, with a force that continues increasing until mid-day. The evaporation from the soil is then more active on account of the increase of temperature; nevertheless the ascending current carries away the greater portion, and there is a diminution in the quantity of vapour. Towards evening, when the temperature begins to fall, the ascending current diminishes in force, or even ceases altogether; then, not only does the vapour accumulate in the lower parts, but it even descends from the higher regions; and on this account, we observe towards evening a second *maximum*, which is not sustained, because, during the night, the vapour precipitating in the form of dew or white frost, the air necessarily becomes drier.

230. Vapour, being thus the result of the action of heat on water, it is evident that its quantity must vary at different hours of the day, in different seasons, in different parts of the globe, and at different heights of the atmosphere.

231. Daily experience has long taught us, that the air is not equally moist with every wind. When the farmer wishes to dry his corn or his hay, or the housewife spreads out her wet linen, their wishes are soon satisfied if the wind blows continuously, but a much longer time is required with a W. wind. Certain operations in dyeing do not succeed unless during E. winds.‡

232. Dr Dalton found that the force of vapour in the torrid zone varies from 0·6 of an inch to 1 inch of mercury. In Britain, it seldom amounts to 0·5 of an inch, but is sometimes as great as 0·5 of an inch in summer; whereas, in winter, it is often as low as 0·1 of an inch of mercury. These facts would enable us to ascertain the absolute quantity of vapour contained in the atmosphere at any given time, provided we were certain that the density and elasticity of vapours follow precisely the same law as that of gases, as

* *Quarterly Journal of Agriculture,* vol. iii. p. 9. † *Ibid.* p. 10-11.
‡ Kaemtz's *Complete Course of Meteorology,* p. 88-97.

is extremely probable to be the case. If so, the vapour will vary from $\frac{1}{60}$ to $\frac{1}{100}$ part of the atmosphere. Dalton supposes that the medium quantity of vapour in the atmosphere may amount to $\frac{1}{70}$ of its bulk.*

233. The height to which the great body of vapour daily carried into the atmosphere attains, must depend on the degree of temperature. When it attains but a moderate height, its upper stratum may be easily discerned by the lower portion of the atmosphere appearing more dense than that above it. This upper stratum of vapour is called the *vapour-plane*, and a cloud often descends and is attracted by it, and rests upon it, the lower stratum of the cloud seeming straight and horizontal.

234. *Hygrometers.*—Damp air, and indeed any thing that feels damp, is unpleasant to our feelings. "Hygrometers were made of quills by Chiminello, which renders it probable that birds are enabled to judge of approaching rain or fair weather. For it is easy to conceive that an animal having a thousand hygrometers intimately connected with its body, must be liable to be powerfully affected, with regard to the tone of its organs, by very slight changes in the dryness or humidity of the air; particularly when it is considered that many of the feathers contain a large quantity of blood, which must be alternately propelled into the system, or withdrawn from it, according to their contraction or dilation by dryness or moisture."† It is from some such hygrometric feeling as this in birds, that the crane is represented by Virgil as foreseeing the coming storm:—

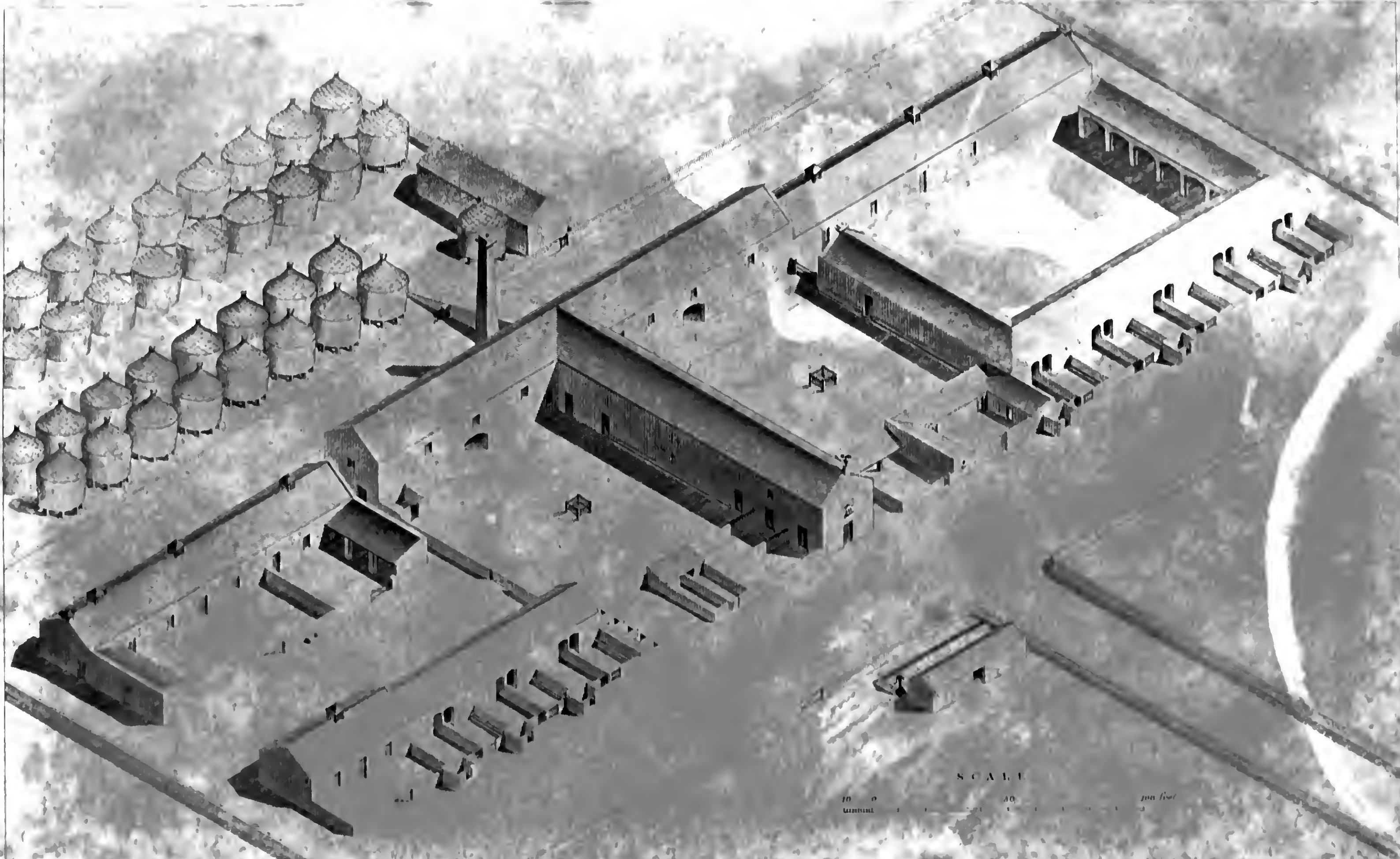
Wet weather seldom hurts the most unwise,
So plain the signs, such prophets are the skies;
The wary crane foresees it first, and sails
Above the storm, and leaves the lowly vales.‡

235. The vapour issuing from the funnel of a locomotive steam-engine may be regarded as a sort of hygrometer. When the air is saturated with vapour, it cannot dissolve the spare steam as it is ejected from the locomotive, and hence a long stream of white steam is seen attached to the train; when the air is dry, the steam is dissolved and taken up as it issues from the funnel. In like manner the moist air cannot at times dissolve the vapour issuing from the crater of Stromboli, which thus remains as a cloud over the volcano; and the inhabitants of the Lipari islands regard the phenomenon as a sign of rain.

236. *Clouds.*—Among the objects of nature, there are few more certain premonitors of change in the weather than the clouds, and as such they are worthy of the attentive study of the farmer. In a casual glance at the clouds, exhibiting, as they generally do, so great a variety of forms, it can scarcely be believed that these are all produced by the operation of any positive law. But such unbelief is unreasonable, because no phenomenon in nature can possibly occur but as the effect of some physical law, although its mode of action may have hitherto eluded the acutest search of philosophical observation. Indeed it would be unphilosophical to believe otherwise. We may, therefore, depend upon it, that every variety of cloud is an effect of a definite cause; and if we cannot predict what form of cloud a mass of vapour will assume, it is because we are unacquainted with the precise method by which their law of formation operates. But observation has enabled meteorologists to classify every variety of cloud under only three primary forms, and all others are only combinations of two or more of these. The three primary forms are the *Cirrus* or curl-cloud, the *Cumulus* or heap-cloud, and the *Stratus*, or lay-cloud. The combinations of these three forms are the *cirro-cumulus*, the heaped curl; the *cirro-stratus*, the lay curl; the *cumulus-stratus*, the heaped layer; and the *cumulo-cirro-stratus*, the heaped-curl-lay-cloud or *nimbus*, a rain cloud.

237. The suspension of clouds in the air is a phenomenon that has not yet been satisfactorily explained; and when we see a cloud pour out thousands of tons of water upon the ground, we cannot comprehend how it can float in the atmosphere. If we consider the constitution of a cloud, we may arrive at a probable solution of the

* *Philosophical Magazine*, vol. xxiii. p. 353. † *Edinburgh Encyclopædia;* art. "Hygrometry."
‡ Dryden's *Virgil, Georgics*, 514.



George H Slight Del^t

W. & A. K. Johnston Lith^r

problem. When the vapour of water is precipitated in the atmosphere, the transparency of the air is disturbed; and this aqueous precipitation takes the name of fog when it is on the surface of the earth, and of cloud when it remains suspended at a certain height in the atmosphere. So the traveller, who journeys to the summit of a high mountain, complains that the fog intercepts his view, whilst the inhabitant of the plain says, the summit of the said mountain is enveloped in clouds. Now the cloud is composed of small vescicles of water, which, in obedience to the laws of universal gravitation, are grouped into the form of spherules; and it is highly probable that these spherules are hollow or contain air, for, according to Saussure, these spherules, which readily rise in the air, differ so much in appearance from those that fall, that no doubt remains of their being hollow; they present, besides, no scintillations when exposed to a strong light, like drops of water, nor is a rainbow ever seen projected in the face of a cloud. When left to themselves, these vescicles would fall to the ground, like any other body that is heavier than air; but there are influences constantly in action in the atmosphere, which prevent their fall to an indefinite period. There is the upper current of air, daily occasioned by the action of heat; there are the horizontal currents, which are propelled at times with great force; and there is, moreover, the momentum impelled in the vescicles by these causes, together with the elasticity imparted to them directly by the action of heat. Besides these physical causes, chemical ones may be in operation between them and the air, or the gases forming the component parts of the air; and, above all, the mysterious agency of electricity may have an influence beyond the power of gravitation, to keep them afloat at given heights.

238. *Cirrus.*—The first form of clouds which demands attention is the *cirrus* or curl-cloud. This is the least dense of all clouds. It is composed of streaks of vapour of a whitish colour, arranged in a fibrousform, and occurring at a great height in the atmosphere. These fibrous streaks assume modified shapes. Sometimes they are like long narrow rods, lying quiescent, or floating gently along the upper region of the atmosphere, their motion being from S. to N., but chiefly from S.W. to N.E. At other times one end of the rod is curled up, and spread out like a feather; and, in this shape, the cloud moves more quickly along than in the other, being evidently affected by the wind. The rod shape is supposed to be caused by the cirrus cloud being the means of the transit of electricity from one cloud to another, or from one part of space to another. Another form is that familiarly known by the "gray mare's tail" or "goat's beard." This is more affected by the wind than even the former. Another form is in thin fibrous sheets, expanded at times to a considerable breadth, like the gleams of the aurora borealis. There are many other forms—such as that of network, bunches of feathers, hair, or thread—which may respectively be designated reticulated, plumose, comoid, and filiform cirri. The cirrus is called by the Swiss peasants the S.W. cloud, because it is invariably preceded by the south wind. From its uniformly bright white colour, Kaemtz supposes that it is composed of snow and not of vapour, its great elevation placing it in the region of perpetual snow. That elevation, he says, cannot be less than 13,700 feet, according to observations he made relatively with the summit of a mountain.

239. In regard to the relative heights at which these different forms of cirri appear, the fibrous rod assumes the highest position in the air, the rod with the feathered end the next highest, the bunch of feathers is approaching the earth, the mare's tail is descending still farther, and the sheet-like form is not much above the denser clouds.

240. As to their relative periods of duration, the fibrous rod may be seen high in the air for a whole day in fine weather; or it vanishes in a short time; or it descends into a denser form; when its end is feathered, its existence is hastening to a close; the plumose form soon melts away; the gray mare's tail bears only a few hours of pretty strong wind; but the broad sheet may be blown about for some time.

241. The sky is generally of a gray-blue when the fibrous rod and feathered-end rod appear; and it is of the deepest blue, with

the plumose watery cirrus. It is an observation of Sir Isaac Newton, that the deepest blue happens just at the changes from a dry to a moist atmosphere.

242. When cirri appear in a clear settled dry sky, a change in the weather is taking place. When they appear like goat's hair or gray mare's tails, wind will ensue, and it will blow from the quarter to which the tufts point, which is generally to the S.W. When cirri unite and form cirro-strati at a comparatively low elevation, rain is indicated. When seen through a broken cloud, in deep blue sky, during rain, the rain will continue. Cirri extending on both sides of the zenith forebode a storm of wind of some days' duration. In whatever direction cirri are observed to move, and whatever may be the direction of the wind at the surface of the earth at the same time, the wind will in a few hours be felt as the cirri indicate.

243. *Cumulus.*—The *cumulus* may be likened in shape to a heap of natural meadow hay. It never alters much from that shape, nor is it ever otherwise than massive in its structure; but it varies in size and colour according to the temperature and light of the day, becoming larger and whiter as the heat and light increase; hence it generally appears at sunrise, assumes a larger form by noon, often screening the sun from the earth, and then melts away towards night. On this account it has received the designation of the "cloud of day." Its density will not allow it to mount very high in the air; but it is, nevertheless, easily buoyed up for a whole day by the vapour-plane above the reach of the earth. When it so rests it is terminated below by a straight line. It is a prevailing cloud in the daytime at all seasons, and is exceedingly beautiful when it presents its silvery tops tinted with sober colours, against the bright blue sky. Cumuli sometimes join together and as suddenly separate again, though in every case they retain their peculiar form. They may often be seen floating in the air in calm weather, not far above the horizon; and they may also be seen driving along with the gale at a greater height, casting their fleeting shadows upon the ground. When in motion, their bases are not so straight as when at rest. Cumuli at times disperse, mount into the air, and form cirri, or they descend into strati along the horizon; at others, a single cumulus may be seen at a distance in the horizon, and then increasing rapidly into the storm-cloud, or else overspreading a large portion of the sky with a dense veil. Does not the poet in these beautiful words refer to the cumulus, as seen in a summer afternoon?

> And now the mists from earth are clouds in heaven,
> Clouds slowly castellating in a calm
> Sublimer than a storm; which brighter breathes
> O'er the whole firmament the breadth of blue,
> Because of that excessive purity
> Of all those hanging snow-white palaces,
> A gentle contrast, but with power divine.*

244. "Cumuli are formed," observes Kaemtz, "when ascending currents draw the vapours into the higher regions of the atmosphere, where the air, being very cold, is rapidly saturated. If the current increases in force, the vapours and clouds become more elevated; but there they increase in greater ratio, on account of the reduction of the temperature. Hence it happens that the sky, though fine in the morning, is entirely clouded at mid-day. When the ascending current relaxes towards evening, the clouds descend; and on arriving into strata of air which are less heated, they again pass into the state of invisible vapour. According to Saussure, the rounded form of clouds is due to this mode of formation. Indeed, when one liquid traverses another in virtue of the resistance of the ambient medium, and the mutual resistance of its parts, the former takes a cylindrical form with a circular section, or one composed of the arcs of a circle. Thus the masses of ascending air are great columns, the shape of which is defined by the clouds. Add to this, the little whirlwinds on the border of the clouds, which also contribute to give to the whole, rounded forms analogous to those whirls of smoke escaping from a chimney." A figure of the cumulus floating in air, as well as resting on the vapour-plane, is represented in the plate along with the Leicester tup.

245. Round well-formed cumuli indicate

* Professor Wilson.

settled weather; when ragged on the edges, rain may be looked for; if their edges curl inwards, a storm is brewing; when blown outwards, wind will follow. When cumuli remain during the evening, and increase in size, they indicate rain; but when they form in the morning and disappear at night, they indicate steady weather. Cumuli are most characteristic of the fine days of summer.

246. "While the true cumuli are formed by day and disappear during the night," observes Kaemtz, "another variety of these clouds is seen under very different circumstances. It is common to observe, in the afternoon, dense cloudy masses, rounded or extended, with borders badly defined, the number of which increases towards evening, until, during the night, the sky is completely overcast. The next day is still overcast, but some hours after sunrise all disappear; the true cumuli then occupy the sky, when they float at a more considerable height. I have determined this by direct measurements. At evening, clouds of the former class again replace the true cumuli. These clouds are composed of very dense vescicular vapour, like the cumulus and the cumulo-stratus. They differ in their dependence in the hours of the day; they have also an analogy with the stratus, on account of their extent, and are distinguished from them by their greater height. However, they approach nearer to them than to the cumulus, and I propose designating them under the name of *strato-cumulus*.

247. "The influence of the sun on the clouds gives rise to atmospheric variations, which are well known to husbandmen. In the morning the sky is clouded, and it rains abundantly; but towards nine o'clock the clouds separate, the sun shines through, and the weather is fine for the rest of the day. At other times, during the morning, the sky is clear, but the air moist. The clouds soon appear; toward mid-day the sky is covered, the rain falls, but it ceases toward evening. In the former case they were *strato-cumulus;* in the latter *cumulo-stratus*. The former are dissipated by the rays of the sun, the latter are formed under their influence. If the temperature and hygrometric conditions of the air at two or three thousand yards above the earth were as well known as at its surface, these apparent anomalies, which astonish us, might be more easily explained." *

248. *Stratus.*—The stratus is that bed of vapour which is frequently seen in the valleys in a summer evening, permitting the tops of the trees and church spires to protrude through it in bold relief; and it is that horizontal bank of dark cloud seen to rest for a whole night along the horizon. It also forms the thin dry white fogs which come over the land from the sea with an E. wind in spring and summer, wetting nothing that it touches. When this dry fog hangs over towns in winter, which it often does for days, it appears of a deep yellow hue, in consequence, most probably, of a mixture with smoke; and such constitutes the November fog in London. The stratus is frequently elevated by means of the vapour-plane, and then it passes into the cumulus. On its appearing frequently in the evening, and its usual disappearance during the day, it has been termed the "cloud of night." Having a livid gray colour when the moon shines upon it, the stratus is probably the origin of those supposed spectral appearances seen at night through the influence of superstition by people in days of yore. The light or dry stratus is most prevalent in spring and summer, and the dense or wet kind in autumn and winter. A figure of stratus fringed on the upper edge with cirri, is given in the plate along with the three short-horn cows.

249. If stratus evaporates before the mounting sun, there will be a fine day; but if it makes its way to the mountain-tops, and lingers about them, rain will come in the afternoon. If it creeps down mountain sides into the valley during the day, rain will certainly fall; and if it continues stationary for a time at a slight elevation, it will resolve itself into a steady rain.

250. *Cirro-cumulus.* — The cirrus, in losing the fibrous, assumes the more even-grained texture of the cumulus, which, when subdivided into spherical fragments, constitute small cumuli of little density,

* Kaęmtz's *Complete Course of Meteorology*, p. 120-2.

and of white colour, arranged in the form of a cirrus or in clusters. They are high in the air, and beautiful objects in the sky. In Germany this form of cloud is called "the little sheep"—an idea which has been embodied by a rustic bard of England:—

Far yet above these wafted clouds are seen
(In a remoter sky, still more serene,)
Others, detach'd in ranges through the air,
Spotless as snow, and countless as they're fair;
Scatter'd immensely wide from east to west,
The beauteous semblance of a flock at rest.*

Cirro-cumuli are most frequently to be seen in summer.

251. "When the S.W. wind prevails, and extends to the lower regions of the atmosphere," observes Kaemtz, "the cirri also become more and more dense, because the air is moister, and they then pass into the condition of light cirro-cumuli, which are entirely composed of vescicular vapour. They do not weaken the light of the sun, for it passes through them; and Humboldt has often been able to see through these clouds stars of the fourth magnitude, and even to recognise the spots on the moon. When they pass before the sun and the moon, these bodies are surrounded with an admirable corona. The cirro-cumuli foretell heat; it seems that the hot S. winds, which prevail in the lower regions, do not convey a sufficient quantity of vapour to cover the sky entirely with clouds, and they only act by their elevated temperature."

252. Dense and compact cirro-cumuli forebode storm; small round lumps foreshow thunder; the ribbed, windy and rainy weather. Cirro-cumuli frequently surmount the nimbus without rain. If gray-coloured ones prevail in the morning, there will be fair weather; but if red, rain will ensue. They evince "the approach of an electrical discharge. Such a phenomenon, indeed, will occur within twenty-four hours of the time when these clouds form themselves into their conspicuous groups."†

253. *Cirro-stratus.*—While cirri descend and assume the form of cirro-cumuli, they may still farther descend and take the shape of cirro-stratus, whose fibres become dense and decidedly horizontal. Its characteristic form is shallowness, longitude, and density. It consists at times of dense longitudinal streaks, and the density is increased when a great breadth of cloud is viewed horizontally along its edge. At other times, it is like shoals of small fish, when it is called a "herring sky;" at others mottled, when it is named a "mackerel-back sky." Sometimes it is like veins of wood, and at other times like the ripples of sand left by a retiring tide on a sandy shore. The more mottled the cirro-stratus the higher in the air, and the more dense and stratified the nearer the earth. In the last position it may be seen cutting off a mountain top, or stretching behind it, or cutting across the tops of large cumuli. Sometimes its striated lines, not very dense, run parallel over the zenith, whose opposite ends apparently converge at opposite points of the horizon, and then they form that peculiar phenomenon named the "boat," or "Noah's ark." At times cirro-strati cut across the field of the setting sun, where they appear in well-defined dense striæ, whose upper or lower edges, in reference to their position with the sun, are burnished with the most brilliant hues of gold, crimson, or vermilion. Sometimes the cirro-stratus extends across the heavens in a broad sheet, obscuring more or less the light of the sun or moon for days together; and in this case a halo or corona is frequently seen to surround these orbs, or a parhelion may be expected to accompany the sun. In a more dense form, it assumes the shapes of some small long-bodied animals, and even like architectural ornaments; and in all its mutations it is more varied than any other form of cloud. The streaked cirro-strati are of frequent occurrence in winter and autumn, whereas the more delicate kinds are mostly seen in summer.

254. "When the S.W. wind prevails," says Kaemtz, "and extends to the lower regions of the atmosphere, the cirri also become more and more dense, because the air is moister. They then pass into the condition of cirro-stratus, which first appear under the form of a mass like carded cotton, the filaments of which are closely

* Bloomfield's *Farmer's Boy*.

† Whistlecraft's *Climate of England*, p. 27.

interlaced, and they gradually take a grayish tint; at the same time, the cloud seems to get lower, and vescicular vapour is formed, which fails not to be precipitated in the form of rain." When cirro-strati are white, and have a positive outline on a deep blue sky, a storm is sure to ensue.

255. *Cumulo-stratus.*—This is always a dense cloud. It spreads out its base to the stratus form, and, in its upper part, frequently inosculates with cirri, cirro-cumuli, or cirro-strati. In this particular form it is represented in the plate of the three short-horn cows. With all or either of these it forms a large massive series of cumulative clouds which hang on the horizon, displaying great mountain shapes, raising their brilliantly illuminated silvery crests towards the sun, and presenting numerous dusky valleys between them. Or it appears in formidable white masses of variously defined shapes, towering upwards from the horizon, ready to meet any other form of cloud, and to conjoin with them in making the dense dark-coloured storm-cloud. In either case, nothing can exceed the picturesque grandeur of its dazzling towers, or the sublimity of its masses when surcharged with lightnings, wind, and rain, hastening with scowling front to meet the gentle breeze, hurling it along before it in its determined course, as if impatient of restraint; and all the while casting a portentous gloom over the earth, until, bursting with terrific rage, it scorches with lightning some devoted object more prominent than the rest, and deluges the plain with devastating floods. A tempest soon exhausts its force in the temperate regions; but in the tropics it rages at times for weeks, and then woe to the poor mariner who is overtaken by it at sea unprepared. Of the cumulo-stratus the variety called "Bishop's wigs," as represented near the horizon in the plate of the draught-mare, may be seen at all seasons along the horizon; but the other and more imposing form of mountain scenery is only to be seen in perfection in summer, when storms are rife. It also assumes the shapes of the larger animals, and of the more gigantic forms of nature and art. Is the cumulo-stratus in all its varieties the form of cloud thus described by Shakespere?

Sometime we see a cloud that's dragonish;
A vapour, sometime, like a bear or lion,
A tower'd citadel, a pendent rock,
A forked mountain or blue promontory
With trees upon't, that nod unto the world,
And mock our eyes with air:———
That, which is now a horse, even with a thought,
The rack dislimns, and makes it indistinct,
As water is in water.*

256. "The cumuli do not always disappear toward evening," remarks Kaemtz; "on the contrary, they often become more numerous, their borders are less brilliant, their tint deeper, and they pass into the state of cumulo-stratus, especially if a stratum of cirri exists below them. We then expect rains or storms, for in the higher and mean regions the air is near the point of saturation. The S. wind and the ascending currents give rise to changes of temperature, which determine the precipitation of aqueous vapour in the form of rain. The cumuli that are heaped up in the horizon in the fine days of summer, are those which are the most fertile for the plays of the imagination. . . . As they are often of the same height, an appearance results which I should mention. When I was living at the Faalhorn, the sky was frequently perfectly clear over my head; but a little above the horizon, a belt of clouds, the width of which did not exceed double or treble that of the moon, extended like a pearl necklace along the West Alps, from France to the Tyrol. My station at 8794 feet above the sea was a little more elevated than the clouds, and their projection on the sky formed a narrow belt, although they were spread over a vast extent of the sky. From this projection it follows, that it is often very difficult to distinguish the cumulus from the cumulo-stratus."

257. When cumuli change rock-like into *cumulo-strati*, rain will follow, and the exception is when it continues fair.

258. *Cirro-cumulo-stratus*, or *Nimbus.*—A showery form of this cloud may be seen in the plate of the draught-horse. For my part, I cannot see that the mere resolution of a cloud into rain is of sufficient importance to constitute the form into a separate and distinct cloud; for rain is not so much a form as a condition of a cloud, in the final state in which it reaches

* *Anthony and Cleopatra,* Act iv. scene xii.

the earth. Any of the three compound forms of clouds just described may form a rain-cloud, without the intervention of any other. Cirro-strati are often seen to drop down in rain, without giving any symptoms of forming the more dense structure of the nimbus; and even light showers fall without any visible appearance of a cloud at all. The nimbus is most frequently seen in summer and autumn. The nimbus is uniformly distinguished by its gray tint and fringed edges, and is of very complicated form.

259. *Scud.*—There is a kind of cloud, not unlike cumuli, called the scud, which is described usually by itself as broken nimbus. It is of dark or light colour, according as the sun shines upon it, of varied form, floating or scudding before the wind, and generally in front of a sombre cumulo-stratus stretching as a background across that portion of the sky, often accompanied with a bright streak of sky along the horizon. The ominous scud is the usual harbinger of the rain-cloud, and is therefore commonly called "messengers," "carriers," or "water-waggons," which are sure precursors of rain.

260. On concluding the very important subject of the forms and aspect of clouds to farmers as prognostics of the changes of the weather, I may remark as a general prognostic that when clouds attach themselves to others or to mountain-tops they give indications of rain. When they form and soon disappear, fair weather ensues. The ragged edges of clouds indicate a moist state of air; when much ragged, wind may be expected. When the edges are well defined, the air is in a dry state; when they are much rolled or tucked in, a discharge of electrical matter may be looked for. It is always unwholesome weather when clouds of all denominations have undefined edges. When cirrus, cumulus, or stratus appears alone, and in its own appropriate region, none of these clouds can be regarded as an immediate indication of rain, or other foul weather. The cirrus is at first visible in a dry state of the air, and being situated in the highest portion of the atmosphere, it can only be observed from the earth when the air is clear. But its non-observance from the earth during the obscuration of low clouds, is no proof that it does not exist. Cirrus is an indication of the positive state of electricity in the air; and it is conceived that its great office is the diffusion of electric matter throughout the air, so that it cannot be seen when the air is surcharged with thunder-clouds. Its pointed form is favourable to transmitting electricity from one cloud to another, and it sometimes appears to perform this office betwixt cumuli. "When two or more of these simple species of cloud meet upon the confines of their respective regions, or otherwise mingle in the sky, a greater extent of atmospheric derangement is indicated, and foul weather may usually be expected, unless the disturbed atmosphere shall be carried away by a general seasonal current; and this is the case in great part of the British islands, after the dry countries to the S. and E. of the Baltic have reached the maximum of their summer heat. This removal of disturbed air by the general current, is the cause which has given rise to the popular maxim, 'that all signs of rain fail in fine weather,' and certainly it much depends on the general character of the season, whether a moderate degree of atmospheric disturbance, and formation and blending of clouds of different species, shall or shall not be followed by rain." The *most wholesome weather* is when W. winds and day cumuli prevail—when a stratus evaporates as the sun rises—during the formation of well-defined cumuli throughout the day, most abundant in the afternoon, and disappearing again in the evening—to be succeeded by strong dew and the stratus—and accompanied with westerly breezes, which die away towards evening. In these circumstances the barometer is always steady, and the thermometer high. When other points of wind accompany this weather, they are attended either with frost or heat, according to the season of the year.

261. *Heights of clouds.*—There exist a great many measurements of the heights of clouds. According to the best authorities it would appear that their extreme range of height extends from 1300 to 21,300 feet above the sea. That clouds exist at different heights is easily proved while ascending mountains; and another proof consists in their being seen to move in opposite directions at the same time: one set may

be seen moving in one direction near the earth, whilst another may be seen unmoved through their openings. Clouds may be seen moving in different directions, at apparently great heights in the air, whilst those near the ground may be quite still. The whole clouds seen may be moving in the same direction with different velocities. It is natural to suppose that the lighter clouds—those containing vapour in the most elastic state—should occupy a higher position in the air than the less elastic. On this account, it is only fleecy clouds that are seen over the tops of the highest Andes. Clouds, in heavy weather, are seldom above ½ mile high, but in clear weather from 2 to 4 miles, and perhaps the cirri are 5 or 6 miles.

262. *Size of clouds.*—Clouds are often of enormous size, 10 miles each way and 2 miles thick, containing 200 cubic miles of vapour; but sometimes they are even 10 times that size. The size of small clouds may be easily estimated by observing their shadows on the ground in clear breezy weather in summer. These are usually cumuli scudding before a W. wind. The shadows of larger clouds may be seen resting on the sides of mountain ranges, or spread out upon the ocean. Messrs Peytier and Hossard had favourable opportunities of ascertaining the heights and sizes of clouds while prosecuting the triangulation that was executed in the Pyrenees in 1826. On the 29th September the two observers were so placed as to see at the same moment the two opposite surfaces of the same cloud, and its thickness was 1458 feet: next day it had increased to 2786 feet.

263. *Fog or Mist.*—The phenomenon of fog or mist occurs at all seasons, and it appears always under the peculiar circumstances explained by Sir Humphry Davy. His theory is, that radiation of heat from land and water sends up vapour until it meets with a cold stratum of air, which condenses it in the form of mist,—that naturally gravitates towards the surface. When the radiation is weak, the mist seems to lie upon the ground, but when more powerful, the stratum of mist may be seen elevated a few feet above the ground. Mist, too, may be seen to continue longer over the water than the land, owing to the slower radiation of vapour from water; and it is generally seen in the hollowest portions of ground, on account of the cold air, as it descends from the surrounding rising ground, mixing with the air in the hollow, and diminishing its capacity for moisture.

264. Mist also varies in its character according to its electric state; if negatively affected, it deposits its vapour more quickly, forming a heavy sort of dew, and wetting every thing like rain; but if positively, it continues to exist as fog, and retains the vapour in the state in which it has not the property of wetting like the other. Thin hazy fogs frequently occur in winter evenings after clear cold weather, and they often become so permanently electric, as to resist for days the action of the sun to disperse them. Thick heavy fogs occur also in the early part of summer and autumn, and are sometimes very wetting.

265. The formation of fog is often accompanied with circumstances which it is at first difficult to explain. For example, when the sky is cloudy, a local fog is often observed on the declivity of mountains, occupying only a small surface; and is soon dissipated, but again appears immediately. In such a case of fog, it is formed over ground covered with long grass, compared with that around it; and the explanation is, that the long grass preventing the heating of the ground so quickly as the barer ground near it, a less active evaporation takes place over it.

266. In countries where the soil is moist and hot, thick and frequent fogs may be expected. This is the case in England, the coasts of which are washed by the sea at an elevated temperature. The same is more constantly the case with the polar seas of Newfoundland, where the gulf-stream, which comes from the S., has a higher temperature than that of the air.

267. But fogs are not always formed from the vapour derived from the ground over which they are observed to exist. Vapour may be transported by winds to cold countries, and be there converted into fog at a notable distance from the place of its origin. The S.W. winds generally bring abundance of vapour into Germany, whilst the N.E. instantly precipitates the vapour radiated from the soil below.

268. The prognostic regarding fog is, that if it creep towards the hills it will be rain, but if it goes to the sea it will be fine weather.

269. Fog has the effect of both concealing and magnifying distant objects; it can clearly exhibit the shadows of near objects, and is an excellent conductor of sound: all which phenomena can easily be explained on optical and acoustical principles.

270. *Rain.*—The life of plants and animals depending as much on moisture as on temperature, and their development being greatly modified by the dryness or humidity of the atmosphere, the cause and effects of rain become important objects of study to the agricultural student.

271. *Rain-gauge.*—Although the actual quantity of rain that falls in a given part of a country is not an exact measure of the dryness or humidity of its climate, that being chiefly determined by the frequency and not the quantity of rain that falls; still it is interesting to know the quantity of rain that falls in any given locality. The rain that falls is measured by a rain-gauge. This instrument is of no use to the farmer as an indicator of rain, and, like some of the rest which have been described, only professes to tell the result after it has occurred; and even for the purpose of indicating the quantity of rain that has actually fallen in a given space, it is an imperfect instrument. "The simplest form of this instrument," says Mr John Adie, "is a funnel, with a cylindrical mouth, 3 or 4 inches high, and having an area of 100 square inches, made of tinned iron or thin copper. It may be placed in the mouth of a large bottle for receiving the water, and, after each fall, the quantity is measured by a glass jar, divided into inches and parts. A more elegant arrangement of the instrument is formed by placing the funnel at the top of a brass cylindrical tube, having at one side a glass tube, communicating with it at the under part, with a divided scale placed alongside of it. The area of the mouth is to that of the under tubes as 10 : 1; consequently 1 inch deep of rain falling into the mouth will measure 10 inches in the tubes, and 1 inch upon the scale will be equal to a fall of $\frac{1}{10}$ of an inch, which quantities are marked upon the scale, and the water is let off by a stopcock below. The instrument should be placed in an exposed situation, at a distance from all buildings and trees, and as near the surface of the ground as possible. . . . In cases of snow-storms, the rain-gauge may not give a correct quantity, as a part may be blown out, or a greater quantity have fallen than the mouth will contain. In such cases, the method of knowing the quantity of water is, to take any cylindrical vessel—such as a case for containing maps, which will answer the purpose very well, and, pressing it perpendicularly into the snow, bring out a cylinder of snow with it equal to the depth; and this, when melted, will give the quantity of water by measurement. The proportion of snow to water is about 17 : 1, and hail to water 8 : 1. These quantities, however, are not constant, but depend upon the circumstances under which the snow or hail has fallen, and the time they have been upon the ground." *

272. The cost of a rain-gauge, according as it is fitted up, is £1, 5s., £2, 12s. 6d., and £4, 4s.

273. *Udometer.*—"M. Flaugergues, professor at the school of naval artillery at Toulon, presented to the Society of Science of that city, in the course of 1841, a new gyratory *udometer*, arranged not only for measuring the quantity of rain that falls, but also to make known, by mere inspection, the portions of this quantity which have fallen for each determinate wind. This instrument is composed, 1st, Of a funnel movable round a vertical axis, covered at its upper part, and carrying at its lower extremity an escape-tube, the axis of which is in the same vertical plane with the axis of rotation, and with a vane placed in the very body of the funnel, so that the escape of water, accumulated there, takes place in a direction constantly parallel with that of the wind; 2d, Of a cylindrical receptacle divided by eight vertical partitions, radiating into eight chambers, and corresponding to the eight principal points of the compass. This receptacle is, in the outset, duly adjusted, and solidly fixed on a base

* *Quarterly Journal of Agriculture*, iii. p. 13.

at the bottom of each of the divisions, by a tube which ascends vertically outside the receptacle, and in which the height of the water in the correspondent cell is observed. An udometer of this kind has been used since the commencement of 1841, at the naval battery at Toulon, and it leaves nothing to be desired." *

274. The *theory* proposed by Dr Hutton, that rain occurs from the mingling together of great beds of air of unequal temperatures differently stored with moisture, is that which was adopted by Dalton, Leslie, and others, and is the current one, having been illustrated and strengthened by the clearer views of the nature of deposition which we now possess; and which teach that as the S. to S.W. winds bring the vapour, so the upward current of the atmosphere carries it to a lower temperature, when an immediate precipitate takes place of the vapour in the form of rain.

275. On the connexion of rain with the *fall of the barometer*, Mr Meikle has shown that the change of pressure may be a cause as well as an effect; for the expansion of air accompanying diminished pressure, being productive of cold, diminishes the elasticity of the existing vapour, and causes a deposition.†

276. Taking a general view of the rain that falls over the face of the globe, it is found that the tropical region is subject chiefly to *periodical rains*, that is, large quantities falling at one time of the year, while at other times none falls for months. In portions of the globe no rain falls at all, and they are, in consequence, called the "rainless districts;" these comprehend part of the desert of Sahara and Egypt in Africa, part of Arabia, Persia, the desert of Gobi, Thibet and Mongolia in Asia, and the W. coasts of Mexico and Peru in America.

277. On each side of the tropical zone, towards the poles, is the zone of "constant precipitation," not that rain constantly falls, but that it may fall in any day of the year; while, in a stripe of the same zone, at a short distance from, and parallel with, the equator, rain is frequent, almost constant, and always accompanied with electrical explosions.

278. The annual amount of rain that falls in the Old and New World, distinguishing the annual amounts in the tropics, within the zone of periodical rains, from those in the zones of constant precipitation, is as follows:—

The annual amount of rain

Under the tropics of the New World,	115	inches.
... ... Old World,	76	...
Within the tropics generally, .	95½	...
In the temperate zone of the New World, (United States,) . .	37	...
Of the Old World, (Europe,) .	31¾	...
Generally, ...	34¾	...

279. Confining our general view of the fall of rain to Europe, that quarter may be divided into three portions; 1st, The province of *winter* rains, comprehending part of the southern portion of Europe; 2d, The province of *autumn* rains, comprising the remainder of the southern and the western portions; and, 3d, The province of the *summer* rains, embracing the whole of the interior of the continent.

280. There are general laws which affect the distribution of rain over the globe; and these are:—"The amount of rain decreases as we recede from the equator to the poles; thus, while under the tropics the yearly average amount of rain is 95 inches, in Italy it is less than a half, or 45 inches; in England about one-third, or 30 inches; in the north of Germany, about one-fourth, or 22½ inches; and at St Petersburg, only one-fifth, or 17 inches."

281. Though this be the case, the number of rainy days increases from the equator to the poles; so that, where the most rain falls, there are the fewest rainy days. According to the observation of M. Cotte, the numbers stand thus:—

From N. Lat.	12° to 43°	there are	78	rainy days.
... ...	43° to 46°	...	103	...
... ...	46° to 50°	...	134	...
... ...	50° to 60°	...	161	...

282. "The quantity of rain decreases, in general, in ascending low plains to elevated table-lands; but this law is reversed

* Kaemtz's *Complete Course of Meteorology*, p. 125-6. *Note.* † *Royal Institution Journal.*

in ascending steep and rugged mountain-chains. The former case is illustrated by the Iberian peninsula; for while on the coast of Spain and Portugal the annual fall of rain amounts to from 25 to 35 inches, on the plateau or table-land of Castile, which is surrounded with mountains, it is only 10 inches. In the latter case, the effect of the Alps is so great, that while the annual amount of rain in the valley of the middle Rhine and on the plateau of Bavaria is only 21 inches, in Berne and Tegernsee, at the foot of the Alps, it is nearly double, or 43 inches. In England the amount of rain which falls in the mountainous districts, is more than double that of the less elevated portions of the country; thus, while the meteorological reports for Essex give only an annual average of 19·5 inches, those for Keswick in Cumberland show no less than 67·5 inches; and at Kinfauns, in Scotland, the amount shown, on an average of five years, is 25·66, whilst that in the vicinity, placed on a hill 600 feet above the level of the sea, amounts to 41·49 inches.

283. "The amount of rain decreases in the direction from the coasts to the interior of continents; and this is exemplified by the difference between the coasts of the Atlantic Ocean and the countries of Eastern Russia. The western coasts of Great Britain, France, and Portugal, have an annual average of from 30 to 35 inches. Bergen, in Norway, has 80, and Coimbra, in Portugal, 111 inches of rain; while in central and eastern Europe, in Bavaria, and through Poland and Russia, it falls to 15 inches. At Iekatrinburg, in the Ural mountains, it is only 13 inches, and in the interior of Siberia it is still less.

284. "In both hemispheres, within the temperate zone, the W. coasts are proportionally more moist than the E. In this quarter of the globe, it is explained by the prevalence of the W. winds, which, before arriving in Europe, become charged with vapour in passing over the Atlantic Ocean; whilst those which blow from the E. pass over the interior of the continents of Europe and Asia, where the dryness of the air increases so rapidly from W. to E. that a mean of seven years' observation gives to Moscow 205, to Karau 90, and to Irkoutzk only 57 days of rain; and the rains which accompany the W. winds have been observed at Penzance to exceed those caused by the E. winds in the ratio of 3 : 1. The determining causes of the distribution of rain in Europe are thus seen to be the predominance of W. winds with the existence of a vast ocean on one side, and a great continent on the other. The former of these causes is thus explained by A. von Humboldt: 'The predominating winds of Europe are E., which for the W. and central portions of it are sea-winds—currents which have been in contact with a mass of waters, the temperature of which, at the surface, even in the month of January, does not, at 45° and 50° of latitude, fall below 51° and 48° Fahrenheit.'"*

285. Mr Howard remarks, that, on an average of years, it rains every other day; and, by a mean of 40 years at Viviers, M. Flaugergues found 98 days of rain throughout the year.

286. He also states, that of 21·94 inches—a mean of 31 lunar months—rain fell in the day to the amount of 8·67 inches, and in the night to 13·27 inches. Dr Dalton also states, that more rain falls when the sun is under the horizon than when it is above it.

287. Mr Howard further remarks, that 1 year in every 5 in this country may be expected to be extremely dry, and 1 in 10 extremely wet.†

288. Notwithstanding the *enormous annual fall of rain at the equator*, particular instances of a great depth of rain in a short time have occasionally occurred in Europe, which probably have seldom been equalled in any other part of the globe. At Geneva, on the 25th October 1822, there fell 30 inches of rain in one day. At Joyeuse, according to M. Arago, on the 9th October 1827, there fell 31 inches of rain in 22 hours. With regard to remarkable variations in the quantity of rain in different places, among the Andes it is said to rain perpetually; whereas in Peru,

* Johnston's *Physical Atlas—Meteorology;* a new work of great accuracy, beauty, and interest.
† *Encyclopædia Metropolitana;* art. *Meteorology.*

as Ulloa affirms, it never rains, but that for a part of the year the atmosphere is obscured by thick fogs called *garuas*. In Egypt it hardly ever rains at all, and in some parts of Arabia it seldom rains more than two or three times in as many years; but the dews are heavy, and refresh the soil, and supply with moisture the few plants which grow in those sunny regions.*

289. The *influence of the lunar periods on the amount of rain* deserves attention. Professor Forbes believes that there is some real connexion between the lunar phases and the weather. M. Flaugergues, who has observed the weather at Viviers with the greatest assiduity for a quarter of a century, marked the number of rainy days corresponding with the lunar phases, and found them at a maximum at the first quarter, and a minimum at the last.

290. It almost always happens that rain *brings down foreign matter from the air.* It is known that the farina of plants has been carried as far as 30 or 40 miles, and the ashes of volcanoes have been carried more than 200 miles. We can conceive that when the magnitude of the particles of dry substances is so reduced as to render them incapable of falling in any given velocity, that their descent may be overcome by a very slight current of the air; but even in still air a sphere of water of only the almost inconceivable size of $\frac{1}{600000}$ part of an inch in diameter falls 1 inch in a second; and yet particles of mist must be much larger than this, otherwise they could not be visible as separate drops; the least drop of water that is discoverable by the naked eye falls with a velocity of 1 foot in the second, when the air is still. Although it is probable that the resistance opposed to the descent of small bodies in air, may be considerably greater than would be expected from calculation, still the wonder is how they are supported for any length of time. In this difficulty there is much inclination to call in the aid of electricity to account for the phenomenon. Mr Leithead accounts for it in this way: "When the earth is positive and the atmosphere negative, the electric fluid, in endeavouring to restore its equilibrium, would cause a motion amongst the particles of the air in a direction from the earth towards the higher region of the atmosphere; for the air being a very imperfect conductor, the particles near the earth's surface can only convey electricity to the more remote particles by such a motion. This would, in effect, partly *diminish* the downward pressure of the air, which is due to its actual density;" and, in doing this, might it not, at the same time, counteract in some degree the gravity of any substance in the air by surrounding it with an electrical atmosphere? "When, on the contrary," continues Mr Leithead, "the earth is negative and the air positive, this motion of the particles will be reversed; thus increasing the pressure towards the earth, and producing the same effect as if the air had actually *increased in density;*" † and would it not thereby be more capable of supporting any foreign body in it?

291. Gaseous as well as vegetable and mineral matters are brought by rain from the atmosphere. Nitrogen and hydrogen, in the form of ammonia and carbonic acid—the two last forming the most essential elements in the food of plants—are brought down by rain.

292. "The nitrogen of putrefied animals," says Liebig, "is contained in the atmosphere as ammonia, in the state of a gas, which is capable of entering into combination with carbonic acid, and of forming a volatile salt. Ammonia, in its gaseous form, as well as all its volatile compounds, is of extreme solubility in water. Ammonia, therefore, cannot remain long in the atmosphere, as every shower of rain must effect its condensation, and convey it to the surface of the earth. Hence, also, rain-water must at all times contain ammonia, though not always in equal quantity. It must contain more in summer than in spring or in winter, because the intervals of time between the showers are in summer greater; and when several wet days occur, the rain of the first must contain more of it than that of the second. The rain of a thunder-storm, after a long

* Forbes's *Report on Meteorology*, vol. i. p. 251-252.

† Leithead *On Electricity*, p. 373. This explanation Mr Leithead also gives to account for the changes in the density of the atmosphere, as indicated by the oscillations of the barometer.

protracted drought, ought for this reason to contain the greatest quantity conveyed to the earth at one time."

293. As regards the quantity of ammonia thus brought down by the rain, — as 1132 cubic feet of air, saturated with aqueous vapour at 59° Fahrenheit, should yield 1 lb. of rain-water, if the pound contain only one-fourth of a grain of ammonia, a piece of ground of 26,910 square feet—43,560 square feet being in an acre—must receive annually upwards of 80 lbs. of ammonia, or 65 lbs. of nitrogen, which is much more nitrogen than is contained in the form of vegetable albumen and gluten in 2650 lbs. of wood, 2500 lbs. of hay, or 200 cwt. of beetroot, which are the yearly produce of such a piece of ground; but it is less than the straw, roots, and grain of corn, which might grow on the same surface, would contain.

294. Snow-water yields ammonia as well as rain-water, and the snow which is next the ground, and which fell first, yields more than what lies above it. The ammonia contained in snow and rain-water possesses a smell of perspiration and putrefying matter — a fact which leaves no doubt of its origin; for "the ammonia received from the atmosphere by rain and other causes, is as constantly replaced by putrefaction of animal and vegetable matters. A certain portion of that which falls with the rain evaporates again with the water; but another portion is, we suppose, taken up by the roots of plants, and, entering into new combinations in the different organs of assimilation, produces, by the action of these and of certain other conditions, albumen, gluten, &c. The chemical characters of ammonia render it capable of entering into such combinations, and of undergoing numerous transformations."*

295. These are general prognostics of *rain:* — When cattle snuff the air and gather together in a corner of the field with their heads to leeward, or take shelter in the sheds — when sheep leave their pastures with reluctance — when goats go to sheltered spots — when asses bray frequently and shake their ears — when dogs lie much about the fireside and appear drowsy — when cats turn their backs to the fire and wash their faces — when pigs cover themselves more than usual in litter—when cocks crow at unusual hours and flap their wings much — when hens chaunt — when ducks and geese are unusually clamorous — when pigeons wash themselves — when peacocks squall loudly from trees — when the guinea-fowl makes an incessant grating clamour — when sparrows chirp loudly, and clamorously congregate on the ground or in the hedge — when swallows fly low, and skim their wings on water, on account of the flies upon which they feed having descended towards the ground —when the carrion-crow croaks solitarily — when water wild-fowl dip and wash unusually — when moles throw up hills more industriously than usual — when toads creep out in numbers — when frogs croak — when bats squeak and enter houses — when the singing birds take shelter—when the robin approaches nearest the dwellings of man — when tame swans fly against the wind — when bees leave their hives with caution, and fly only short distances — when ants carry their eggs busily — when flies bite severely, and become troublesome in numbers — when earthworms appear on the surface of the ground and crawl about—and when the larger sorts of snails appear.

296. *Wind.* The variations in the intensity and direction of the winds are the best indices to the change of weather that the agricultural student can study. In the temperate zone, and particularly in this island, flanked as it is with one great ocean, and not far removed from an extensive continent, the variations of the wind are so great, and apparently so capricious, as to baffle minute and correct inquiry; whereas in the tropics, the periodic winds correspond exactly with the uniform course of the seasons, and the limited range of the barometer—phenomena characteristic of that portion of the globe.

297. The disparity of phenomena between these zones may be accounted for. In the tropics, the direct influence of the solar rays upon so considerable a portion

* Liebig's *Chemistry of Agriculture and Physiology*, 3d edition, p. 43-47.

of the surface of the globe as is comprehended in the breadth of the ecliptic, 23° 18′ on each side of the equatorial line, at once circumscribes and guides the aërial current within certain limits, which is effected by the rarefaction of the air, as the earth presents a portion of its surface to that influence in the diurnal rotation round its axis. This influence being in constant action, and exercised on a pretty uniform surface, the current generated to supply so regular and constant a rarefaction must be also constant and regular. In the temperate zones, on the other hand, the solar action is always oblique, and in consequence comparatively weak; and the aërial current becomes subject besides to secondary influences, which, operating on it in different degrees at different times, cause irregularities in its course. It is probable, too, that the electric agency may have a more powerful influence on the atmosphere in the temperate than the torrid zone, by reason, perhaps, of the diminished power of the solar influence; and as the electric action is more varied and unequal than that of the sun, the currents of the atmosphere may thereby be rendered as varied and unequal.

298. This not yet well understood subject may perhaps be made clearer by reflecting on the origin of the *regular winds* of the torrid zone. In the zone of greatest heat, in the tropics, the air is more rarefied than any where else. "In consequence of this," says Mr Mudie, "the rarefied air ascends into the upper part of the atmosphere, and its place is supplied by cooler and less rarefied air from the N. and S. at the same time; and it is rarefied in its turn, and ascends in the air. Hence there is a constant ascent of the atmosphere from the point where the sun's heat is greatest, and this travels W. round the globe, every 24 hours, at a rate from 900 to 1000 miles an hour in the tropical zone, having, of course, no *definite* boundary, but extending on each side of the zone. In this way, all along this zone, the general motion of the atmosphere is upward away from the surface of the earth; and little or no wind or current blows in any direction *within* it, unless from disturbance produced by terrestrial causes, such as the land, islands, and mountains. *Without* the indefinite boundaries of this zone, however, there is a motion of the surface atmosphere, both from the N. and from the S., which extends farther into either hemisphere, in proportion as the sun has more declination in it. But as the atmospheric air, when undisturbed by currents on the surface of the earth, is carried E. with the same velocity as the surface itself, that is, less than 1000 miles an hour, in the proportion of the cosines of the latitude as we recede from the equator, this real motion of the air E. along the earth's surface, is the counterpart of the apparent motion W. as indicated by the progress of the sun in the zone of highest temperature; and though these motions are exactly equal on the same parallel; the rate of motion in the hour, the day, or any fraction of it, is less and less as the latitude increases. Therefore, when the current from the N. and from the S. from the high latitudes, besides the time it takes to travel, has less real motion E. or apparent motion W. than the tropical zone into which it arrives, the consequence is, that it is deflected W. in both hemispheres, and becomes a wind from the SE. on the S. side of the parallel of greatest heat, and from the NE. from the N. of the same. This is what is usually termed the *trade-wind*, and would be perfectly palpable all round the globe were its surface uniform; but, like all other phenomena of the earth, this wind is so much modified by surface-action, that the actual result accords but little with what might be inferred from principles alone. Still this is the grand cause which puts the currents of the atmosphere in motion; and, notwithstanding all its modifications, it has great influence in determining the climate and productiveness of the different regions of the earth." This cause of the trade-winds was first assigned by Hadley in 1734.

299. The influence of the tropical zone on the currents of the atmosphere elsewhere will become more apparent, when we trace the courses of those currents in the higher latitudes. "This *surface*-current from the N. and from the S. towards the equator," continues Mr Mudie, "necessarily requires, and therefore produces, a counter-current in the *higher atmosphere*. The air, which is continually drawn to-

wards the parallel of greatest heat, either in a palpable trade-wind, or a silent current, cannot accumulate over the equator, because as it ascends it gets into a cold region, and is there condensed. After this it descends towards the poles along the upper part of the atmosphere, and ultimately replaces that which finds its way to the tropical zone, producing a general motion in each hemisphere towards the tropical zone near the surface of the earth, and a counter-current from the equator at a higher elevation. This counter-current is the reverse of that from the poles, and therefore the different rate of motion in the different parallels of latitude has a contrary effect upon it. As it gets into higher latitudes, it has more E. motion than the surface there; and thus it is converted into a current from the SW. in the N. hemisphere, and a current from the NW. in the S. In latitudes near the equator, this counter-current in the atmosphere is not observed on the surface of the ground, because both the S. and N. currents occupy the surface, and indeed the whole atmosphere to a considerable altitude. When, however, we come to the middle latitudes, the SW. wind, at least in countries to the E. of the Atlantic, descends so low, that it is not only felt on the mountain-tops throughout great part of the year, but the effects of it, and the rain which this wind often brings along with it, are seen in the bleaching or wearing away of the W. sides of mountains of bold escarpment; for it is to be understood, that though, in many such countries, the E. wind is the surface-wind, which precedes or ushers in the rain, the SW. wind being the warmer one, and as such holding the greater quantity of moisture in a state of vapour, is really the one out of which the rain is elaborated by the friction of the E. wind against it."*

300. The course of the wind, caused by the diurnal action of the sun's rays in the tropics, is still farther affected by another circumstance. Since the attraction of the sun and moon produces the remarkable effect of an oceanic wave, we cannot but suppose that an effect equally great at least is produced upon the atmosphere by forming an atmospheric wave. Indeed, as the atmosphere is nearer both those attractive objects than the ocean, the effect upon it should be even greater. When we add to this the elasticity of the air, or that disposition which it has to dilate itself when freed from any of the pressure affecting it, we must conclude that the atmospheric tides are considerable. Now, since the apparent diurnal motion of the sun and moon is from E. to W., the atmospheric tides must follow it, and consequently produce a constant motion in the atmosphere from E. to W. This cause was first assigned by D'Alembert.

301. The currents of air toward the tropical zone are affected in their direction by the change of the sun's position in the ecliptic, and the winds thereby generated are also regular, and are called the *monsoons*, — a word said to be derived from the Malay word *moosin*, signifying a season. The SW. monsoon blows from April to October; and its cause is the rarefaction of the air over the land as the sun proceeds N. to the tropic of Cancer, while its supply of cold air is from the Indian Ocean. The other blows from the NE. from October to April, and is caused by the cold air of the Indian Ocean flowing towards the land of New Holland, when the sun travels S. to the tropic of Capricorn. Great storms prevail at what is called the breaking up of the monsoons, that is, at the equinoxes, when the sun is in the parallel of the equator, as may be expected to be the case when any system of atmospheric phenomena, which has continued for six months together, is undergoing a great and opposite change. There are many more and greatly modified monsoons besides these regular ones, along all the southern coasts of land bounded by the Indian Ocean within the limits of the tropics.

302. A regular form of wind in the tropics is the *land* and *sea-breeze*. In all maritime countries of any extent between the tropics, the wind blows during a certain number of hours every day from the sea, and a certain number of hours from the land. The *sea*-breeze generally sets in about 10 A.M., and blows till 6 P.M.;

* Mudie's *World*, p. 101-104.

when it lulls into a calm. At 7 P.M. the *land*-breeze begins, and continues till 8 A.M., when it subsides into a calm. These winds are thus accounted for:—During the day, the cool air of the sea, loaded with vapour, moves over the land, and takes the place of the rarefied land-air; but as the sun declines, the rarefaction of the land-air diminishes, the equilibrium is restored, and a calm ensues. The sea is not so much heated during the day as the land, neither is it so much cooled during the night, because it is constantly exposing a new surface to the atmosphere. As the night approaches, therefore, the cooler and denser air of the *hills* (for where there are no hills there can be no land and sea breezes) falls down upon the plains, and, pressing upon the now comparatively lighter air of the sea, in a state of calm, causes it to return towards the sea in the character of a land-breeze.

303. Whenever we pass from the tropical to the temperate zones, we always meet with *variable* winds, and it is these which stamp the nature of every climate; for although most apparent in their effects in the temperate regions, they nevertheless also exist in the tropics, as may be experienced along every coast and large island in the Indian Ocean. Their course, therefore, depends on causes which act uniformly, notwithstanding their apparent irregularities. They may be all intimately connected with one another, and may probably succeed each other in a certain order, though that connexion and that order have not hitherto been ascertained. When both have been discovered, then the course and intensity of the variable winds may be reduced to calculation as certainly as the regular winds are already. This brings us at once to the consideration and elucidation of the variable winds of Europe.*

304. I have already alluded to the division of Europe by meteorologists into three rainy provinces; and as certain winds are believed to produce these seasonal rains, their action, which has been observed for a number of years to be of so regular an order, may be traced with interest, and this M. Kaemtz has done in a satisfactory manner. "On collecting all that is known in the different climates of Europe," observes M. Kaemtz, in recounting the rainy winds of Europe, "we are led to establish three hyetographic regions: 1st, that of England and the west of France, which extends in a modified form even into the interior of the continent; 2d, that of Sweden and Finland; and 3d, that of the coasts of the Mediterranean. The limits of these regions are not always rigorously defined; they are not clearly recognised, except in points where they are marked by great chains of mountains. Every where else the transitions are found to be very orderly. The differences of these three groups, consist in the different direction of the rainy winds, and of the distribution of the quantity of water which falls each year. Let us consider that part of Europe N. of the Alps and the Pyrenees; the predominance of W. winds, a vast ocean on one side, a great continent on the other, are the determining circumstances of the distribution of rains. If the NE. wind always prevailed, even at a considerable height, it would never rain, for it passes over lands, before arriving at the two latitudes, where the elevation of temperature removes the vapours from their point of condensation. If the SW. wind, on the contrary, blew without ceasing, it would always rain, for as soon as the moist air gets cool, the vapour of water is precipitated. In spite of their alternations, these winds always preserve their relative characters. If we imagine, with M. de Buch, how many times each wind brings rain, these results become evident. In 100 showers which fell at Berlin, the different winds blew in the following proportions:—

N.	NE.	E.	SE.	S.	SW.	W.	NW.
4·1	4·0	4·9	4·9	10·2	32·8	24·8	14·4

Thus scarcely any rain falls with the NE. wind, whilst at least half are brought by the W. and SW. winds. But the winds do not all blow an equal number of times in the course of the year. The number of times that each wind has blown must, therefore, be decided by the number corresponding to each wind in the preceding table. We then obtain the following numbers:—

N.	NE.	E.	SE.	S.	SW.	W.	NW.
5·8	8·1	8·8	6·9	3·8	2·8	4·2	4·5

* See Polehampton's *Gallery of Nature and Art*, vol. iv. p. 185-205; in which an interesting collection of accounts of varieties in the phenomena of the winds is given.

The law is always the same; out of nine times which the E. wind blows, it only rains once; whilst it rains once in three times during the SW. wind. The influence of seasons is also recognised. Whilst it frequently rains in winter during E. or N. winds, these same winds are almost always dry in summer. This fact accords very well with what we have said on the relative humidity of the different winds, for with E. winds the air is very dry in summer, but very moist in winter. Rains brought by NE. winds are even very different from those brought by the SW. When the NE. wind suddenly begins to blow, the temperature falls; large drops of rain fall in abundance for several moments; the sky then again becomes serene. In SW. winds, the rain is fine, and lasts a long time. So the rains are in general due to a cooling, and to the precipitation of the vapours brought by the SW. wind. In high latitudes, on the contrary, the NE. wind suddenly cools masses of air, which can then no longer contain vapours in the elastic state. As these winds succeed each other with a certain regularity, there must follow a very regular succession of changes of weather; on this we will now make a few observations.

305. "When the weather has been fair for a long time, and a SW. wind begins to blow in the higher regions of the atmosphere, cirri make their appearance, and soon cover the sky. Beneath them is formed a stratum of *cumulus*, which allows a light rain to escape. The wind turns to the W., the clouds become thicker, the rain falls more abundantly, and the air becomes colder. With the N. or NW. wind the rain continues, although the thermometer falls. In winter, the rain passes into the state of snow. If the wind does not entirely cease with the N. wind, it is not, however, continuous; the blue of the sky is seen in the intervals which separate the clouds. Showers alternate with sunshine, especially with the NE. wind; but if the wind passes to the E. or the S., the sky is then covered with small rounded *cumuli*, or else it becomes perfectly serene. These phenomena succeed each other in an almost uniform manner, over large surfaces. Mountain-chains alone have the power of slightly modifying the succession of phenomena. If they extend from N. to S., they arrest the SW. wind, and it will rain more on their W. than on their E. side. Thus the SW. is not the rainy wind in the S. of Germany, but the NW.; because the SW. winds lose the water with which they are charged when they arrive on the other side of the Alps. The same thing happens in the Scandinavian peninsula. On the W. side of Norway, rain falls for entire days during SW. winds, the summits of the Scandinavian Alps are covered with hoar-frost; and on the other side of the chain only a few drops disturb the serenity of the sky of Sweden. The sea-winds lose the moisture with which they were charged in traversing the large table-land that separates the two countries; so that it rains more frequently in Sweden with E. than with W. winds. The proof that this is not connected with the vapours which rise from the Baltic is, that a similar relation is found in Finland. Wherever the region of rainy E. winds comes into contact with that of the rainy W. winds, it rains indifferently with all winds; this is remarked at St Petersburg. We are still in want of a sufficient number of observations in order to follow out these laws into their details.

306. "The Atlantic is the great reservoir of rains for the European regions that we have hitherto been considering, but it has little influence over the climate of countries situated on the north of the Mediterranean."*

307. The comparative prevalence of the E. and W. winds in Great Britain is shown in this table:—

Years of Observation.	Places.	Wind.	
		Westerly.	Easterly.
10	London,	233·	132·
7	Lancaster,	216·	149·
51	Liverpool,	190·	175·
9	Dumfries,	272·5	137·5
10	Branxholm, near Hawick,	232·	133·
7	Cambuslang,	214·	151·
8	Hawkhill, near Edinburgh,	229·5	135·5
	Mean,	220·3	144·7

* Kaemtz's *Complete Course of Meteorology*, p. 137-139.

308. In London, by a mean of 10 years of the register kept by the Royal Society, these results were obtained:—

Of SW. winds,	.	112 days.
NE. —	.	58
NW. —	.	50
W. —	.	53
SE. —	.	32
E. —	.	26
S. —	.	18
N. —	.	16

309. By registers of the winds kept by the late Admiral Sir David Milne, at Inveresk, near Edinburgh, in the years 1840 and 1841; and by Mr Atkinson, at Harraby, near Carlisle, in 1840, these results were obtained:—

	Inveresk. 1840.	Inveresk. 1841.	Harraby. 1840.
Of N. winds,	86	77	$12\frac{1}{4}$ days.
NNE. —	20	12	$14\frac{1}{2}$
NE. —	41	49	$14\frac{1}{2}$
ENE. —	15	14	$20\frac{1}{4}$
E. —	28	38	$20\frac{3}{4}$
ESE. —	13	7	7
SE. —	32	29	$20\frac{1}{2}$
SSE. —	19	20	$22\frac{1}{2}$
S. —	39	79	$19\frac{1}{2}$
SSW. —	38	62	$24\frac{3}{4}$
SW. —	127	113	$39\frac{1}{4}$
WSW.—	38	45	$70\frac{1}{4}$
W. —	138	105	42
WNW.—	33	29	16
NW. —	45	37	$11\frac{1}{2}$
NNW.—	13*	13†	$10\frac{3}{4}$

310. The direction of the winds in any given locality is greatly affected by the configuration of the country, their general direction being modified so as to coincide with the local lines of elevation and depression of the surface. It is probably on this account that the winds in Egypt are generally either N. or S.; the former prevailing nine months of the year. When the climate is tolerably regular, as in the S. of Europe, the direction of the wind makes all possible difference in its character. The transition from a *sirocco* to a *tramontana* at Rome and Naples is as great in temperature as 10° of latitude.‡ A remarkable effect of local configuration is thus stated: "When the wind is NW. at Manchester, it is N. at Liverpool; when N. at Manchester, it is NE. at Liverpool; when NE. at Manchester, it is E. at Liverpool; and when E. at Manchester, it is SE. at Liverpool. Of course the SW. wind comes the same to both towns, as there are no hills to the S. such as are to the N. and E. of them." §

311. The *force and velocity of winds* are instructive subjects of observation. They have been attempted to be calculated with great care and ingenuity by Mr Rouse, who constructed tables of the results. His tables were much improved and considerably augmented by Dr Young, who, in comparing Mr Rouse's observations with the results of Dr Lind's scale, constructed the following table:—

Force of the Wind on the square foot in lb.	oz.	dr.	Velocity of the Wind, computed from Rouse's Experiments. Feet in 1 second.	Miles in 1 hour.	Denominations of Winds.
0	0	1.2	1.43	1.	Hardly perceptible. *Rouse.*
0	0	5.1	2.93	2.	Just perceptible. *Rouse.*
0	0	11.2	4.40	3.	
0	1	4.2	5.87	4.	Gentle winds. *Lind.*
0	1	15.4	7.33	5	
0	2	1.2	10.67	5.14	A gentle wind. *Lind.*
0	4	2.5	14.67	7.27	Pleasant wind. *Lind.*
0	7	13.9	15.19	10.	Pleasant brisk gale. *Rouse.*
0	8	5.3	22.0	10.35	Fresh breeze. *Lind.*
1	1	11.3	29.34	15.	Brisk gale. *Lind.*
1	15	7.8	33.74	20.	Very brisk. *Rouse.*
2	9	10.6	36.67	23.	
3	1	3.2	44.01	25.	
4	6	13.8	47.73	30.	High wind. *Rouse.*
5	3	5.2	51.34	32.54	High wind. *Lind.*
6	0	6.9	58.68	35.	
7	13	10.6	66.01	40.	Very high. *Rouse.*
9	15	6.5	67.5	45.	Great storm. *Derham.*
10	6	10.4	73.35	46.02	Very high. *Lind.*
12	4	12.8	82.67	50.	Storm or tempest. *Rouse.*
15	10	0.	88.02	56.37	Storm. *Lind.*
17	11	7.	95.46	60.	Great storm. *Rouse.*
20	13	5.2	96.82	65.08	Great storm. *Lind.*
21	6	15.3	106.72	66.	Great storm. *Condamine.*
26	0	10.4	117.36	72.76	Very great storm. *Lind.*
31	7	13.4	116.91	80.	Hurricane. *Rouse.*
31	4	0.	126.43	79.7	Hurricane. *Lind.*
36	8	12.2	135.	86.21	Great hurricane. *Lind.*
41	10	10.7	143.11	92.04	Very great hurricane. *Lind.*
46	14	0.	146.7	97.57	Most violent hurricane.
49	3	3.2	150.93	100.	A hurricane that tears up trees.
52	1	5.2	158.29	102.9	
57	4	11.	160.	107.92	
58	7	3.2	165.34	109.	
62	8	0.		112.73	

I have doubts of the accuracy of some of the contents of this table, as in many particulars they do not correspond with

* Jameson's *Edinburgh New Philosophical Journal*, vol. xxx. p. 423.
† *Edinburgh Evening Post*, January 1842. ‡ Forbes's *Report on Meteorology*, vol. i. p. 247.
§ *Morning Herald*, 19th June 1839.

my own observations on this subject. Whatever may be the accuracy of the higher rates of velocity I cannot say, for no ordinary means of judging of them exists, except by seeing the shadows of clouds passing along the ground; but the accuracy of the smaller velocities may very easily be judged of. It is said that wind moving 2 miles an hour is "just perceptible;" and at 3 and 4 miles it constitutes what are called "gentle winds." Let us test these. Suppose the air to be perfectly calm when one is walking at the rate of 3 miles an hour, is there felt any thing like a "gentle wind" upon the face? I think not. Were it therefore moving at the rate of 3 miles an hour, it would be as little felt. Before wind is *felt* at all, one may safely conclude that the air is moving at a greater velocity than 3 or 4 miles an hour, whatever indication anemometers may give—for the human skin is a much more delicate indicator of the gentle motions of the air than any instrument. On this view of the subject Sir Richard Phillips makes these pertinent remarks: "If wind blows 100 miles an hour—that is, 528,000 feet—then, as air is 833 times rarer than water, this moving at the rate of 660 feet, or 1 furlong per hour, would be equal to it, which is absurd. There must be some mistake. A West India hurricane has blown heavy cannon out of a battery, and water at 5 miles an hour would scarcely bend a twig. Balloons have travelled 60 miles an hour, when the anemometer showed but 8 miles."* When I have observed the shadows of clouds flying over the land in a windy day in spring or summer, I was convinced that the wind may move hundreds of miles per hour; and in this country the highest wind has a small velocity compared to that at times in the tropics. It is recorded that such was the noise occasioned by the hurricane that took place at Pondicherry on the 29th October 1768, that when the signal guns were fired to warn the ships off the coast, their reports were not heard by even the inhabitants within the fort.†

312. The subject of *Storms*, in their origin and direction, after a long period of neglect, has of late again attracted the attention of philosophers. So long ago as 1801, Colonel Capper, of the East India Company's service, in his work on winds and monsoons, gave it as his opinion that hurricanes would be found to be *great whirlwinds*. This idea was adopted and confirmed by Mr W. C. Redfield of New York, in a memoir on the prevailing storms of the Atlantic coast of North America, which appeared in Silliman's Journal in 1831. Colonel Reid, of the Royal Engineers, has since then treated the subject in a philosophical manner in a recent dissertation. His attention was first directed to it in 1831. His military service at Barbadoes, immediately after the desolating hurricane of that year, which in the short space of seven hours destroyed 1477 houses in that island alone, naturally led him to the consideration of the phenomena of hurricanes. After much consideration and investigation, he was impressed with the regularity with which storms appear to pass toward the north pole, always revolving in the same direction, that is, opposite to the hands of a watch, or from the E. round by the N. W. S. to E. From this circumstance he was anxious to ascertain whether the revolution would not be in an opposite direction in the southern hemisphere; and this point was well illustrated by the disastrous storm, in the Indian Sea, of 1809, in which nine sail of Indiamen foundered. He found the general phenomena of these storms to be as a great whirlwind, represented by the revolution of a circle, whose centre is made to progress along a curve or part of a curve, which is, in most cases, of a form approaching the parabolic, the rotatory circle expanding as it advances from the point at which the storm began to be felt,—its rotatory motion in the northern hemisphere being in a contrary direction to that in which the hands of a watch go round, while in the southern hemisphere the rotation is in the same direction as the hands; the diameter of the circle, over which the whirl of the storm is spread, often extending from 1000 to 1800 miles. In the centre of the whirl is a comparative calm, while in its circumference the storm rages, and the wind blows from every conceivable quarter. ‡

* Phillips' *Facts*, p. 455. † Capper *On Winds and Monsoons*.
‡ *Edinburgh New Philosophical Journal*, vol. xxv. p. 342.

313. There are concomitant circumstances attendant on storms worth relating. Major Sabine found the magnetic intensity least at St Helena, where there are no violent storms. The line of least intensity passes through the Pacific Ocean; the lines of greatest magnetic intensity, on the contrary, seemed to correspond with the localities of hurricanes and typhoons; for the meridian of the American magnetic pole is found to pass not far from the Caribbean Sea, and that of the Asiatic pole through the China Sea. He found two instances of water-spouts, one in the northern, the other in the southern hemisphere, in which the revolutions moved in opposite directions, and both in contrary directions to great storms. He explains the variable high winds of our latitudes, by storms expanding in size, and diminishing in force, as they approach the poles, their meridians at the same time nearing each other, and occasioning a huddling together of the gales.

314. Sir Snow Harris of Plymouth has discovered that there is a *connexion betwixt the force of the wind, and the hororary oscillations of the barometer.* Thus the mean force of the wind for the whole year, at 9 A.M. was 0·855, and at 9 P.M. 0·605; but at 3 P.M. it was 1·107 of Lind's anemometer.*

315. M. Schübler has shown that *winds have a characteristic electric power.* The precipitations during the wind from the N. half of the circle of azimuth, have a ratio of positive to negative electricity, which is a maximum, and in the other half it is a minimum; the negative precipitations when the wind is S. being more than double the positive ones. The mean intensity of electricity, independent of its sign, is greatest in N. winds.†

316. There being an atmospherical wave as well as a tidal one, and as any elevation of the atmosphere cannot fail to produce a change in parts immediately below the point of disturbance, there seems no reason to doubt that an *analogy exists betwixt the tides and the winds, and also with rain.* If high tides at London Bridge happen at 12 or 1 noon, rain falls more frequently than at other periods, if the wind is in the E. So it seems probable that, when the changes of the wind can be calculated more perfectly, we shall have more correct tide tables. It thus appears that the nearer the high tide is to noon the greater is the probability of rain, because the breeze from the sea is then strongest.

317. The approach of high *wind* may be anticipated from these general prognostics:—when cattle appear frisky, and toss their heads and jump—when sheep leap and play, boxing each other—when pigs squeal, and carry straw in their mouths—when the cat scratches a tree or a post—when geese attempt to fly, or distend and flap their wings—when pigeons clap their wings smartly behind their backs in flying—when crows mount in the air and perform somersets, making at the time a garrulous noise—when swallows fly on one side of trees, because the flies take the leeward side for safety against the wind—when magpies collect in small companies, and set up a chattering noise.

318. These are general indications of a *storm:*—When the missel thrush (*Turdus viscivorus*) sings loud and long, on which account this bird has received the name of the storm-cock—when sea-gulls come in flocks on land, and make a noise about the coast,—and when the porpoise (*Phocæna communis*) comes near the shore in large numbers.

319. Every one is aware of the uncertainty of foretelling the state of the weather, but every one who has attempted to foretell it, and has not succeeded, is not aware of the nature of the many particulars which render his success doubtful. These particulars are thus well enumerated and arranged by Mr Mudie:—"Though one of the most interesting subjects connected with the economy of our globe, and its use and comfort to man, this is one of the most difficult subjects that can engage his inquiry. One reason of this is, the vast number of elements that have to be studied and taken into account; the different laws which each of these obey; the indeterminable nature of many of them; and the modifying influences which

* Forbes's *Report on Meteorology*, vol. i. p. 248. † *Ibid.*

they have upon each other in their joint working. Thus, the daily and seasonal motions of the earth, and the action of the sun and moon; the reciprocating influences of the hemispheres—those of sea and land, of plain, or valley and mountain, and of surfaces covered with vegetation of different characters—are all causes of the weather; but in most instances, particularly in such variable climates as present themselves about the middle latitudes of the quadrant, and near the shores of the sea—more especially in small countries surrounded by it—these causes are so blended with each other, that it is impossible so to analyse the result as to assign to each of them its due state in bringing about the particular weather of any day, any week, or any period, longer or shorter." *

320. Botany.—The student of agriculture should become acquainted with systematic botany and botanical physiology. The former will enable him to recognise any plant he may meet with in the fields and pastures, and the latter will make him acquainted with the internal structure and functions of the plants he is about to cultivate in agriculture.

321. Systematic botany may be acquired by two methods, the artificial or Linnæan, which was the only method known for many years, and the natural method, which was later discovered and established by Jussien. It has become the practice of some botanists to decry, of late years, the Linnæan method of acquiring a knowledge of the particular parts of plants, and to extol the excellences of the natural method. For my part, I should be sorry to see the Linnæan method entirely abandoned, because I am persuaded that a beginner will much sooner be able to recognise any plant he finds by it than by the natural method; and after all, the Linnæan *is* a natural method of studying the construction of plants, inasmuch as the component parts of a flower, upon which the system is founded, as much belongs to the making up of a plant, as its aspect, form, and habits; and besides, the Linnæan method does not neglect the form of the leaf, the character of the stem, or the structure of the root, any more than the natural or Jussien method. No doubt, when plants are grouped in relation to their general structure, form, habits and uses, they become objects of much greater interest and beauty, than when examined with a view to be placed in any artificial arrangement; and on this account the natural method possesses a charm which the longest and most intimate study of the Linnæan method could never present; still it is only when the botanical student has far advanced into the study of plants, and has become acquainted with their properties and uses, that he can appreciate the beauties and advantages of the natural method. Such being the case, it appears to me the most rational method of acquiring a knowledge of botany is to become acquainted with individual plants as well as possible; and which may be done by the Linnæan method, and then to contemplate them in groups according to the natural method of Jussien.

322. Botanical physiology, which makes us acquainted with the internal structure and functions of the several parts of plants, and the circumstances by which the exercise of these functions is observed to be modified, can only be successfully acquired after the study of systematic botany, and, I should say, after it had been studied in the manner recommended above. This is a science which has been but recently developed, and its development has been mainly brought about by the persevering researches of the chemist, and the use of the microscope. We have only to look into the works of Professor Johnston and of M. Raspail, to be convinced of the vast amount of labour which has been bestowed by chemists in analysing in the laboratory, and observing with the microscope the minutest details of the structure of plants, most of which had eluded human research. In the absence of a sufficient knowledge of their structure, the functions of plants were misunderstood, and in consequence the wildest conjectures were advanced to account for the phenomena they exhibited; but now the functions of plants are daily becoming more and more understood; we now know that plants only receive their food from the soil in a state of solution,

* Mudie's *World*, p. 243.

that the leaves perform the important function of elaborating the sap taken up by the stem, and, at the same time, they act upon the air in such a manner as to withdraw from it materials necessary to increase the structure, and are influenced by the light of the sun, so as to preserve those materials in the best condition, to support the good health of the plant.

323. The relation of the study of plants with agriculture will be well understood by the following extract from Professor Johnston's lectures:—"It is a fact familiarly known to all of you, in addition to those circumstances by which we can perceive the special functions of any one organ to be modified, there are many by which the entire economy of the plant is materially and simultaneously affected. On this fact the practice of agriculture is founded, and the various processes adopted by the practical farmer are only so many modes by which he hopes to influence and promote the growth of the whole plant, and the discharge of the functions of all its parts. Though the manures in the soil act immediately through the roots, they stimulate the growth of the entire plant; and though the application of a top-dressing to a crop of young corn or grass may be supposed first to affect the leaf, yet the beneficial result of the experiment depends upon the influence which the application may exercise on any part of the vegetable tissue. In connexion with this part of the subject," he adds, "I shall only farther advert to a very remarkable fact mentioned by Sprengel, which seems, if correct, to be susceptible of important practical applications. He states that it has frequently been observed in Holstein, that if, on an extent of level ground sown with corn, some fields be marled, and others left unmarled, the corn on the latter portions will grow *less luxuriantly*, and will *yield a poorer crop than if the whole had been unmarled.* Hence," he adds, "if the occupier of the unmarled field would not have a succession of poor crops, he must marl *his* land also. Can it really be that the Deity thus rewards the diligent and the improver? Do the plants which grow in a soil in higher condition take from the air more than their due share of the carbonic acid, or other vegetable food it may contain, and leave to the tenants of the poorer soil a less proportion than they might otherwise draw from it? How many interesting reflections does such a fact as this suggest! What new views does it disclose of the fostering care of the great Contriver—of his kind encouragement of every species of virtuous labour! Can it fail to read us a new and special lesson on the benefits to be derived from the application of skill and knowledge to the cultivation of the soil?" *

324. A knowledge of the geographical distribution of plants is a subject of interest, not only to the general reader, but also to the farmer, and may be useful to him by affording him the means of judging whether or not plants, recommended for cultivation in this country, will be suitable to the soil of his own farm situate in a certain latitude and elevation above the sea.

325. "Every country, as has been observed by writers, and frequently different parts of the same country, possesses a vegetation peculiar to itself; and the limits assigned to each region depend on various causes, since the variously modified organisation of different vegetables imposes upon them different conditions of existence, and they can live and flourish only where these conditions are complied with. The geography of plants, or an inquiry into their distribution, according to soil and climate, is intimately connected with the general physics of the globe, and is quite distinct from the science of descriptive botany. The importance of the former cannot be doubted, when we consider that the character of a country and the whole face of nature are dependent on the predominance of certain families of plants in particular districts, and that the abundance of *gramineæ*, grasses, forming vast savannahs, or of palms or *paniferæ*, produce the most important effects on the social state of a people, their manners, and the progress of the economical arts.

326. "It is the influence of temperature which is the chief cause of the distribution of plants, and on this account the face of the globe has been divided into eight zones,

* Johnston's *Lectures on Agricultural Chemistry and Geology*, 2d edition, p. 159.

called the isothermal zones, each of which is distinguished by a peculiar vegetation, and they are these:—1st, The equatorial zone, on both sides of the equator, to about 15° of latitude, with a temperature extending from the maximum heat to 78°. 2d, The tropical zone, from latitude 15° to the tropics, having a mean temperature of 78° down to 73°—summer temperature 86° to 80°—winter temperature in the eastern coast countries 59°. 3d, The subtropical zone, from the tropics to latitude 34°—mean temperature of the year 71° to 62°; of the summer 82° to 73°. 4th, The warmer temperate zone, from latitude 34° to 45°—mean temperature of the year 62° to 53°; summer temperature in North America 77°, in Europe 75° to 68°, in eastern Asia 82°; temperature of winter in the New World 44° to 32°, in Europe 50° to 34°, in eastern Asia 26°. 5th, The colder temperate zone, between the parallels of 45° and 58°—temperature of the year 53° to 42; minimum summer temperature on the west coast 56°, in the interior of the continent 68°; minimum winter temperature in the interior of Europe 14°. 6th, The sub-arctic zone, from latitude 58° to the polar circle—mean temperature of the year between 42° and 39°; of the summer months in the New World 66°, in the Old World 60° to 68°; of the winter months of the former 14°, of the latter 28°—namely, in western Europe; in the interior of Russia 14° to 10°. 7th, The arctic zone from the polar circle to latitude 72°—mean annual temperature 32° to 28°, or towards the eastern and continental positions, far under the freezing point. 8th, The polar zone, beyond latitude 72°: this parallel is near the mean temperature of 1° in the New World, and 16° in the Old World; the summer of the former 37°, and of the latter 38°; winter, —28° in the New, and —2° in the Old World.

327. "As the physiognomy of the vegetable kingdom is characterised by certain plants in the different latitudinal zones from the equator to the poles, so also, in a perpendicular direction, in the mountain regions which correspond with the zones. Proceeding with the vegetation of the equatorial zone, we follow the series of vegetable regions in ascending lines, one after the other, and may compare them with the different zones as follows:—

1st, The region of palms and bananas—equatorial zone.
2d, — — trees, ferns, and figs—tropical zone.
3d, — — myrtles and laurels—sub-tropical zone.
4th, — — evergreens—warm temperate zone.
5th, — — European trees—cold temperate zone.
6th, — — pines—sub-arctic zone.
7th, — — rhododendrons—arctic zone.
8th, — — alpine plants—polar zone.

328. "Observers who, in a short period of time, have passed through extensive districts of country, and also have ascended mountain ranges, in which climates are placed in layers one above the other, must soon have become aware of the regular distribution of vegetable forms. They gathered new materials for a science, the name of which had not yet been pronounced. The same regions of plants which, as a youth, Cardinal Bembo described on the declivity of Etna, in the sixteenth century, were again found by Tournefort on Ararat, who accurately compared the alpine flora with that of the plain under different latitudes, and was the first to remark that the elevation of the soil above the level of the sea affects the distribution of plants in the same manner as distance from the poles in level countries. Marsel, in an inedited flora of Japan, casually makes use of the geography of plants. This phrase is again found in the fantastic though charming "Studies of Nature," by Bernardin de St Pierre. But the scientific treatment of the subject only commenced when the geography of plants was considered in intimate connexion with the doctrine of the distribution of heat over the surface of the globe; when plants were arranged in natural families, so as to admit of the numerical computation of the forms which decrease or increase towards the poles, and what proportion, in different parts of the earth, each family bears to the whole mass of the indigenous phanerogamæ. Jussieu remarks that, notwithstanding several essays before his time, A. Von Humboldt deserves to be pronounced the founder of the system of the geography of plants, on which he has thrown so much light by his labours in meteorology as well as botany.

329. "The relative proportion of the most important families of plants in the different zones have been determined by Humboldt in the following order:—1. The group of glumaceæ, which unites in itself the plants of the three families of the junceæ, cyperaceæ,

and gramineæ, increases from the equator towards the poles, forming, under the tropics $\frac{1}{11}$, in the temperate zone $\frac{1}{8}$, and in the frigid zone $\frac{1}{4}$ of the entire phanerogamæ. The increase towards the pole is owing to the rushes and sedges, which are more in proportion to the other phanerogamæ in the temperate zone and within the tropics. The junceæ alone almost disappear within the tropics, forming only $\frac{1}{400}$ of the whole phanerogamic plants, while in the temperate zone they form $\frac{1}{90}$, and in the frigid zone $\frac{1}{25}$. The cyperaceæ alone under the tropics in the New World $\frac{1}{50}$, in the Old World $\frac{1}{22}$, in the temperate zone $\frac{1}{20}$, and in the frigid zone $\frac{1}{9}$. The numerous family of the gramineæ is pretty equally distributed over the whole earth; it increases, in a small degree, towards the poles: between the tropics the grains form $\frac{1}{14}$, in the temperate zone $\frac{1}{12}$, and in the frigid zone $\frac{1}{10}$ of all the phanerogamæ. Besides, these families increase in the number of species from the equator towards the poles. The ericeæ under the tropics in America form $\frac{1}{130}$; in the temperate zone of the Old World $\frac{1}{100}$, of the New World $\frac{1}{36}$, in the frigid zone $\frac{1}{25}$: so also, the families the flowers of which form a catkin, or the amentaceæ, which in the torrid zone form only $\frac{1}{800}$, are in the temperate zone in Europe $\frac{1}{45}$, in America $\frac{1}{25}$, and in the frigid zone $\frac{1}{20}$ of the entire phanerogamæ. 2. Four other families—namely the leguminosæ, the rubiaceæ, euphorbiaceæ, and malvaceæ—bear the maximum of their species in the torrid zone. The leguminosæ form under the tropics $\frac{1}{10}$, in the temperate zone $\frac{1}{18}$, and in the frigid zone $\frac{1}{35}$ of all phanerogamæ. The rubiaceæ under the tropics of the Old World $\frac{1}{14}$, in the New World $\frac{1}{25}$, in the temperate zone $\frac{1}{60}$, in the frigid zone $\frac{1}{80}$. The euphorbiaceæ, in the torrid zone $\frac{1}{32}$, in the temperate $\frac{1}{80}$, and in the frigid zone $\frac{1}{500}$. The malvaceæ, in the torrid zone $\frac{1}{35}$, in the temperate $\frac{1}{200}$, and in the frigid zone the plants of this family entirely disappear. In the great family of rubiaceæ, one of its seven groups, that of the coffeæ, form $\frac{1}{3}$ of all the rubiaceæ of tropical America, whilst the groups of the stellatæ principally belong to the temperate zone. 3. The four families of compositæ, cruciferæ, labiatæ, and umbelliferæ have the maximum of their species in the temperate zone, and decrease as well towards the equator as towards the poles. The compositæ form under the tropics of the Old World $\frac{1}{18}$, in the New World $\frac{1}{12}$, in the temperate zone of Europe $\frac{1}{8}$, in America $\frac{1}{6}$, and in the frigid zone $\frac{1}{18}$ of all phanerogamæ. The cruciferæ are almost unknown in the torrid zone, if we consider the mountain regions between 7670 and 10,870 feet in height, where these plants scarcely form $\frac{1}{800}$ of all phanerogamæ. In the temperate zone their quotient in Europe is $\frac{1}{18}$, in America, on the contrary, only $\frac{1}{60}$, in the frigid zone $\frac{1}{24}$. The labiatæ form under the tropics $\frac{1}{40}$, in the temperate zone in Europe $\frac{1}{25}$; in America, as within the tropics, in the frigid zone $\frac{1}{70}$. The scarcity of this family, as well as the cruciferæ in the temperate zone of the New World, is a remarkable circumstance. The umbelliferæ are seldom found, within the tropics, at a height under 7673 feet. Above this elevation they form (with the exception of a very few in the plain) only $\frac{1}{500}$ of all phanerogamæ. They form in the temperate zone $\frac{1}{40}$, and are more numerous in Europe than in North America; in the frigid zone they form $\frac{1}{60}$. 4. Among the acotyledones the family of ferns claim our attention. Contrary to the general law affecting the cryptogamæ, this family decreases towards the poles, which is accounted for by the circumstance, that it requires a moist soil and the shelter of warm woods. Under the tropics it forms $\frac{1}{20}$, and in the temperate zone $\frac{1}{70}$ of all phanerogamæ. In arctic America the filices are entirely awanting."*

330. Geology.—No farmer who derives the entire produce which supports himself and his stock, and enables him to supply the market, directly from the soil, but must see the connexion between geology and agriculture as an inseparable one; but, indispensable as the connexion undoubtedly is, geologists have not afforded the assistance to agriculture which they perhaps might have done by this time. They have ascertained the relative position of the harder rocks which compose the crust of the globe, but have paid comparatively little attention to the explanation and classification of the more recent deposites, which, in reality, constitute the soil and subsoils with which the farmer

* Johnston's *Physical Atlas*—"Botanical Geography."

has alone to do—for a knowledge of the structure and position of the harder rocks would rather confer benefit on the landowner than on him, inasmuch as his property may contain numerous and different mineral products of value to the arts, and of benefit to his plantations. Much yet remains to be known of the origin of the surface-soil, and of the position and structure of subsoils, in which we form our drains, and whether or not those deposites have such a determinate position as to cause them to be best drained by drains running parallel with or at an angle with the line of valleys and rivers; and there cannot be a doubt but that a perfect knowledge of those recent deposites would supply useful hints for the planting of trees in soils and over subsoils best suited to their natural habits—a branch of rural economy that will probably be but little understood and judiciously practised until this knowledge is afforded by geology. The operations of the farmer, then, are most closely connected with the most recent deposites of earthy matter on the surface of the globe; and with these he should become as intimately acquainted as the works of geology, and personal observation, will enable him.

331. *Soils.*—The term *soil* does not convey the same meaning to all persons. The geologist does not recognise the term at all—except, perhaps, in common with the botanist and planter, as the mould which supports ordinary vegetation and trees; for "the term rock," says Sir Henry de la Beche, "is applied by geologists not only to the hard substances to which the name is commonly given, but also to those various sands, gravels, shales, marls, or clays, which form beds, strata, or masses."* The common observer considers the ground he treads on as the soil. The farmer strictly and distinctly confirms his definition of a soil to the portion of the ground turned over by the plough.

332. The external characters of minerals established by Werner of Freyberg, and recognised by mineralogists, has never been used to describe agricultural soils; and it might serve no practical purpose to do so, since the minute shades in the varieties of soils, which are constantly undergoing changes in the course of good and bad modes of cultivation, would soon render the characteristics inapplicable: but practically a knowledge of the external characters of soils is a matter of no difficulty; for however complex the composition of any soil may seem, it possesses a character belonging to its kind which cannot be confounded with any other. The leading characters of all soils are derived from only two earths, *clay* and *sand*, the greater or less admixture of which stamps their peculiar character—for the properties of these earths are also found to exist in purely calcareous and purely vegetable soils.

333. *Clay soil.*—A pure *clay soil* has so distinctive external characters, that it may easily be recognised. When fully wetted, it feels greasy to the foot, which slips upon it backwards, forwards, and sideways. It has an unctuous feel in the hand, by which it can be kneaded into a smooth homogeneous mass, which retains the shape given to it. It glistens in the sunshine. It retains the water upon its surface, and makes water very muddy when mixed with it or runs over it, and the mud is long of settling to the bottom. It feels cold to the touch, and easily soils the hand and every thing that touches it. It cuts like soft cheese with the spade. It parts with its moisture slowly. When dry, clay-soil cracks into numerous fissures, becomes hard to the foot, and collects into lumps, large and small, very difficult to be broken, and indeed cannot be pulverised by the implements in ordinary use. It soils the hand and clothes with a dry, light-coloured, soft dust, which has no lustre. It is heavy and difficult to labour. It absorbs moisture readily, and adheres to the tongue. When neither wet nor dry it is tough, and soon becomes hard with a little drought, or soft with a little rain. On these accounts, it is the most obdurate of all soils to manage, being, even in its best state, heavy to turn over with the plough, and difficult to pulverise with the other implements; and when wet, is in an unfit state to be wrought with any of the implements. A large number of horses is thus required to work a clay-land farm; and its workable state continues only for a short time, even in the best weather. But it is a powerful soil in

* De la Beche's *Manual of Geology*, p. 35.

its capability, bearing luxuriant crops, and producing them of an excellent quality. It generally occurs in deep masses, on a considerable extent of flat surface, exhibiting few undulations, along the margin of a large river, or its estuary, and evidently being a deposition from water. Examples of this kind of soil may be seen in Scotland, in the Carses of Gowrie, Stirling, and Falkirk. It may be characterised a naturally fertile soil, containing little vegetable matter, and of a yellowish-grey colour.

334. *Sandy soil.*—A pure *sandy* soil is as easily recognised as one of pure clay. When wet it feels firm under foot, and then admits of being turned over by the plough with a pretty entire furrow. It feels harsh and grating to the touch, and will not compress into a ball with the hand. When dry it feels soft, and is so yielding that every object of the least weight sinks in it, and is very apt to blow away with the wind. Sandy soil generally occurs in deep masses, near the termination of the estuaries of large rivers, or along the sea-shore; and in some countries in the interior of Europe, and over a large proportion of Africa, it covers immense tracts of flat land, and has evidently been deposited from water.

335. *Tilly soil.*—When *clay is mixed with* a little *sand*, its texture as a soil is very materially altered, but its productive powers are not improved. When such a clay is in a wet state, it still slips a little under the foot, but feels harsh rather than greasy. It does not easily ball in the hand. It retains water on its surface for a time, but is soon partially absorbed. It renders water very muddy, and soils every thing touching it; and on that account never comes clean off the spade, except when wetted with water. It has no lustre. When dry it feels hard, but is not difficult to be wrought with any of the implements of tillage; and when betwixt the states of wet and dry, it is easily reduced to a fine tilth or mould. This kind of soil never occurs in deep masses, is rather shallow, in many instances is not far from the hard rock, is not naturally favourable to vegetation, nor is it naturally prolific. It occupies by far the larger portion of the surface of Scotland, much of the wheat being grown upon it, and may be characterised as a naturally poor soil, with but little vegetable matter, and of a yellowish-brown colour.

336. *Loam.*—When clay or sand is mixed with a considerable proportion of decomposed vegetable matter, naturally or artificially, the soil becomes a *loam*, the distinguishing character of which is derived from the predominating earth. Thus there are clay loams and sandy loams. *Loam*, in the sense now given, does not convey the idea intended by many writers, who express themselves as if it must necessarily be like clay. Thus, Johnson, in defining the verb "to loam," gives as a synonyme the verb "to clay;" and Bacon observes in one of his Essays, that "the mellow earth is the best, between the two extremities of clay and sand, if it be not *loamy and binding*;" evidently referring to the binding property of clay. Sir Humphry Davy defines loam as "the impalpable part of the soil, which is usually called *clay or loam*."* And Mr Hugo Reid defines the same substance in these words: "The term 'loam' is applied to soils which consist of about one-third of finely divided earthy matter, containing much carbonate of lime."† Thus a great diversity of opinion exists as to what loam is. Loam, in my opinion, has changed its meaning since the days of Johnson, and consists of any kind of earth containing a *sensible admixture of decomposed vegetable matter*,—I say a sensible admixture, since no soil under cultivation, whether composed chiefly of clay or of sand, but what contains some decomposed vegetable matter. Unless, therefore, the decomposed vegetable matter of the soil so preponderates as to greatly modify the usual properties of the constituent earths, the soil cannot in truth be called by any other name than a clayey or sandy soil; but when it does so prevail, a *clay loam* or a *sandy loam* is formed—a distinction well known to the farmer. But if loam is almost synonymous with clay, then a *sandy* loam must be a contradiction in terms. Again, a soil of purely vegetable origin—such as crude peat or leaf-mould—cannot be called loam, as admixture of an earth of some sort with vegetable

* Davy's *Agricultural Chemistry*, 6th edit. p. 150.

† Reid's *Chemistry of Nature*, p. 276.

matter is required to make loam under every recorded definition of that term. Thus, then, all soils have the properties of clay or sand, and a considerable admixture of decomposed vegetable matter converts them into loam. Hence it is possible for husbandry to convert any earthy soil into a loam, as is clearly exemplified in the vicinity of large towns.

337. *Clay-loam.*—A clay-loam constitutes a useful and valuable soil. It yields the largest proportion of the finest wheat raised in this country, occupying a larger surface of the country than the carse-clay. It forms a lump by a squeeze of the hand, but soon crumbles down again. It is easily wetted on the surface with rain, and then feels soft and greasy; but the water is soon absorbed, and the surface again becomes dry. It is easily wrought, and may be so at any time after a day or two of dry weather. It becomes finely pulverised: is generally of some depth, forming an excellent soil for wheat, beans, Swedish turnips, and red clover: and is of a deep brown colour, often approaching to red.

338. All clay-soils are better adapted to fibrous-rooted plants than to bulbs and tubers; and to that sort of fibrons root which has also a tap-root, such as is possessed by wheat, the bean, red clover, and the oak. Its crops bearing abundance of straw, require a deep hold of the soil. Clay-soils are generally slow of bringing their crops to maturity, and which in wet seasons they never attain; but in dry seasons they are always strong, and yield both superior quantity and quality.

339. *Gravelly-soils.*—Sandy soils are divided into two varieties, which do not vary in kind but only in degree. Sand is a powder, consisting of small round particles of siliceous matter; but when these are of the size of a hazel-nut and larger,—that is, gravel,—they give their distinctive name to the soil, of a *gravelly soil*, which, when mixed with a sensible proportion of vegetable matter, becomes gravelly loam. The small fragments of a gravelly soil have been derived from all the rock formations: whilst the large boulders, imbedded principally under the surface, have been chiefly supplied by the older formations. Gravelly deposites sometimes occupy a large extent of surface, and are of considerable depth. Such a soil never becomes wet, absorbing the rain as fast as it falls; and after rain, feels somewhat firm under the foot. It can be easily wrought in any state of weather, and is not unpleasant to work, though the numerous small stones, which are seen in countless numbers upon the surface, render the holding of the plough in it rather unsteady. This soil is admirably adapted to plants with bulbs and tubers; and no kind of soil affords so dry and comfortable a lair to sheep on turnips, and on this account it is distinguished as "*turnip-soil.*"

340. *Sandy and gravelly loams.*—Sandy and gravelly loams, if not the most valuable, are the most useful of all soils. They become neither too wet nor too dry in ordinary seasons, and are capable of growing every species of crop, in every variety of season, to considerable perfection. On this account, they are esteemed "*kindly soils.*" They never occur in deep masses, nor do they extend over large tracts of land, being chiefly confined to the margins of small rivers, forming haughs or holms, through which the rivers direct their course from amongst the mountains towards the larger ones, or even to the sea; and, in their progress, are apt at times to become so enlarged with rain, both in summer and winter, as to overflow their banks to a limited extent on either side, and carry off the valuable soil of the haughs.

341. *Chalk soils.*—Besides these, there are soils which have for their basis another kind of earth—*lime*, of which the *chalky soils* of the south of England are examples. But these differ in agricultural character in nothing from either the clay or sandy soils, according to the particular formation in which the chalk is situated. If the chalky soil is derived from flinty chalk, then its character is like that of a sandy soil; but if from the under chalk-formation, its character is like that of clay.

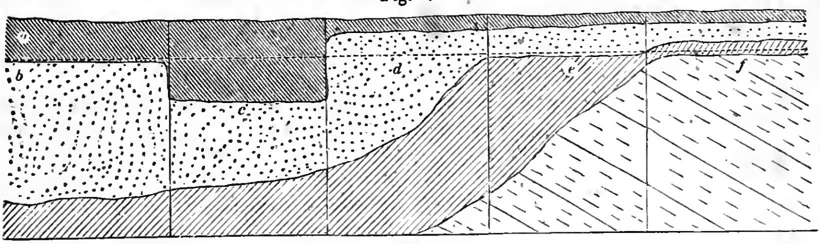
342. *Peat soils.*—Writers on agriculture also enumerate a peat soil, derived from peat; but peat, as crude peat, does not promote vegetation, and when decomposed assumes the properties of *mould*, and should be regarded as such. So that, for all *practical* purposes, soils are most con-

veniently divided into those having clayey and sandy properties, with their respective loams.

343. *Mould.*—Any of the loams which have been long under cultivation, and enriched by putrescent manures, is converted into mould, and forms a most valuable soil for every species of crop, as well the field as in the garden.

344. *Subsoils.*—As the soil consists of that portion of the earth's surface which is turned over by the plough, so the ground left immediately beneath the plough-furrow is the *subsoil;* and it may consist of the same earthy substance as the soil itself; or it may be of similar character, differing only in degree and not in kind; or it may be of quite an opposite character, or may consist of hard rock. The subsoil, whatever it may be composed of, exercising a great influence on the agriculture of the soil, is a subject of great interest to the farmer, and should be carefully studied by the agricultural student; and for this purpose I shall endeavour to illustrate its varieties by this figure. Let *a*, fig. 1, be the surface of the ground, the earthy mould derived from the growth and decay of natural

Fig. 1.



SECTIONS OF SOILS AND SUBSOILS.

plants; *b*, a dotted line, the depth of the plough-furrow. Now, the plough-sole may either just pass through the mould, as at *b*, when the mould will be the soil, and the earth below it the subsoil; or it may not pass entirely through the mould, as at *c*, when the soil and subsoil will be similar, that is, both of mould; or it may pass through the earth below the mould, as at *d*, when the soil and subsoil will again be similar, while neither will be mould, but earth; or it may move along the surface of *e*, when the soil will be of one kind of earth, though not entirely of mould, and the subsoil of another, that is, one of sand, gravel, or clay; or it may penetrate to the surface of *f*, when the soil will be of earth, though again not entirely of mould, but a mixture perhaps of clay, sand, and mould, and the subsoil of hard rock. These different cases of soil and subsoils, thus represented in the figure as each forming a distinct sectional division, may so occur in nature, though probably not all in the same locality.

345. The subsoil undoubtedly *produces a sensible effect on the condition of the soil above it.* If the soil is clay, it is impervious to water, and if the subsoil is clay also, it also is impervious to water. The immediate effect of this juxtaposition of retentiveness is to render both soil and subsoil habitually wet, until evaporation dries first the one and then the other. A retentive subsoil, in like manner, renders even a sandy or gravelly, that is a porous, soil above it habitually wet. On the other hand, a gravelly subsoil, which is always porous, greatly assists to keep a retentive clay soil dry. When a porous soil rests upon a porous subsoil, scarcely any degree of humidity can injure either. Rock may be either a retentive or a porous subsoil, according to its structure—a massive structure keeping the soil above it habitually wet; while a stratified one, if the lines of stratification dip downwards from the soil, (as at *f*, fig. 1,) will preserve even a retentive soil above it in a comparatively dry state.

346. *Condition of soils and subsoils.*—These are the different conditions of soils and subsoils, considered practically. They have terms expressive of their state, which you should keep in remembrance. A soil is said to be *stiff* or *heavy*, when it is difficult to be wrought with the ordinary implements of the farm; and all clay-soils are so, and clay-loams more or less so.

347. *Light.*—On the other hand, soil is light or free, when it is easy to work; and all sandy and gravelly soils and loams are so.

348. *Wet and dry.*—A soil is said to be *wet*, when it is habitually wet; and to be *dry*, when habitually dry; and all soils, especially clays, on retentive subsoils, are habitually wet; and on porous subsoils, especially gravel and gravelly loams, are habitually dry.

349. *Poor and rich.*—Any soil that cannot bring to maturity a fair crop, without an inordinate quantity of manure, is considered *poor;* and any one that does so naturally, or yields a large return with a moderate quantity of manure, is said to be *rich.* As examples,—thin hard clays, and ordinary sands are poor soils; and soft clays and deep loams are rich.

350. *Deep and thin.*—A soil is deep, when it descends to some depth below the reach of the plough; and in that case the plough may be made to take a deeper furrow than usual, and yet continue in the same soil; and a soil is *thin*, when the plough usually reaches beyond it: but good husbandry can, in time, render a thin soil deep, and shallow ploughing may cause a deep soil to assume the character of a thin one. A deep soil conveys the idea of a good one, and a thin that of a bad. Carse clays and sandy loams are instances of deep soils, and poor clays and poor gravel those of thin.

351. *Hungry.*—A soil is called a hungry one, when it requires frequent applications of manure to bear ordinary crops. A thin poor gravel is an instance of a hungry soil.

352. *Grateful.*—A soil is grateful, when it returns a larger produce than might be expected from what was done for it. All loams, whether clayey, gravelly, or sandy,—especially the two last,—are grateful soils.

353. *Kindly.*—A soil is kindly, when every operation performed upon it can be done without doubt, and in the way, and at the time desired. A sandy loam and even a clay-loam, when on porous subsoil, are examples of kindly soils.

354. *Sick.*—A soil becomes *sick*, when the same crop is made to grow too frequently upon it, and it then becomes deteriorated; thus, soils become sick of growing red clover and turnips.

355. *Sharp.*—A sharp soil is that which contains such a number of small gritty stones as to clear up the plough-irons quickly. Such a soil never fails to be an open one, and is admirably adapted for turnips. A fine gravelly loam is an instance of a sharp soil. Some say that a sharp soil means a *ready* one—that is, quick or prepared to do any thing required of it; but I am not of this opinion, because a sandy loam is a ready enough soil for any crop, and it cannot be called a sharp one.

356. *Deaf.*—A deaf soil is the contrary of a sharp one; that is, it contains too much inert vegetable matter, in a soft spongy state, apt to be carried forward on the bosom of the plough. A deep black mould, whether derived from peat or not, is often an example of a deaf soil.

357. *Porous or open.*—A porous or open soil and subsoil, are those which allow water to pass through them freely and quickly, of which a gravelly loam and gravelly subsoil are examples.

358. *Retentive or close.*—A retentive or close soil and subsoil retain water on them; and a clay soil upon a clay subsoil is a double instance of retentiveness.

359. *Hard.*—Some soils are always hard when dry, let them be ever so well wrought as in the case of thin retentive clays.

360. *Soft.*—Other soils are soft, as fine sandy loams, which are very apt to become too soft when too often ploughed, or too much marled.

361. *Fine.*—Some soils are always fine, as is the case with deep easy sandy loams.

362. *Coarse and harsh.*—Other soils are always coarse and harsh, as thin poor clays and gravel.

363. *Smooth.*—A fine clay becomes smooth when in a wet state.

364. *Rough.*—A thin clayey gravel is *rough* when dry.

365. *Fine skin.*—A soil has a *fine skin* when it can be finished off with a beautifully granulated surface. Good culture will bring a fine skin on many soils, and rich sandy and clay loams have naturally one; but no art can give a fine skin to some soils, such as thin hard clay, and rough gravel.

366. *Colours of soils.—Black.*—The colours of soils and subsoils though various, are limited in their range. Black soils are found on crude peat, and in deep deaf vegetable mould, vegetable matter evidently giving origin to the colour. Soils of other colours may be made blacker by the addition of soot, charcoal, and of composts of peat, when this vegetable abounds in the locality. Very black soils are deaf and inert.

367. *White.*—Whitish coloured soil is met with in some of the chalky districts of the south of England. Many sandy soils forming tracts of country as well as near the sea shore, are of a yellow-white colour; and so are calcareous sands formed in a great measure of the comminuted shells of crustaceous animals. White soils assume a tinge of brown by the addition of vegetable matter in cultivation. Greyish white stones and sand indicate the moory origin of the soil in which they occur. Some strong clays are light yellowish brown.

368. *Blue.*—Fine clay, originating in the bottom of basins of still water, have frequently a bluish colour, which changes to dark brown or brownish-black on cultivation and exposure to the air, and forms a useful soil for wheat and Swedish turnips.

369. *Red.*—Soils are not unfrequently of a red colour; dull brownish red, derived most probably from an oxide of iron; and this colour is a favourable indication of the good quality of the soil or subsoil, whether of a heavy or light texture.

370. *Brown.*—But the most common colour presented by soils is brown, and the tint most desired is the brown of the hazel nut, and on that account is named hazel-brown. This colour is most probably derived from oxide of iron existing in the soil, which is rendered darker by the addition of vegetable manure, used in cultivation, to hair and dark chestnut brown. Sharp, grateful, and kindly soils are always of a brown colour. Sand and gravel loams are usually of this colour.

371. *Colour of subsoils.*—The colour of *subsoils* is less uniform than that of soils, owing, no doubt, to their exclusion from direct culture and air. Some subsoils are very particoloured, and the more they are so, and the brighter the colours they sport, are the more injurious to the soils resting upon them; such as light blue, green, bright red, and bright yellow. Dull red and chestnut brown subsoils are good; but the nearer they approach to hazel brown the better. The dull browns, reds, and yellowish grays are permanent colours, and are little altered by cultivation; but the blues, greens, bright reds, and yellows, become darker and duller by exposure to the air, and admixture with manures and the surface soil.

372. The colours of soil have a considerable influence in regulating the quantities of heat absorbed by soils from the sun's rays: the darker coloured, such as the black and brown and dark reds, absorb more heat than the greys and yellows, and all dark-coloured soils reflect the least, whilst light coloured ones reflect the most calorific rays. According to Schübler, while the thermometer was 77° in the shade in August, sand of a natural colour indicated a temperature of $112\frac{1}{2}$°, black sand $123\frac{1}{2}$°, and white sand 110°, exhibiting a difference of 13° in favour of the black colour. The highest temperature attained by the soil was observed by Schübler on 16th June 1828, in a fine day, calm, with the air from the west, at $153\frac{1}{2}$°, that in the shade being 78°.

373. It is a fact well known to farmers, that the soil becomes much more heated when exposed to the rays of the sun in a perpendicular than in a sloping direction. "If the actual increase of temperature," says Schübler, "produced by the perpendicular rays of the sun beyond the temperature in the shade be between 45° and 63°, as is often the case in clear summer

days, this increase would only be half as great, if the same light spread itself in a more slanting direction, over a surface twice as large. Hence it is sufficiently explained why, even in our own climate, the heat so frequently increases on the slopes of mountains and rocks which have an inclination towards the south. When the sun is at an elevation of 60° above the horizon, as is more or less the case toward noon in the middle of summer, the sun's rays fall on the slopes of mountains, which are raised to an inclination of 30° to the horizon, at a right angle; but even in the latter months of summer, the sun's rays frequently fall on them under a right angle, in cases where the slopes are yet sharper." Where the exposure and aspect of the soil is most favourably situated for absorbing the sun's rays, the light coloured ones will derive more benefit than dark ones in a less favourable position.

374. *Retention of heat.*—Colour has also an influence in retaining the heat acquired by soils from the sun; the dark coloured radiating their heat more quickly in the absence of the sun's rays than the light coloured; and colour, together with dryness, has a greater influence in warming the soil than that of the different materials composing it. Thus sand will cool more slowly than clay, and the latter than a soil containing much humus. According to Schübler, a peat soil will cool as much in 1 hour 43 minutes, as a pure clay in 2 hours 10 minutes, and as a sand in 3 hours 30 minutes. The practical effect of this difference is, that while the sand will retain its heat for three hours after the sun has gone down, and the clay two hours, the vegetable soil will only retain it for one hour; but then the vegetable soil will all the sooner begin to absorb the dew that falls, and in a dry season, it may in consequence sustain its crops in a healthy state of vegetation, while those in the sandy soil may be languishing for want of moisture. If we compare in the earths their power of retaining heat with their other physical properties, we shall find it to be nearly in proportion to their specific gravities. We may therefore conclude from this, with a tolerable degree of probability, as to the greater or less power of retaining heat. The specific gravity of some of the soils is the following:—

Of Siliceous sand	2·653
Sandy clay	2·601
Loamy clay	2·581
Brick clay	2·560
Pure grey clay	2·533
Pipe clay	2·440
Arable soil	2·401
Garden mould	2·332
Humus	1·370

375. *Shrinking by heat.*—Heat renders all sorts of soil dry, by evaporating the moisture out of them; and so great an effect has heat on peat and strong clay in a course of dry weather, that they shrink one fifth of their bulk. Thus, according to Schübler, in 100 parts the following soils shrunk in these proportions:—

Siliceous sand	no change.
Sandy clay	6·0 parts.
Loamy clay	8·9 —
Brick clay	11·4 —
Grey pure clay	18·3 —
Garden mould	14·9 —
Arable soil	12·0 —
Humus	20·0 —

376. *Warmth by heat.*—The influence of a damp or dry state of soils on their acquisition of warmth, is also considerable. As long as they remain moist, the depression of temperature, arising from the evaporation of the water, amounts to $11\frac{1}{4}$° to $13\frac{1}{2}$° Fahrenheit; and in this state they exhibit but little difference in the power of acquiring heat, as they give off to the air, in this state of saturation with water, nearly equal quantities of vapour in the same time. When they have become a little dried, it is found that the light-coloured earths, with great powers of containing water, acquire heat the most slowly, while dark-coloured ones, with less power of containing water, become warm in a quicker and more powerful manner.

377. *Absorption of moisture.*—Excepting siliceous sand, all kinds of soil have the property of absorbing moisture from the atmosphere; and the absorption is the greatest in clay soils, especially when they contain humus. Humus shows the greatest power of absorption. The absorption by all soils is greatest at first, and they absorb the less the more gradually they become saturated with moisture, and they attain that point in a few days. If

exposed to the sunlight, a portion of the absorbed moisture becomes again vaporised, and this is again absorbed during the night. These daily periodic changes in respect to moisture must have a beneficial effect on vegetation. Schübler has given the following table of the relative absorbing powers of soils;—

Kinds of earth.	1000 grains of earth on a surface of 50 square inches absorbed in			
	12 hours.	24 hours.	48 hours.	72 hours.
	Grains.	Grains.	Grains.	Grains.
Siliceous sand	0	0	0	0
Sandy clay .	21	26	28	28
Loamy clay .	25	30	34	32
Brick clay .	30	36	40	41
Grey pure clay	37	42	48	49
Garden mould	35	45	50	52
Arable soil	16	22	23	23
Humus . . .	80	97	110	120

378. *Saturation by water.*—Different soils have different capacities for containing water to saturation. Schübler gives this table of differences:—

Siliceous sand . . .	27·3 ℔ per cubic foot.	
Sandy clay	38·8	— — —
Loamy clay	41·4	— — —
Brick clay	45·4	— — —
Pure grey clay . .	48·3	— — —
Pipe clay	47·4	— — —
Garden mould . . .	48·4	— — —
Arable soil	40·8	— — —
Humus	50·1	— — —

The sands have the smallest power of containing water, whether they are compared in weight or in volume with the other earths; and siliceous sand has the least power of all. These differ according to the different fineness of their grains; the power of the large grained becomes diminished down to 20 per cent, while it amounts to 40 per cent when the particles are very fine. Humus has usually the greatest power of containing water to saturation of all the ingredients of the soil, and especially when the humic acid is still mixed with a large proportion of half decomposed organic matters, as remains of wood, leaves, roots, &c. Where we meet with a great water-holding power exceeding 90, we may reckon, with great probability, on an abundant admixture of organic matter.

379. *Retention of moisture.*—So, in like manner, different soils have different powers of retaining the moisture they have absorbed to saturation until they become dry, and this power increases with the depth of soils. Schübler has given this table on the subject:—

Kinds of earth.	Water evaporated in 4 days.	Containing power of water of the earths.
	Grains.	Per cent.
Calcareous sand .	146	29
Light garden mould .	143	89
Very light turf soil .	132	366
Arable soil . .	131	60
Black turf soil not so light . . .	128	179
White fine clay .	123	70
Grey fine clay .	123	87

Hence the difference in the degree of looseness or consistency of the ground has a considerable influence on the more or less easy drying of deep soils. The garden mould, notwithstanding its great power of containing water, in which it stands near to pure clay, gave off to the air far more moisture, in the same time, than the clays. The turf soils, though high in containing water, also became dry again at a quicker rate than the clays. The fine grey clays, after 14 days, exhibited still a damp surface, while the surfaces of the turf soils were perfectly dry many days earlier. The consistency of a soil, and its tendency to become contracted into a narrower space, exerts a greater influence in a deep than a shallow soil.

380. *Absorption of oxygen.*—Another important physical property of soils is their power to absorb oxygen from the atmospheric air. Schübler's experiments on this subject afforded these results:—

Grains.		Cubic inches.	
1000	Siliceous sand, in a wet state, absorbed — — —	0·24	From 15 cubic inches of atmospheric air containing 21 per cent of oxygen.
—	Sandy clay — — —	1·39	
—	Loamy clay — — —	1·65	
—	Brick clay — — —	2·04	
—	Grey pure clay — — —	2·29	
—	Garden mould — — —	2·60	
—	Arable soil — — —	2·43	
—	Humus — — —	3·04	

All the earths lose, in drying, the property of absorbing oxygen from the air, but regain it in the same proportion as before on being moistened. If covered with water, the absorption takes place in the same manner. Water alone, however, in the same quantity, absorbs only a small portion per cent—a clear proof that it is the earths themselves which induce this process in a greater proportion. Humus, of all the earths, exhibits the greatest degree of absorption of oxygen; the clays approach nearly to it, the sands the least. The included air standing over them becomes at last so poor in oxygen that lights would become extinguished, and animals die in it. In this mode of absorption there is an essential difference between humus and the inorganic earths. Humus combines partly with the oxygen, in a strictly chemical sense, and assumes a state of higher oxygenation, in consequence of which there is formed also more carbonic acid. The inorganic earths, on the other hand, absorb the oxygen without intimate combination. In the case of earths which are frozen or covered with a surface of ice, no absorption of oxygen takes place, any more than in the case of dry earths. In a moderately warm temperature, between 59° and 66° Fahrenheit, the earths absorb, in a given time, more oxygen than in a temperature only a few degrees above the freezing point.

381. *Physical properties of soil.*—M. Schübler thus recapitulates the results of these experiments of his on the physical properties of soils:—"In the examination of soils, the determination of their power of containing water, and of their weight, consistency, and colours, in connexion with their chemical analyses, will, in the majority of cases, be sufficient to enable us to conclude, with great probability, as to their remaining physical properties. The more an earth weighs, the greater also is its power of retaining heat: the darker its colour and the smaller its power of containing water, the more quickly and strongly will it be heated by the sun's rays: the greater its power of containing water, the more has it in general the power also of absorbing moisture when in a dry, and oxygen when in a damp state, from the atmosphere; and the slower it usually is to become dry, especially when endued with a high degree of consistency: lastly, the greater the power of containing water, and the greater the consistency of a soil, the colder and wetter, of course, will that soil be, as well as the stiffer to work, either in a wet or dry state." *

382. *Discriminating soils by the plants growing on them.*—There is another method by which the physical characters of soils and subsoils, such as I have endeavoured to explain, may be discriminated, namely, by the plants which grow upon them. This test cannot be relied on so confidently as the chemical composition, or the external characters, given above for distinguishing soils. The chemical and physical properties of soils are open to observation, and may, therefore, be acquired with correctness; but in judging of soils by their vegetation, which necessarily excludes them from observation, the judgment is liable to err. Such a mode of estimating the comparative properties of soils might be correct enough were their products constant; but when these change with the circumstances in which the soil is placed, the test scarcely admits of general application. The same rock and the same diluvium or alluvium possess the same external characters throughout the globe, but the plants which grow upon them differ not only by the change of the latitude, but at different heights above the sea in the same latitude. The sands of the tropics, for example, yield very different plants to those of the temperate and frigid zones. Climate is thus the great agent which determines the existence of plants. But, besides climate, a great variety of plants are found on the same soil; so that an extensive knowledge of plants is requisite to enable any one to detect a specific soil. Moreover, natural plants alone indicate the natural state of the soil; for the cultivated soil produces plants very different from what it did when in a state of nature.

383. Still, notwithstanding the difficulties attending the discrimination of soils by plants, it is an undoubted fact that plants do affect certain soils, as also certain conditions of the same soil. Such plants are limited in number, and may

* *Journal of the Royal Agricultural Society of England,* vol. i. p. 177-212.

therefore be easily remembered. I shall only enumerate those which have fallen under my own observation; and separate those which grow upon the soil, in a state of nature, from those which make their appearance after the land is in a state of cultivation. Every plant found among the cultivated corn and green crops, and sown grasses, is a *weed*.

383. On good *clay* soils, in a state of nature, in the low country, these herbaceous plants will be found—

Spiræa ulmaria	Queen of the meadow.
Angelica sylvestris	Wild angelica.
Ranunculus lingua	Great spear-wort.
Rumex acetosa	Common sorrel.

384. After such soils are brought into cultivation, these plants make their appearance as *weeds*, some of which have been sown with the corn, others with the grass seeds, whilst the rest have been carried by the wind, or brought on amongst the dung.

Rumex obtusifolius	Common broad-leaved dock.
Senecio vulgaris	Groundsel.
Lapsana communis	Nipple-wort.
Agrostemma githago	Corn cockle or popple.
Matricaria chamomilla	Wild chamomile.
Sonchus oleraceus	Common sow-thistle.

385. Thin clays, in their natural state in the low country, yield the following plants—

Ranunculus acris	Upright meadow or bitter crowfoot.
Aira cæspitosa	Tufted hair-grass.
Equisetum arvense	Corn horse-tail.
Stachys palustris	Marsh woundwort.

386. These become clay loams under cultivation, and then yield those plants as *weeds*—

Tussilago farfara	Common colt's-foot.
Sinapis arvensis	Wild mustard.
Polygonum aviculare	Knot-grass.

387. On deep strong clayey loam, on a porous subsoil, in a state of nature, in the low country, these plants are found—

Silene inflata	Bladder campion.
Antirrhinum linaria	Toad-flax.
Scabiosa arvensis,	Field scabious.
Centaurea scabiosa	Great knapweed.
Polygonum amphibium	Redshank.
Dactylis glomerata	Rough cock's-foot grass.

388. On thin, strong, clay loam, on a porous subsoil, in a state of nature, in the low country, these plants are found—

Ononis arvensis	Common rest-harrow.
Trifolium arvense	Hare's-foot trefoil.
Trifolium procumbens	Hop trefoil.

389. After cultivation, both deep and thin clay loams, on a porous subsoil, in the low country, yield these plants as *weeds*—

Anagallis arvensis	Scarlet pimpernel.
Veronica hederifolia	Ivy-leaved speedwell.
Sinapis nigra	Black mustard.
Ervum hirsutum	Hairy tare, or fetter.

390. The herbaceous plants peculiar to *sandy* soils, in a state of nature, in the low country, are—

Lotus corniculatus	Bird's-foot trefoil.
Campanula rotundifolia	Common bluebell.
Euphrasia officinalis	Eyebright.
Anthoxanthum odoratum	Sweet-scented vernal grass.

391. After cultivation, these plants appear as *weeds*—

Spergula arvensis	Common spurry.
Lamium purpureum	Purple dead-nettle,
Fumaria officinalis	Common fumitory.
Thlaspi bursa-pastoris	Shepherd's purse.
Scleranthus annuus	Common knawel.
Gnaphalium germanicum	Common cud-weed.
Triticum repens	Common couch-grass.

392. Upon sandy loam on clay subsoil, in a state of nature, in the low country, these are the characteristic plants—

Juncus effusus	Common or soft rush.
Achillea ptarmica	Sneeze-wort.
Potentilla anserina	Wild tansy or silver-weed.
Artemisia vulgaris	Mugwort.

393. After cultivation, these plants appear on this soil as *weeds*—

Raphanus raphanistrum	Charlock,
Rumex acetosella	Sheep's sorrel.
Chrysanthemum segetum	Corn marigold.
Juncus bufonius	Toad-rush.

394. Sandy loam upon a porous subsoil, in a state of nature, in the low country, yields these plants most abundantly—

Genista scoparia	Common broom.
Centaurea nigra	Black knapweed.
Galium verum	Hollow bed-straw.
Senecio jacobea	Common rag-weed.

395. When cultivated, this soil yields these plants most conspicuously as *weeds*—

Mentha arvensis	Common corn-mint.
Centaurea cyanus	Blue-wort.
Sherardia arvensis	Corn madder.
Lithospermum arvense	Corn gromwell.
Alchemilla arvensis	Parsley-pest.
Avena elatior	Tall oat-grass.
Cnicus arvensis	Corn-thistle.

396. *Alluvial* deposites, in a state of nature, in the low country, yield a vegetation indicative of a wet and strong soil and subsoil—

Arundo phragmites	Common reed.
Juncus conglomeratus	Round-headed rush.
Agrostis alba	White bent-grass.
Poa aquatica	Reed meadow-grass.
Poa fluitans	Floating meadow-grass.

397. All these plants disappear on cultivation, except the common reed, which keeps possession of the soil for an indefinite period amidst the best cultivation. Where such soil is indifferently cultivated, the corn thistle, *Cnicus arvensis*, is a very troublesome *weed*. In other respects, the weeds are the same as in the cultivated clays.

398. Besides these soils, there are others in the low country which cannot be rendered arable, but form the sites of numerous plants peculiar to them, which occasionally find their way into the adjoining arable soils. From the sea-beach, gravel-pits, and sandy downs, for example, plants stray by the assistance of the wind into any kind of arable soil in their respective neighbourhoods.

399. *Beaches*, consisting chiefly of pebbles, are maritime, lacustrine, and fluviatile. The plants of maritime beaches are—

Silene maritima -	- Seaside campion.
Plantago maritima -	- Sea plantain.
Glaux maritima -	- Black saltwort.
Pulmonaria maritima	- Sea lungwort.
Eryngium maritimum	- Sea holly.
Salsola kali - -	- Glasswort.

400. Those on lacustrine beaches are—

Prunella vulgaris -	- Self-heal.
Rubus fruticosus -	- Common bramble.
Bellis perennis -	- Common daisy.
Plantago media -	- Hoary plantain.

401. And on fluviatile beaches, these—

Anthyllis vulneraria	- Common kidney-vetch.
Silene maritima -	- Seaside campion.
Polygonum aviculare	- Knot-grass.
Achillea millefolium	- Common yarrow.
Alchemilla vulgaris	- Common lady's-mantle.
Galium verum - -	- Hollow bed-straw.
Teesdalia nudicaulis	- Naked-stalked teesdalia.
Linum catharticum -	- Purge flax.
Saxifraga aizoides -	- Yellow saxifrage.
Apargia autumnalis	- Autumnal apargia.

402. In all such soils the vegetation is generally thin and scanty. In wet seasons it becomes luxuriant, but in dry weather is very liable to be burnt up by the heat of the sun.

403. On *gravel*, whether water-worn, as usually found in the deposites of the low country, or in the shape of grit, that is, angular gravel, as found in the debris on the sides of mountains, occasioned by the disintegration of indurated rocks, the vegetation is somewhat different from that of the beaches. In gravel pits in the interior of the low country these plants are found—

Polygonum aviculare	- Knot-grass.
Rumex acetosella -	- Sheep's sorrel.
Agrostis vulgaris -	- Common bent-grass.
Aira caryophyllea -	- Silvery hair-grass.
Festuca duriuscula -	- Hard fescue-grass.
Arenaria serpyllifolia	- Thyme-leaved sandwort.
Hieracium murorum	- Wall hawkweed.
Papaver dubium -	- Long smooth-headed poppy.
Papaver rhœas -	- Common scarlet poppy.
Polygonum convolvulus	- Climbing buckwheat.
Chenopodium urbicum	- Upright goose-foot.
Lolium perenne -	- Perennial ryegrass.
Bromus mollis -	- Soft brome-grass.

404. Gravel on the sea-shore produces these maritime plants—

Cakile maritima -	- Sea-rocket.
Chenopodium maritimum	Seaside goose-foot.
Atriplex laciniata -	- Frosted sea-arache.
Silene maritima -	- Seaside campion.

405. Gravel on the sides of rivers produces these plants, which indicate a wet subsoil—

Juncus bufonius -	- Toad-rush,
——— *acutiflorus* -	- Sharp-flowered rush.
Littorella lacustris -	- Plantain shore-weed.

406. And grit on the mountain-sides produces the alpine plants of the district.

407. *Drifting sands, links*, or *downs*, have a peculiar vegetation—

Arundo arenaria -	- Sea-bent.
Triticum junceum -	- Sand wheat-grass.
Festuca duriuscula -	- Hard fescue-grass.
Carex arenaria -	- Sand carex.
Galium verum -	- Hollow bed-straw.

408. This vegetation is mixed and modified towards the sea-side, to a maritime one, and on the land side to that of arable light loam.

409. The vegetation of *moory* ground only a little elevated, varies according to the wetness or dryness of the subsoil. The wetness of the subsoil arises from retentive clay. Wet moors are characterised by these plants—

Salix repens - -	- Dwarf silky willow.
Pinguicula vulgaris	- Butterwort
Carex pilulifera	- Round-fruited carex.
Juncus squarrosus -	- Moss-bush.
Scirpus cæspitosus -	- Scaly-stalked club-rush.
Parnassia palustris	- Grass of Parnassus.

410. On dry moors, which usually contain a considerable proportion of peat-earth, when resting on a porous subsoil of sand or gravel, these plants are found—

Genista anglica -	- Needle green-weed or petty whin.
Nardus stricta - -	- Mat-grass,
Viola lutea - -	- Yellow mountain-violet.
Tormentilla officinalis	- Common tormentil.
Gnaphalium dioicum	- Mountain cud-weed

411. *Marshes* in the interior of the country produce these plants—

Lychnis flos-cuculi	Ragged robin.
Menyanthes trifoliata	Fringed buck-bean.
Caltha palustris	Marsh marigold.
Veronica beccabunga	Brook-lime.
Comarum palustre	Marsh cinquefoil.
Galium uliginosum	Marsh bed-straw.

412. And in marshes near the sea these plants are found—

Triglochin maritimum	Sea arrow-grass.
Poa procumbens	Sea marsh-grass.
Carex pallescens	Pale carex.
—— *riparia*	Great common carex.

413. After marshy ground has been dried and cultivated, these plants retain a pretty strong hold of their respective positions as *weeds*—

Tussilago farfara	Common colt's foot.
Petasites hybrida	Common butter-bur.
Galium aparine	Goose-grass.

414. On *peat* or *moss* the vegetation differs according to its state of wetness or dryness. On dry spots of peat these plants are found—

Erica tetralix	Cross-leaved heath.
Calluna vulgaris	Common ling.
Agrostis canina	Dog bent-grass.

415. In wet hollow parts of peat these plants establish themselves—

Eriophorum polystachion	Cotton grass.
Vaccinium oxycoccus	Orange-berry.

416. When peat is dried and cultivated, these plants infest it as weeds—

Bromus mollis	Soft brome-grass.
Myosotis arvensis	Field scorpion-grass.
Avena fatua	Wild oats.
Galium aparine	Goose-grass.

417. On *mountain pastures* the plants are numerous, though a few only serve to show the peculiarities of the range of elevation. At moderate heights these plants prevail—

Calluna vulgaris	Common ling.
Astragalus uralensis	Hairy milk-vetch.
Dryas octopetala	Mountain avens.
Salix reticulata	Reticulated willow.
Gnaphalium alpinum	Mountain cud-weed.
Rubus chamæmorus	Cloud-berry.
Arbutus uva-ursi	Common bear-berry.*

418. In very elevated mountain pastures these plants are found on a mossy soil, according to the observations of the late Mr William Hogg, shepherd in Peeblesshire, brother to the famed Ettrick Shepherd—

Calluna vulgaris	Common ling.
Empetrum nigrum	Crow-berry.
Erica tetralix	Cross-leaved heath.
Lycopodium clavatum / —— *alpinum*	Club-moss.
Juncus squarrosus	Stool bent.
Equisetum palustre	Paddock-pipe.
Scirpus cæspitosus	Deer-hair.
Narthecium ossifragum	Yellow grass.
Melica cærulea / *Sesleria cærulea*	Fly-bent or rot-grass.
Nardus stricta	Wire-bent or mat-grass.

419. In wet places in mountain pastures these plants are found to thrive—

Juncus effusus	Soft rush.
Holcus mollis	Soft meadow-grass or Yorkshire fog.
Carex cæspitosa	Risp.
Juncus acutiflorus	Sprat.
Carex panicea	Pry.
Scabiosa succisa	Devil's bit scabious.
Hypnum palustre	Marsh-fog.†

420. Professor Macgillivray has truly remarked, that "No soil that we have examined has been found to produce plants peculiar to itself, excepting *sand* and *peat*; and these two soils, so different from each other in their mechanical and chemical nature, also form a striking contrast in respect to the plants growing upon them, each being characterised by a vegetation differing in aspect and qualities from each other, and scarcely agreeing in any one circumstance."‡ The existence of peat is invariably indicated by *Calluna vulgaris*, common ling,—*Erica cinerea*, fine-leaved heath,—and *Erica tetralix*, cross-leaved heath; and loose sand is as invariably covered with *Arundo arenaria*, sand-reed, most frequently accompanied by *Triticum junceum*, sand wheat grass, and *Galium verum*, hollow bed-straw.

421. In so far, then, as the arable soils are concerned, the information imparted by their *weeds* possesses greater interest to the farmer than their natural vegetation; and these give a truer account of the *condition* of the soils at the time, than of their nature, though the latter property is by no means overlooked. For example, *clayey* soils are indicated by the existence of the *grasses*, and of these the genera of *Poa*, *Agrostis*, and *Festuca* prevail.

422. *Gravelly* soils by *Aira caryophyllea*, silvery hair-grass; *Aira præcox*, early hair-grass; and *Rumex acetosella*, sheep sorrel. When intermixed with a little clay, the grasses prevail.

* *Prize Essays of the Highland and Agricultural Society*, vol. vii. p. 123-135.
† *Ibid.*, vol. vii. p. 281-282. ‡ *Ibid.*, vol. vii. p. 102.

423. Good *vegetable* soil is indicated by *Trifolia*, *Viciæ*, and *Lathyrus pratensis*. *Thymus serpyllum*, wild thyme, indicates a vegetable mould of great thinness; and ragweed, *Senecio jacobæa*, one of depth; and when the ragweed prevails, it indicates the absence of sheep, which are very fond of, and eat down its young leaves.

424. Purge flax, *Linum catharticum;* Autumn apargia, *Apargia autumnalis;* and mouse-eared hawk-weed, *Hieracium pilosella*, indicate a dry soil;—the *Galium verum*, hollow bed-straw, a very dry one.

425. Yellow iris, *Iris pseud-acorus;* the sharp-flowered rush, *Juncus acutiflorus;* lady's smock, *Cardamine pratensis;* and ragged robbin, *Lychnis flos-cuculi*, assure us of a supply of moisture below.

426. The purple dead-nettle, *Lamium purpureum;* and smooth naked horse-tail, *Equisetum limosum*, indicate a retentive subsoil.

427. The broom, *Genista scoparia*, indicates a pernicious, and the whin, *Ulex Europæus*, a more favourable subsoil.

428. The common nettle, *Urtica dioica;* common dock, *Rumex obtusifolius;* mugwort, *Artemisia vulgaris;* annual poa, *Poa annua;* field poa, *Poa pratensis;* and common tansy, *Tanacetum vulgare*, grow near the dwellings of man, on the bare soil, irrespective of its kind; while in the same locality the white clover, *Trifolium repens;* red clover, *Trifolium pratense;* annual poa; hoary plantain, *Plantago media;* ribwort, *Plantago lanceolata;* purple meadow vetch, *Vicia cracca;* and common daisy, *Bellis perennis*, are found in the pasture around his house.

429. Common chickweed, *Stellaria media;* and common fumitory, *Fumaria officinalis*, indicate a rich condition of soil.

430. The great ox-eye, *Chrysanthemum leucanthemum*, points out a soil in a state of poverty; and its poverty from want of manure is indicated by the parsley-pest, *Alchemilla arvensis*.

431. Wild mustard, *Sinapis arvensis*, tells of the application of manure derived from towns.

432. The common corn thistle, *Cnicus arvensis*, indicates that the land is not well farmed.

433. Wherever the least admixture of peat is found in the soil, the *Erica* or *Calluna* and spotted-bearded orchis, *Orchis maculata*, are sure to be there.

434. Taking a more extended view of the indications of the condition of soils by plants, these observations of Dr Singer seem well founded:—"*Green* mountains, like those of Cheviot and Ettrick Forest, abounding in grass without heath, indicate a strong soil, which is rendered productive, though frequently steep and elevated, by a retentive subsoil. This quality, and the frequent mists and showers that visit rather elevated sheep-walks, render them productive in strong grasses *(Agrostis.)* . . . *Dark* mountains, clothed with a mixture of heath and grass, indicate a drier soil on a less retentive bottom. Such are many of the Highland mountains, and such also are some of those which appear occasionally among the green mountains of the southern pastoral district, in which the light soil is incumbent commonly on gravel or porous rock. On these dark-coloured mountains, a green and *grassy* part often appears where there is no heath, and the subsoil is retentive; and if the upper edge of such a spot appears well defined, this is occasioned by the regular approach of a stratum of clay or other substance impervious to water towards the surface, and the green hue disappears below, when the subsoil again becomes open. . . . On any of the mountains, whether dark or green, when the fern or bracken, *Pteris aquilina*, appears in quantities, it indicates a deep soil and a dry subsoil."* A stunted growth of heath indicates a part having been bared by the paring-spade; and when vegetation becomes of a brown colour in summer, the subjacent rock is only a little way under the surface.

* *Prize Essays of the Highland and Agricultural Society*, vol. vii. p. 264.

435. Viewing the connexion of plants to the soil on the great scale, we cannot but be forcibly impressed with the conviction, that "the grand principle of vegetation is simple in its design; but view it in detail, and its complication astonishes and bewilders." And yet, as Professor Macgillivray justly observes, "it is the same sun that calls forth, and, thus elicited, gives vigour to the vegetation, the same earth that supports it, the same moisture that swells its vessels, the same air that furnishes the medium in which it lives; but amid all these systems of general, how multiple the variations of particular constituent causes, and how infinitely diversified their results!"*

436. *Mechanical structure of soils.*—It is now time to take a closer view of soils, their structure and composition; their structure is mechanical, and their composition chemical. We shall first consider their mechanical structure; and I shall describe these in the words of Dr Henry Madden of Brighton. "Soil, considered scientifically," he observes, "may be described to be essentially a mixture of an impalpable powder with a greater or smaller quantity of visible particles of all sizes and shapes. Careful examination will prove to us, that although the visible particles have several *indirect* effects, of so great importance that they are absolutely necessary to soil, still the impalpable powder is the only portion which *directly* exerts any influence upon vegetation. This impalpable powder consists of two distinct classes of substances, viz., *inorganic* or *mineral* matters, and *animal* and *vegetable* substances, in all the various stages of decomposition.

437. "A very simple method may be employed to separate these two classes of particles from each other, viz., the impalpable powder and the visible particles; and, in so doing, we obtain a very useful index to the real value of the soil. Indeed all soils, except stiff clays, can be discriminated in this manner. The greater the proportion of the impalpable matter, the greater, *cæteris paribus*, will be the fertility of the soil.

438. "To effect this separation, the following easy experiment may be performed. Take a glass-tube about 2 feet long, closed at one end; fill it about half full of water, and shake into it a sufficient quantity of the soil to be examined, to fill the tube about 2 inches from the bottom; then put in a cork, and having shaken the tube well to mix the earth and water thoroughly, set the tube in an upright position, for the soil to settle down. Now, as the larger particles are of course the heavier, they fall first, and form the undermost layer of the deposite, and so on in regular gradation, the impalpable powder being the last to subside, and hence occupying the uppermost portion. Then by examining the relative thickness of the various layers, and calculating their proportions, a very accurate mechanical analysis of the soil may be made.

439. "The *stones* which we meet with in soil have in general the same composition as the soil itself, and hence, by gradually crumbling down under the action of air and moisture, they are continually adding new impalpable matter to the soil, and as a large quantity of this impalpable mineral matter is annually removed by the crops, it will at once be perceived that this constant addition must be of great value to the soil. This, therefore, is one important function performed by the stones of soil,—viz., their affording a continually renewed supply of impalpable mineral matter.

440. "On considering the nourishment of plants, we find that their food undergoes various preliminary changes in the soil previous to its being made use of by the plants, and the aid of chemistry will prove to us that the effect is produced by the joint action of air and water; it follows, therefore, that soil must be porous. Now, this porosity of the soil is in part produced by the presence of the larger particles of matter, which, being of all varieties of shape, can never fit closely together, but always leave a multitude of pores between them; and in this manner permit of the free circulation of air and water through the soil.

441. "As the porous nature of soil may,

* *Prize Essays of the Highland and Agricultural Society*, vol. vii. p. 117.

to a certain extent, be taken as an index of its power of retaining moisture, it is advisable to determine its amount. This is effected in the following way:—Instead of putting the water first into the tube, as directed above, (438,) and shaking the soil into it, take a portion of soil dried by a heat of about 200° Fahr., and shake it into the dry tube, and by tapping the closed end frequently on the table, make the soil lie compactly at the bottom; when this has been fully effected, that is, when further tapping produces no reduction of bulk, measure accurately the column of soil, cork the tube, shake it till the soil becomes again quite loose, and then pour in the water as directed above (438.) After the soil has fully subsided, tap the tube as before, and re-measure the column of soil, and the increase of bulk is dependent upon the swelling of each particle by the absorption of water, and hence shows the amount of porosity. In very fertile soil, I have seen this amount to one-sixth of the whole bulk.

442. "The functinos of the *impalpable* matter are far more complicated, and will require a somewhat detailed description. In this portion of the soil, the mineral and organic matter are so completely united, that it is quite impossible to separate them from each other; indeed, there are weighty reasons for believing that they are chemically combined. It is from this portion of the soil that plants obtain all their mineral ingredients, and likewise all their organic portions, in so far as these are obtained by the roots; in fact, plants receive nothing from the soil except water, which has been associated with that portion which is at present engaging our attention.

443. "The particles forming the impalpable matter are in such close apposition, that the whole acts in the same way as a sponge, and is hence capable of absorbing liquids and retaining them. It is in this way that soil remains moist so near the surface, even after a long continued drought; and I need not say how valuable this property must be to the plants, since by this means they are supplied with moisture from below, induced by the capillary action of the soil during the heat of summer, when otherwise, unless artificially watered, they would very soon wither."

444. On the important results arising from the action of the mechanical property of the soil, of the capillary power, and of its mode of action, Professor Johnston has these observations:—"When warm weather comes, and the surface soil dries rapidly, then by capillary action the water rises from beneath, bringing with it the soluble substances that exist in the subsoil through which it ascends, for water is never pure. Successive portions of the water evaporate from the surface, leaving their saline matter behind them. And as the ascent and evaporation go on as long as the dry weather continues, the saline matter accumulates about the roots of plants, so as to put within their reach an ample supply of any soluble substance which is really not defective in the soil. I believe that in sandy soils, and generally in all light soils, of which the particles are very fine, this capillary action is of great importance, and is intimately connected with their power of producing remunerating crops. They absorb the falling rains with great rapidity, and these carry down the soluble matters as they descend, so that when the soil becomes soaked, and the water begins to flow over its surface, the saline matter being already deep, is in little danger of being washed away. On the return of dry weather, the water reascends from beneath, and again diffuses the soluble ingredients through the upper soil."*

445. "Another most useful function of this impalpable portion," continues Dr Madden, "is its power of separating organic matter from water in which it has been dissolved. Thus, for example, if the dark brown liquid which flows from a dunghill is taken and poured on the surface of some earth in a flower-pot, and a sufficient quantity added to soak the whole earth, so that a portion flows out through the bottom of the pot, this latter liquid will be found much lighter in colour than before it was poured upon the earth, and this effect will be increased the nearer the soil approaches in its nature to subsoil. Now, as the colour was entirely owing to the organic matter dissolved in it, it follows

* Johnston's *Lectures on Agricultural Chemistry and Geology*, 2d edit. p. 535.

that the loss of colour is dependent upon an equivalent loss of organic matter, or, in other words, a portion of the organic matter has entered into *chemical combination* with the impalpable mineral matter, and has thus become insoluble in water. The advantage of this is, that when soluble organic matter is applied to soil, it does not all soak through with the water, and escape beyond the reach of the roots of the plants, but is retained by the impalpable portions in a condition not liable to injury from rain, but still capable of becoming food for plants when it is required.

446. "Hitherto I have pointed out merely the *mechanical* relations of the various constituents of soil, with but little reference to their chemical constitution; this branch of the subject, although by far the most important and interesting, is nevertheless so difficult and complex, that I cannot hope for the practical farmer doing much more than making himself familiar with the *names* of the various chemical ingredients, learning their relative value as respects the fertility of the soil, and acquiring a knowledge of the quantities of each requisite to be applied to particular crops; for, as to his attempting to prove their existence in his own soil by analysis, I fear that is far too difficult a subject for him to grapple with, unless regularly educated as an analytical chemist."

447. *Chemical composition of soils.*—"Soil, to be useful to the British agriculturalist, must contain no less than 12 different chemical substances, viz., silica, alumina, oxide of iron, oxide of manganese, lime, magnesia, potass, soda, phosphoric acid, sulphuric acid, chlorine, and organic matter. I shall confine my observations almost solely to their relative importance to plants, and their amount in the soil.

448. "*Silica.*—This is the pure matter of sand, and also constitutes on an average about 60 per cent of the various clays; so that in soil it generally amounts to from 75 to 95 per cent. In its uncombined state, it has no *direct* influence upon plants, beyond its mechanical action, in supporting the roots, &c.; but, as it possesses the properties of an acid, it unites with various alkaline matters in the soil, and produces compounds which are required in greater or less quantity by every plant. The chief of these are the *silicates of potass and soda*, by which expression is meant the compounds of silica, or, more properly, silicic acid with the alkalies potass and soda.

449. "*Alumina.*—This substance never exists pure in soil. It is the *characteristic* ingredient of clay, although it exists in that compound to the extent of only 30 or 40 per cent. It exerts no *direct chemical* influence on vegetation, and is scarcely ever found in the ashes of plants. Its chief value in soil, therefore, is owing to its effects in rendering soil more retentive of moisture. Its amount varies from ½ per cent to 13 per cent.

450. "*Oxide of Iron.*—There are two oxides of iron found in soils—namely, the protoxide and peroxide; one of which, the protoxide, is frequently very injurious to vegetation: indeed, so much so, that ½ per cent of a soluble salt of this oxide is sufficient to render soil almost barren. The peroxide, however, is often found in small quantities in the ashes of plants. The two oxides together constitute from ½ to 10 per cent of soil. The blue, yellow, red, and brown colours of soil, are more or less dependent upon the presence of iron.

451. "*Oxide of Manganese.*—This oxide exists in nearly all soils, and is occasionally found in plants. It does not, however, appear to exert any important influence either mechanically or chemically. Its amount varies from a mere trace to about 1½ per cent. It assists in giving the black colour to soil.

452. "These four substances constitute by far the greatest bulk of every soil, except the chalky and peaty varieties, but, nevertheless, *chemically speaking*, are of trifling importance to plants; whereas the remaining eight are so absolutely essential that no soil can be cultivated with any success, unless provided with them, either naturally or artificially. And yet, when it is considered that scarcely any of them constitute 1 per cent of the soil, their value will no doubt excite surprise. The sole cause of their utility lies in the fact, that they constitute the *ashes of the plants;* and as no plant can, by possibility, thrive

without its inorganic constituents, (*its ashes,*) hence no soil can be fertile which does not contain the ingredients of which these are made up. The very small percentage of these ingredients in any soil necessitates a minute analysis of every soil before it can be ascertained whether or not it contains any, or what proportion of these ingredients. But the reason for such minuteness in analysis becomes obvious when we consider the immense weights which have to be dealt with in practical agriculture; for example, every imperial acre of soil, considered as only 8 inches deep, will weigh 1884 tons, so that 0·002 per cent, that is, only a two-thousandth per cent—the amount of sulphuric acid in a barren soil—amounts to 80·64 lbs. in the imperial acre!

453. "*Potass* and *soda* exist in variable quantities in many of the more abundant minerals, and hence it follows that their proportion in soil will vary according to the mineral which produced it. For the sake of reference, I have subjoined the following table, which shows the amount per cent of alkalies in some of these minerals, and likewise a rough calculation of the whole amount per imperial acre, on the supposition of a soil composed solely of these rocks, and of a depth of 10 inches; and the amount is abundant beyond conjecture:—

Name of Mineral.	Amount per cent of Alkali.	Name of Alkali.	Amount per Imperial Acre in a soil 10 inches deep.
			Tons. cwt. qr. lb. Tons. cwt. qr. lb.
Felspar . .	17·75	Potass	422 18 2 8
Clinkstone .	3·31 to 6·62	Potass and soda	71 17 2 0 to 143 15 0 0
Clay-slate .	2·75 to 3·31	Potass	35 18 3 0 to 71 17 2 0
Basalt . .	5·75 to 10	Potass and soda	17 0 0 7 to 25 7 3 7

454. "One acquainted with chemistry will naturally ask the question, How is it that these alkalies have not been long ago washed away by the rain, since they are both so very soluble in water? The reason of their not having been dissolved is the following—and it may in justice be taken as an example of those wise provisions of nature, whereby what is useful is never wasted, and yet is at all times ready to be abundantly supplied:—

455. "These alkalies exist in combination with the various other ingredients of the rock in which they occur, and in this way have such a powerful attraction for these ingredients, that they are capable of completely resisting the solvent action of water as long as the integrity of the mass is retained. When, however, it is reduced to a perfectly impalpable powder, this attraction is diminished to a considerable extent, and then the alkali is much more easily dissolved. Now this is the case in soil, and, consequently, while the stony portions of soil contain a vast supply of these valuable ingredients in a condition in which water can do them no injury, the impalpable powder is supplied with them in a soluble state, and hence in a condition available to the wants of vegetation.

456. "In the rocks which we have mentioned, the alkalies are always associated with clay, and it is to this substance that they have the greatest attraction; it follows, therefore, that the more clay a soil contains, the more alkalies will it have, but at the same time it will yield them less easily to water, and through its medium to plants."

457. *Analysis of soils.*—I shall give only a single instance of the minute analysis of a soil, without reference to its barrenness or fertility, in order to show the great variety of substances found in it. The soil was from a tract in North Holland, gained by embankment from the sea, and its analyses were made by Baumhauer in Mülder's laboratory at Utrecht.

	Soil. Surface.	Subsoil. 15 in. deep.	Subsoil. 30 in. deep.
Organic matter and combined water .	8·324	7·700	9·348
Humic acid .	2·798	3·911	3·428
Crenic acid . .	0·771	0·731	0·037
Apocrenic acid .	0·107	0·160	0·152
Potash . .	1·026	1·430	1·521
Soda . . .	1·972	2·069	1·937
Ammonia . .	0·060	0·078	0·075
Lime . . .	4·092	5·096	2·480
Magnesia . .	0·130	0·140	0·128
Peroxide of iron .	9·039	10·305	11·864
Protoxide of iron .	0·350	0·563	0·200

	Soil. Surface.	Subsoil. 15 in. deep.	Subsoil. 30 in. deep.
Protoxide of manganese	0·288	0·354	0·284
Alumina . .	1·364	2·576	2·410
Phosphoric acid .	0·466	0·324	0·478
Sulphuric acid .	0·896	1·104	0·576
Carbonic acid .	6·085	6·940	4.775
Chlorine . .	1·240	1·382	1·418
Soluble silica .	2·340	2·496	2·286
Insoluble silicates .	57·646	51·706	55·372
Loss	1·006	0·935	1·231
	100·	100·	100·*

458. On comparing the constituents of such a soil as the above, with the mineral ingredients obtained by incineration from the ashes of plants, it is found that plants withdraw from the soil chiefly its alkaline, mineral acid, and earthy ingredients; and if all these were not essential to the very existence of the plants, they would not, of course, be taken up by them; and as the plants constituting our cultivated crops withdraw those ingredients in a varied amount, it follows that, unless the soils we cultivate contain them in ample amount and variety, it will be impossible for the plants placed upon them to arrive at a perfect state of development of all their parts; for, chemically speaking, and rationally speaking too, soils cannot be expected to produce crops abundantly, unless they contain a sufficient supply of every ingredient which all the crops we wish to raise require from them.

459. The practical purpose of all analyses of plants and soils should, therefore, be to make us acquainted with the constituents of every variety of cultivated crop at their different stages of growth; and to ascertain whether or not each soil in use contains a sufficient supply of such ingredients. The analyses of plants should have thus a twofold object—namely, to guide the cultivator in the treatment of the plants at the various stages of their growth, and to instruct him as to what quantity the ripe plant in its healthy state finally carries off of those ingredients from the soil.

460. "The latter only of these two applications of such knowledge," observes Professor Johnston on this subject, "has hitherto been kept in view by chemists; and so little has been done in reference to it, that we scarcely know as yet what any one *entire* plant, when fully ripe, carries off from the soil. In reference to the former application, the few imperfect researches detailed in the preceding sections," (of the second edition of his Lectures on Agricultural Chemistry,) "contain all that we yet know. We may well say, therefore," he concludes, "that our knowledge of the inorganic constituents of plants is yet in its infancy, and that our present opinion upon the subject ought, therefore, to be permitted to hang very loosely about us."

461. Here, then, the agricultural student will observe, is an extensive and interesting field for exercising the researches of the analytical chemist for years to come, and a most useful subject upon which to expend a proportion of the funds of agricultural societies, until every variety of soil, whether under cultivation or in a state of nature, and every variety of plant, whether under cultivation or in a state of natural pasture, shall have been minutely and rigorously analysed.

462. *Per-centage of mineral ingredients taken from the soil.*—As an example merely of the quantity of the mineral ingredients taken from the cultivated soil by some of the cultivated plants, I shall enumerate these instances:—

By grain crops:—

100 lbs. of	Grain.	Husk.	Straw.	
Wheat, - -	1·2 to 2·0	—	3·5 to 18·5	
Barley, - -	2·3 to 3·8	—	5·2 to 8·5	
Oats, - -	2·6 to 3·9	5 to 8	4·1 to 9·2	
Rye, - -	1·0 to 2·4	5 to 8	2·4 to 5·6	
Rice, -	0·9 to 0·7	14 25	—	
Indian corn, -	1·3	—	2·3 to 6·5	
Buck-wheat, -	2·13	—	—	
Millet seed, -	3·9	—	—	
Field beans, -	2·1 to 4·0 ?	—	3·1 to 7·0	
Field pease, -	2·5 to 3·0	Pod 7·1	4·3 to 6·2	
Vetches, - -	2·4	—	—	
Lentils, - -	2·06	—	—	Flax.
Linseed, - -	3·8 to 4·63	—	4·5	1·28
Hemp seed, -	5·6	—		Hemp. 1·78
Mustard seed, -	4·2 to 4·3	—		—
Coffee, - -	3·19	—		—

463. *By root and leaf crops:—*

	Root or tuber.		Leaves.	
100 lbs. of	Undried.	Dried.	Undried.	Dried.
Potato, -	0·8 to 1·1	3·2 to 4·6	1·8 to 2·5	18 to 25
Turnip, -	0·6 to 0·8	6·0 to 8·0	1·5 to 2·9	14 to 20
Beet, -	—	6·3	—	—
Jerusalem artichoke, -	—	6·0	—	—
Carrot, -	0·7	5·1	—	16·42
Parsnip, -	0·8	4·3	—	15·76
Mangold-wurtzel, -	1·1	7·0	0·53	7·55
Cabbage,	—	—	—	18 to 26

* Johnston's *Lectures on Agricultural Chemistry and Geology*, 2d edition, p. 528.

464. *By grasses:—*

100 lbs. of	Green.	Dry.
Lucerne - - -	2·6	9·5
Red clover, - -	1·6	7·5
White clover, - -	1·7	9·1
Rye-grass, - - -	1·7	6·0
Knot-grass, - - -	—	2·3
Holcus lanatus, - -	—	5·6 to 6·8
Poa pratensis, - -	—	6·2
Scirpus, - - -	—	2·3

465. *By trees:—*

100 lbs. of	Wood.	Seed.	Leaves, dried.
Larch, - -	0·33	5·0	6·0
Scotch fir, -	0·14 to 0·19	4·98	2·0 to 3·0
Pitch pine, -	0·25	4·47	3·15
Beech, - -	0·14 to 0·60	—	4·2 to 6·7
Willow, - -	0·45	—	8·2
Birch, - -	0·34	—	5·0
Elm, - -	1·88	—	11·8
Ash, - -	0·4 to 0·6	—	—
Oak, - -	0·21	—	4·5
Poplar, - -	1·97	—	9·2
Common furze,	0·82	flower.	3·1
Hop, - -	5·0	10·90	16·3

466. On the results exhibited in these tables, Professor Johnston makes these observations. "That the quantity of inorganic matter contained in the same weight of the different crops we raise, or of the different kinds of vegetable food we eat, or with which our cattle are fed, is very unlike; and the quantity contained in different parts of the same plant is equally unlike. These results cannot be the result of accident. They are constant on every soil, and in every climate; they must, therefore, have their origin in some natural law. Plants of different species must draw from the soil that proportion of inorganic matter which is adapted to the constitution, and is fitted to supply the wants of each; while of that which has been admitted by the roots into the general circulation of the plant, so much must proceed to, and be appropriated by, each part, as is suited to the functions it is destined to discharge. And as from the same soil different plants select different quantities of saline and earthy matter, so from the same common sap do the bark, the leaf, the wood, and the seed, select and retain that proportion which the healthy growth and development of each requires. It is with the inorganic as with the organic food of plants: some draw more from the soil, some less; and of that which circulates in the sap, only a small portion is expended in the production of the flower, though much is employed in forming the stem and leaves.

467. "On this subject I shall add two other observations," continues the Professor: "from the constant presence of this inorganic matter in plants, given under all circumstances, a doubt can hardly remain that it is an essential part of their substance, and that they cannot live and thrive without it. But that it really is so, is beyond a doubt, by the farther experimental fact, that if a healthy young plant be placed in circumstances where it cannot obtain this inorganic matter, it droops, pines, and dies. But if it be really essential to their growth, this inorganic matter must be considered as part of the *food* of plants; and we may as correctly speak of feeding or supplying food to plants, when we add earthy and mineral substances to the soil, as when we mix it with a supply of rich compost, or of well fermented farm-yard manure.

468. "I introduce this observation for the purpose of correcting an erroneous impression entertained by practical men in regard to the way in which mineral substances act when applied to the soil. By the term *manure*, they generally designate such substances as they believe to be capable of *feeding* the plant, and hence reject mineral substances, such as gypsum, nitrate of soda, and generally lime, from the list of manures properly so called. And as the influence of these substances on vegetation is undisputed, they are not unfrequently considered as *stimulants* only. Yet if, as I believe, the use of a wrong *term* is often connected with the prevalence of a wrong *opinion*, and may lead to grave errors in practice, I may be permitted to press upon your consideration the facts above stated—I may almost say demonstrated—that plants *do feed* upon dead unorganised mineral matter, and that you, therefore, really manure your soil, as well as permanently improve it, when you add to it such substances of this kind as are found by experience to promote the growth of your crops."

469. The discovery of the constant existence of inorganic matter in plants, which could have been discovered by chemistry alone, must have, in future, a very important influence in modifying the notions, and regulating the practice of cultivating all our plants. "It establishes a clear relation between the kind and quality of the crop, and the nature and che-

mical composition of the soil in which it grows;—it demonstrates what soils ought to contain, and therefore how they are to be improved;—it explains the effect of some manures in permanently fertilising, and of some crops in permanently impoverishing the soil; it illustrates the action of mineral substances upon the plant, and shows how it may be, and really is, in a certain measure, *fed* by the dead earth:—over nearly all the operations of agriculture, indeed, it throws a new and unexpected light." *

470. The great importance to agriculture of ascertaining the constituents of plants by analysis, is thus estimated by Liebig:—"By an exact examination of the quantity of ashes in cultivated plants," he observes, "growing on various kinds of soils, and by their analysis, we learn those constituents of the plants which are variable, and those which remain constant. Thus, also, we will attain a knowledge of the quantities of all the constituents removed from the soil by different crops. The farmer will then be enabled, like a systematic manufacturer, to have a book attached to each field, in which he will note the amount of the various ingredients removed from the land in the form of crops, and therefore how much he must restore to bring it to its original state of fertility. He will also be able to express, in pounds weight, how much of one or of another ingredient of soils he must add to his own land, in order to increase its fertelity for certain kinds of plants. These investigations are a necessity of the times in which we live; but in a few years, by the united diligence of chemists of all countries, we may expect to see the realisation of these views; and, by the aid of intelligent farmers, we may confidently expect to see established, on an immoveable foundation, a rational system of farming for all countries and for all soils." †

471. *Classification of soils.*—A correct and intelligible classification of soils would much facilitate their description by writers on agriculture, and would render their characters more easily understood by the readers of agricultural works. For want of any systematic classification, farmers have established a classification amongst themselves, which seems to answer all practical purposes. Thus, when a soil is described as being clayey or sandy as its fundamental characteristic, it is understood to be strong or light, and when it is said to be sharp or heavy, the kind of crop each is best suited to grow—namely, turnips on the former, and wheat on the latter—is easily understood; but, of course, these conventional terms are only understood by practical men, and convey no definite meaning to others.

472. Were soils as definite in their characters as minerals are, there would be no difficulty in applying to them the external characters employed to describe minerals, and these are quite sufficient to identify them to mineralogists; but as soils are so varied in aspect and texture, definite rules are quite inapplicable to them.

473. And if the external characters cannot be employed to describe soils correctly, much less can their chemical composition be adopted as a basis of classification suited to the wants of practical men. Chemical tests can only be employed when the soil is about to be analysed; and to require an analysis before a soil can be described or understood, is to place a direct barrier against acquiring a scientific knowledge of its characters by practical men.

474. All I can present on this subject is a sketch of a classification of soils, proposed by M. De Gasparin, who, though employing some chemical tests to ascertain the nature of soils, had previously endeavoured to ascertain it by studying their agricultural characters. The result was, that he was led to adopt the following conclusions in regard to the relative values of the characters of soils. "It is," he says, "only after having destined a particular soil to an appropriate culture, that we can begin to consider the labour and improvement it requires. Those labours and improvements will be without an object and a bearing, if we are still ignorant of the plant to which they would be useful. And,

* Johnston's *Lectures on Agricultural Chemistry and Geology*, 2d edition, p. 303-7.
† Liebig's *Chemistry of Agriculture and Physiology*, 3d edition, p. 213.

moreover, this investigation of the appropriation of soils to particular kinds of culture, is connected with the most natural classification in a mineralogical point of view; it breaks the smallest number of affinities, and consequently renders the determination of soils more easy and more satisfactory." I cannot help thinking that M. De Gasparin has here hit upon the *principle* upon which a correct and useful classification of soils may be founded.

475. In his endeavour to reduce this principle to practice, he has placed soils in two great divisions; the *first* includes those having a *mineral* or inorganic basis, the *second* those having an *organic* one.

476. The first great division, consisting of soils having a mineral or inorganic basis, he divides into four classes, comprehending *saliferous* soils, *siliceous* soils, *clays*, and *calcareous* and *magnesian* soils.

477. The character of *saliferous* soils is, that they have "a salt or styptic taste, containing at least 0·005 parts of hydrochlorate of soda, or sulphate of iron;" and they consist 1st, of *saline* soils; and, 2d, of *vitriolic* soils.

478. The character of *siliceous* soils is, that they produce "no effervescence with acids, affording by levigation at least 0·70 of large particles, which are deposited when the water in which the earth is dissolved is strongly shaken."

479. *Clays* are characterised by "not yielding effervescence with acids, and by affording by levigation less than 0·70 of the first portion."

480. And the characters of *calcareous* and *magnesian* soils are, that they "produce effervescence with acids; lime or magnesia, or both, being found in the solution." This class is subdivided into five sub-orders, namely, *chalks*, *sands*, *clays*, *marls*, and *loams*. The marls, again, are farther subdivided into two sections, namely, *calcareous* marls and *argillaceous* marls.

481. The second great divison, consisting of soils having an organic basis, he divides into two classes, comprehending *fresh* mould and *acid* mould.

482. The character of *fresh mould* is, that "the water in which this mould is digested or boiled does not redden litmus paper."

483. That of *acid mould* being, that, under the same circumstances, it "reddens litmus paper."

484. It is intimated that M. De Gasparin has laid "down rules for the description of *species*, and with *examples* of all the methods of description. In reading these, we at once perceive how precise an idea of soils is conveyed in a manner that cannot be misunderstood by any agriculturist. The possibility of transmitting these clear and pointed descriptions to a distance, follows as a matter of course; and we shall in this manner be freed from all that vagueness which has been so long a just cause of complaint." This is all that can be desiderated on the subject; but, useful as all M. De Gasparin's services to agriculture have been in the right direction, he has not yet succeeded in establishing a faultless description of soils, for, let me apply some of the rules he has offered above, and test his own application of them. For example, he says, that *clay* soils are characterised by "*not* yielding effervescence with acids, and affording by levigation less than 0·70 of the first portion;" and the character of *siliceous* soils he gives in these words, "producing *no* effervescence with acids, affording by levigation at least 0·70 of large particles." Surely the mere difference of affording "at least" and "less" than 0·70 of any ingredient, is not sufficient to account for the great difference existing in agriculture betwixt clay and sandy soils. He does not, however, confound *loams* with *clays*, as some writers have done, the loams containing clay only a little "more than 0·10 of the weight of the soil;" whereas clays afford only a little "less than 0·70 of the first portion" of the matter separated by levigation, thereby establishing a great difference of character betwixt them.

385. There is no doubt, however, of the truth of the opinion expressed by M. De Gasparin, were a correct nomenclature and classification of soils established, when he says, "that the study of agricultural

treatises would be greatly facilitated; the different methods of culture which are followed in distant countries will no longer appear so marvellous, and will become more intelligible; we shall comprehend better the considerations which limit or extend the several cultures; and a necessary link being established between the science of agriculture and the other natural sciences, it will become more intelligible to all, and will more readily profit by the progress of all the other branches of human knowledge." *

486. *Origin of soils.*—On endeavouring to establish a relationship between geology and agriculture, it seems incumbent to give the agricultural student some idea of the origin of the soil upon the cultivation of which he is about to exercise his skill, and from which he is to extract his future subsistence; and, in consulting geological and other writers on this subject, some seem to regard the existing soils as not only exceedingly simple in their origin, but certainly indicative of the rock on which they rest. Thus, Mr Morton says, that "the surface of the earth partakes of the nature and colour of the subsoil or rock on which it rests. The principal mineral of the soil of any district is that of the geological formation under it; hence we find argillaceous soil resting on the various clay formations—calcareous soil over the chalk—and oolitic rocks and siliceous soils over the various sandstones. On the chalk the soil is white; on the red sandstone it is red; and on the sands and clays the surface has nearly the same shade of colour as the subsoil. The lime, potash, and iron, existing in various proportions in the rock, are acted on by the atmosphere, and the rock is decomposed; some of it will form impalpable matter, some into sand, and some into coarse gravel or rubble. The surface is composed of the same materials as the subsoil, with the addition of vegetable and animal matter, in every state of decay, intimately mixed with it; and we perceive a change in the external appearance of the surface whenever there is a change in the subsoil below."† Here the direct derivation of the soil from the subjacent rock is fully stated.

487. A subsequent author, Mr Whitley, gives his view of the formation of soils in these words:—"The ordinary effect of atmospheric influence does not appear sufficient to produce such changes, (those observable on the surface of the globe;) for, if we examine the granitic tors, we shall find that mosses and lichens grow around their bases, and creep up their sides, forming, by their decay, a light vegetable mould on which the weather produces little effect. Much less would atmospheric influence be able to produce such extensive changes as those we have described. We are therefore led to the conclusion that some more powerful and effective agent has been at work; and the phenomena connected with the facts we have reviewed, are only consistent with the theory of a vast body of water having, by its violent action, broken and comminuted the earth's surface to a considerable depth—thus holding in mechanical suspension the materials of which the soil and subsoil are composed—the coarser and heavier parts of which first subsided, then the clays, and lastly, the fine earthy matter. . . . . In endeavouring to establish this view of the formation of soil, the decomposition of rocks by atmospheric and chemical agencies must not be overlooked. These causes had probably produced extensive changes before that catastrophe whose effects we have just been describing; and to the present time their operation tends to improve and deepen the soil. The crumbling down of rocks by decomposition may be regarded as conservative of the soil, by supplying fresh portions to replace those which are constantly being washed away." Yet after a review of "the violent action of a body of water" having swept away "large portions of the earth's surface from their original position, and deposited them at lower levels," Mr Whitley arrives, rather unexpectedly, at a conclusion of the origin of the present soil, which is much in unison with, and even in the same words as, the

* *Comptes Rendues de l'Académie des Sciences*, tome viii., No. 8, p. 285, 1839, as translated in Jameson's *Edinburgh New Philosophical Journal*, vol. xxvii., p. 84. I may here mention that M. De Gasparin is engaged in a voluminous work on *Agronomy*, volumes of which have already appeared in France.

† Morton *On Soils*, p. 1. 1838. I have not seen the subsequent editions of this work.

opinion of Mr Morton, that, "from the foregoing statement, we conclude that the soil we now cultivate has been derived generally from the rock on which it rests, and rendered fertile by the addition of decayed animal and vegetable matter. It will follow that the same mineral constituents which enter into the composition of the rock, will be found also in the soil; and any marked colour peculiar to the one will be communicated to the other: thus, in the chalk, the soil is white; in the red sandstone, red; and in the clay-slate, yellow." *

488. Mr Ansted professes to follow the views of Mr Whitley on this subject, though he expresses himself, in some particulars, in modified language. "It must not be supposed," he observes, "that a violent rush of water is necessary for the formation of a soil. Rain, penetrating into the crevices of an exposed rock, and succeeded by frost, crumbles down the hardest materials; and if these crumbled portions are washed away, they are rapidly succeeded by others, so that a soil is formed, which at length, under favourable circumstances, becomes covered by mosses and lichens, and from their decay is obtained that supply of carbon and other materials which, in process of time, renders the soil fit for the growth of other vegetables which are useful to man. In either case, however, the result to the agriculturist is the same; for there is a superficial coating of *mould*, and a subsoil chiefly or entirely mineral between the mould and the parent rock. An examination of the soil, and a chemical analysis of it, will, in most cases, immediately show that the soil, as well as the subsoil, are derived from the underlying rock; and it seems that this extends even to the colour, which is white in chalky soils, red in the new red sandstone, and the ochraceous beds of the green-sand, and yellow in the clays and clay-slate, &c. But it will not be expected that these conditions should hold when there is a thick bed of superficial detritus, such as gravel; for the gravel must then be looked upon as the parent rock, and the condition of the soil will be little influenced by the actual underlying bed."†

489. As it appears to me, the origin of the soil is not so easily explained as the matter seems to be assumed by the authors I have just quoted; and that difficulty attends the explanation of their origin may be inferred from the fact of most geologists having hitherto paid little attention to the relations of the loose materials composing the *surface* of the globe. They are well acquainted, and coincide in opinion, with the relations of the indurated rocks which form the *crust* of the earth, but are far from being agreed as to the causes which have placed the enormous masses of incoherent matter, met with in every quarter of the globe, in their present positions. These masses of clay, sand, and gravel, bear no fixed relation to one another, like the indurated rocks; and therefore have not been placed by the operation of any law of order, but simply that of gravity; and it is this want of order in their position which baffles the ability of the geologist to ascribe the origin correctly.

490. The incoherent rocks, when complete in all their members, consist of three parts. The oldest or lowest part, not unfrequently termed *diluvium*, but which is an objectionable term, inasmuch as it conveys the idea of its having been formed by the Noachian deluge, which it may not have been, but may have existed at a much older period of the globe. This cannot be called *alluvium*, according to the definition of that deposite given by Mr Lyell, who considers it to consist of "such transported matter as has been thrown down, whether by rivers, floods, or other causes, upon land not *permanently* submerged beneath the waters of lakes or seas;—I say *permanently submerged*, in order to distinguish between *alluviums* and *regular subaqueous deposites*. These regular strata," he continues, "are accumulated in lakes or great submarine receptacles; but the alluvium is in the channels of rivers or currents, where the materials may be regarded as still *in transitu*, or on their way to a place of rest."‡ Diluvium, therefore, should rather be termed subaqueous deposites, and may consist of clay, or gravel, or sand, in deep masses and of large extent. It may, in fact, be transported materials, which, if

* Whitley's *Application of Geology to Agriculture*, p. 10-17. 1843.

† Ansted's *Geology*, vol. ii. p. 485.

‡ Lylle's *Principles of Geology*, vol. iii. p. 218.

they had been allowed to remain in their original site, would have formed indurated aluminous and siliceous rocks. When such subaqueous deposites are exposed to atmospherical influences, an arable soil is easily formed upon them.

419. True *alluvial* deposites may raise themselves by accumulation above their depositing waters, and art can assist the natural process by the erection of embankments against the waters of rivers and lakes, and by forming large ditches for carrying the waters away, as has been done in several places in the rivers and lakes of our country. Atmospherical influences soon raise an arable soil on alluvium.

492. The third member of soils is the upper *mould*, which is directly derived from vegetation, and can only come into existence after either of the other soils has been placed in a situation favourable for the support of plants—that is, in the atmosphere. Mould, being the production of vegetation, always exists on the surface, but when either the subaqueous deposite or the alluvium is awanting, it rests upon the one present; and when both are awanting, it is formed upon the indurated rock still by the atmosphere.

493. When the last case happens, if the rocky stratum is porous, by means of numerous fissures, or is in inclined beds, the mould is of good quality for agricultural purposes,—such as are the moulds upon sandstones, limestones, and trap, and the upper chalk formation; but if it rest on a massive rock, then it is converted into a spongy wet pabulum for subaquatic plants, forming a marsh, if its site is low, but if high, is converted into thin peat; and both are worthless soils for agriculture. When the mould rests immediately upon clay subaqueous deposite, a coarse and rank vegetation appears upon it; and if the water which supports this has no opportunity of passing away, in time a bog is formed by the cumulative growth of the subaquatic mosses.* On the other hand, when it is formed on gravelly deposite, the vegetation is short, and dry, and sweet, and particularly well adapted to promote the sound feeding and health of sheep. On such deposites water is never seen to remain after the heaviest fall of rain. Mould resting on alluvial deposite of whatever nature, is a rich soil in consequence, and it will be dry when the deposite is gravelly or sandy; but not if clayey.

494. Notwithstanding the possibility of the formation of *mould* upon the surface of hard rocks by means of atmospheric influences, there cannot, I think, a doubt exist that by far the largest proportion of the agricultural soil is based upon the incoherent, and not the indurated rocks. And that there may be no mistake in the use of terms, I here use the term *rock* as geologists use it, that is, according to the definition of Sir Henry De la Beche. "The term rock is applied by geologists, not only to the hard substances to which this name is commonly given, but also to those various sands, gravels, shales, marls, or clays, which form beds, strata, or masses."† I do not profess to be a geologist, in the legitimate sense of the term, but I have paid some attention to the science for many years past, and never have had an opportunity of observing the position of rocks without availing myself of it in order to become acquainted with the loose deposites on the surface, because they evidently have an immediate connexion with agriculture; and I must say that all my observations in this country, as well as on the Continent, have convinced me that the agricultural soils of the low part of a country are generally not derived from the hard rocks upon which they may happen to be placed, but have been brought to their present position from a distance by means of water.

495. Many instances occur to my knowledge of great tracts of soils, including subsoils, having no relation to the "geological formation under them." The fine strong deep clay of the Carse of Gowrie rests on the old red sandstone—a rock having nothing in common, either in consistence or colour, with the clay above it. The large extent of the grey sands of Barrie, and the great grey gravelly deposites of the valley of the Lunan, in Forfarshire, both rest on

* For an account of the origin of Bogs, see Aiton *On Moss*, p. 1-120.
† De la Beche's *Manual of Geology*, p. 35.

the same formation as the carse clay—namely, the old red sandstone, and so of numerous other examples in Scotland. In fact, soils are frequently found of infinitely diversified character, over extensive districts of rock, whose structure is nearly uniform; and, on the other hand, soils of uniform character occur in districts where the underlying rocks differ as well in their chemical as their geological properties. Thus a uniform integument of clay rests upon the grey sandstone to the westward of the Carse of Gowrie, in Perthshire, and the same clay covers the Ochil Hills in that county and Fifeshire with a uniform mantle—over hills which are entirely composed of trap. On the other hand, a diversified clay and gravel are found to cover a uniform track of greywacke in Perthshire. "We have grey sandstone," says Mr Buist aptly, when treating of the geology of the north-east portion of Perthshire, "red sandstone, and rock-marl, as it is called, cut by various massy veins of trap or beds of conglomerate and lime; yet I defy any man to form the smallest guess of the rocks below from the soils above them, though the ground is sufficiently uniform to give fair scope for all to manifest the influence possessed by them. There are lands whose agricultural value has been so greatly modified by the presence or withdrawal of a bed of gravel between the arable soil and tilly subsoil, that, when present, it affords a universal drain—when absent, it leaves the land almost unarable. But if we must show a relation betwixt the sandstone and any of these beds, which of the three," very properly asks Mr Buist, "are we to select as having affinity with the rock?"*

496. What are we to say of the vast quantity of solid matter held for a time in mechanical suspension in the water of rivers, and brought down to be deposited at the mouth of the stream, or spread over the bed of the ocean? The matter brought down the Rhine, and deposited in Holland before the water reaches the sea, to the extent that, in 2000 years, it may have brought down materials to form a soil one yard thick, and covering an extent of 36 square miles—the gigantic delta of the Ganges, whose head commences at a distance of 220 miles in a direct line from the sea, and whose base is 200 miles along the coast, comprises a triangular space of 20,000 square miles of new made soil—the immense tract of swamp forming along the coast of Guiana, in South America, by the deposite of the mud brought down by the Amazons river, and the shallow sea along that coast is rapidly being converted into land.† Many other instances of a similar character could be referred to. Are we to say that these great deposites of soil rest upon the indurated rocks upon which they rest?

497. It is not denied that the chemical action of the air, and the physical force of rain, frost, and wind, produce visible effects upon the most indurated rocks, but, of course, they must have much greater effects upon incoherent ones. Combined in their action, they could only originate a mere coating of soil over the surface of indurated rock, if the rock were situated within the region of phanarogamous vegetation, because then it would be constantly covered with plants. But the plants, in their turn, would protect the rocks against the action of external agencies; and although they could not entirely prevent, they would at least retard, the accumulation of soil beyond what the decay of vegetation supplied. Even in the tropics, where vegetation displays its greatest luxuriance on the globe, the mould does not increase, though the decay of vegetables every year is enormous. "The quantity of timber and vegetable matter which grows in a tropical forest in the course of a century," says Mr Lyell, "is enormous, and multitudes of animal skeletons are scattered there during the same period, besides innumerable land shells and other organic substances. The aggregate of these materials, therefore, might constitute a mass greater in volume than that which is produced in any coral reef during the same lapse of years; but although this process should continue on the land for ever, no mountains of wood or bone would be seen stretching far and wide over the country, or pushing out bold promontories into the sea. The whole solid mass is either devoured by animals,

* *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 44-9.
† Ansted's *Geology*, vol. i. p. 6-9.

or decomposes into their gaseous constituents, as does a portion of the rock on which the animals and plants are supported." These are the causes of the prevention of the accumulation of soils in the tropics. In colder regions a similar result is thus brought about. "It is well known," continues Mr Lyell, "that a covering of herbage and shrubs may protect a loose soil from being carried away by rain, or even by the ordinary action of a river, and may prevent hills of loose sand from being blown away by the wind; for the roots bind together the separate particles into a firm mass, and the leaves intercept the rain-water, so that it dries up gradually, instead of flowing off in a mass and with great velocity."*

498. Some other agent, therefore, more powerful than the ordinary atmospherical elements, must be brought to bear upon indurated rocks, before a satisfactory solution of the formation of soils can be accepted. That other agent is water; but the moment we assent to the agency of water being able by its abrasive power and buoyant property, when in motion, to transport the abraded parts of rocks to a distance, and let them fall on coming in contact with some opposing barrier, that moment we must abandon the idea of the soils formed from abraded matter having been derived from the indurated rock upon which they rest. Mr Buist draws these conclusions after describing the relative positions of the deposites to the rocks upon which they rest in a large and important district of Perthshire, where he says, "that the alluvial matters of these districts, in general, belong to periods much more remote than those ordinarily assigned to them, and came into existence under circumstances prodigiously different from those which presently obtain: that the present causes—that is, the action of our modern rivers, brooks, and torrents, and of the air and water on the surfaces now exposed to them—have had but little share in modifying our alluvial formations, or bringing them into their present form. The doctrine seems to me most distinctly demonstrable, that wherever gravel or clay beds alternate with each other, and wherever boulder stones prevail remote from the parent rock, or cut off from it by high intervening ridges, that, at the time when the surface of the solid rock became covered with such alluvium, much the greater part of it was hundreds of feet beneath the waves. The supposition of the prevalence of enormous lakes, requiring barriers only less stupendous than our highest secondary mountain-ranges, whose outbursts must have swept every movable thing before them, seems far more untenable than the assumption that the present dry land, at the era of boulders being transported, was beneath the level of the ocean, from which by slow elevations, it subsequently emerged. Our newer alluvia, again, which are destitute of erratic boulders in general—such as our Carse of Gowrie and other clays—must have originated when the sea occasionally invaded the land to such moderate extent, that the transportation of rocky masses from great distances from our mountain-land had been rendered impossible, by the intervention of elevated ridges, or of secondary mountain-ranges."†

499. More than this, is it not probable that, when the sedimentary rocks were being deposited in water, the upper portions of the matter of which they were about to be formed, were never indurated at all, probably from want of superincumbent pressure, and were afterwards carried away by currents, and deposited at a distance in eddies in a mechanical instead of the crystalline form of indurated rock? May not all diluvium have thus originated, instead of being abraded from solid strata? It is quite conceivable that where indurated rock—such as chalk, and sandstone, and limestone—were left bare by the subsiding waters, and exposed to atmospherical influences, the upper surface may have been converted into *thin* soil; but we can allow no greater power to the atmosphere.

500. Since we have ventured on the field of speculation, why may we not go a little farther, and imagine that, since the structure and appearance of the beds of clay and sand existing at present are so very similar to those of the existing sedimentary indurated rocks, that after these beds had all been deposited in the

* Lyell's *Principles of Geology*, vol. iii. p. 177 and 184. Fourth edition.

† *Prize Essays of the Highland and Agricultural Society of Scotland*, vol. xiii. p. 49.

bottom of the ocean, they had never been indurated, either for want of pressure above, or the indurating effect of the heat below, or from the want of both causes, and that in consequence of the subsequent and general upheaving of the indurated part of the sedimentary rocks by the rising of the igneous rocks below them, suppose of granite, which is universally distributed over the globe as a fundamental rock, the upper unindurated parts had been removed from their site in superposition upon the indurated, by the currents created in the ocean in consequence of the general upheaving, and been deposited in those places which presented the greatest calmness in the water, and have covered other loose or indurated rocks as the case might have happened. The subsequent and partial upheavings of the trap rocks would produce somewhat similar though partial results. This conjecture would explain the existence of the enormous masses of diluvial deposites found in the globe more satisfactorily than from the disintegration of indurated rock by ordinary existing causes; for as to the great changes occasioned by the action of rivers, alluded to above, it should be borne in remembrance, that their visible effects are produced chiefly by the action of water on existing disintegrated masses, and not to any sensible effect on indurated rock.

501. Keeping in mind these conjectures, and employing them as modifying strictures, I think the agricultural student will find a satisfactory account of the origin of soils in these words of Professor Johnston:—" On many parts of the earth's surface, the naked rocks appear over considerable tracts of country, without any covering of loose materials from which a soil can be formed. This is especially the case in mountainous and granitic districts, and in the neighbourhood of active and extinct volcanoes, where, as in Sicily, streams of naked lava stretch in long black lines amid the surrounding verdure. But over the greater portion of our islands and continents, the rocks are covered by accumulations, more or less deep, of loose materials—sands, gravels, and clays chiefly,—the upper layer of which is more or less susceptible of cultivation, and is found to reward the exertions of human industry with crops of corn of greater or less abundance. This superficial covering of loose materials varies from a few inches to one or two hundred in depth, and is occasionally observed to consist of different layers or beds, placed one over another,—such as a bed of clay over one of gravel or sand, and a loamy bed under or over both. In such cases, the characters and capabilities of the soil must depend upon which of these layers may chance to be uppermost; and its qualities may often be beneficially altered by a judicious admixture with portions of the subjacent layer. It is often observed, where naked rocks present themselves, either in cliffs or on more level parts of the earth, that the action of the rains and frosts causes their surfaces gradually to shiver off, crumble down, or wear away. Hence, at the base of cliffs, loose matter collects,—on comparatively level surfaces, the crumbling of the rocks gradually forms a soil,—while from those which are sufficiently inclined, the rains wash away the loose materials as soon as they are separated, and carry them down to form deep deposites in the valleys. The superficial accumulation of which we have spoken, as covering rocks in many places to a depth of one or two hundred feet, consist of materials washed down or otherwise transported—by water, by winds, or by other geological agents. Much of these heaps of transported matter is in the state of too fine a powder to permit us to say, upon examining it, from whence it has been derived. Fragments of greater or less size, however, are always to be found, even among the clays and fine sands, which are sufficient to point out to the skilful geologist the direction from which the whole has been brought, and often the very rocks from which the entire accumulations have been derived.

502. " Thus, the general conclusion is fairly drawn, that the earthy matter of *all* soils has been produced by the gradual decay, degradation, or crumbling down of previously existing rocks. It is evident, therefore, that whenever a soil rests immediately upon the rock from which it has been derived, it may be expected to partake more or less of the composition and character of that rock; and that where the soil forms only the surface layer of a considerable depth of transported materials,

it may have no relation whatever, either in mineralogical character or in chemical constitution, to the immediately subjacent rocks. The soils of Great Britain are divisible into two such classes. In some counties, an acquaintance with the prevailing rock of the district enables us to predict the general character and quality of the soil; in others—and nearly all our coal-fields are in this case—the general character and capabilities of the soil have no relation whatever to the rocks on which the loose materials immediately rest." *

503. I have hitherto purposely abstained from even mentioning the *fertility* of soils, whether natural or artificial, as the subject will more appropriately engage our attention when we come to treat of manures. On viewing, then, the chemical composition of soils of known natural fertility, a standard will be afforded us by which we may, perhaps, be enabled to render other soils equally fertile by artificial means; but all our exertions may soon find a limit in this direction, inasmuch as without a certain amount of impalpable matter, soils cannot possibly be fertile, and how can we produce this impalpable matter? Yet, while the existence of this material proves the soil to be *mechanically* well suited for cultivation, *chemical* analysis alone can *prove* its absolute value to the farmer. The subject of soils is thus full of interest to the agricultural student.

504. Zoology.—Zoology treats of the classification and habits of all animals, from the lowest or simplest to the highest or most complicated structure—man. It is thus a comprehensive branch of natural history, embracing within its range the study of beasts, birds, reptiles, fishes, and insects. The history and habits of the quadrupeds and birds that form the domesticated live stock of the farm, cannot fail to engage the interest of the agricultural student; and though such a study may not afford him much information in the practical treatment of stock, it will certainly present him with a comprehensive view of the animal economy, and of the relations which one class of animals bear to every other. The geographical distribution, too, of animated beings over the surface of the globe is a subject which at once finds acceptance in any intelligent mind; and this delightful and instructive study is now placed in every one's power by the really beautiful maps published by Johnston in his Physical Atlas, a work which may be studied and consulted in all its details with profit by every dweller in the country.

505. Many of the animals indigenous to this country, whether quadruped, bird, or insect, are found in their habits at one season to be injurious, and at another beneficial to the interests of the farmer. No method is more effectual of knowing how to ascertain their injurious practices, or how to encourage their beneficial ones, than to acquire an intimate knowledge of their habits at all seasons. The weasel destroys the eggs and young birds of the poultry yard, but it also overcomes the rats and mice, whether in granary or stack, and these do no good at all to the farmer. The rook and hedge-birds devour grain at the ripening of the crops, but they destroy myriads of the insect tribe in the season of rearing their young. All insects are not injurious to the farmer; on the contrary, many are positively beneficial. The lady-bird destroys multitudes of the aphides, which injure many useful plants and trees, while itself does no injury at any time. The song-birds cheer our hearts in spring; and the only way for the farmer of repaying them for their song, is to feed them generously during the severity of winter, and which if he do, he is quite entitled to protect his fruit from their depredations in autumn by the use of simple safeguards.

506. *Entomology*, or the study of insects, might be made to serve agriculture to a considerable extent. In this department of science, farmers might greatly assist the entomologist, by observing the minute, but varied and interesting, habits of insects. The difficulty of comprehending the true impulses of insects, as well as of identifying species in the different states of transformation, render the observations of farmers less exact than those of entomologists who have successfully studied the technicalties of the science. The field of observation in the insect creation being very wide, and there being comparatively

* Johnston's *Lectures on Agricultural Chemistry and Geology*, 2d edition, p. 449-50, and Bakewell's *Geology*, p. 192-202.

but few explorers in it, a large portion of a man's life would be occupied in merely observing species and their habits, and a much larger in forming general deductions from repeated observations. The result would be, were farmers to study entomology, that a long period must elapse ere the habits of even the most common destructive insects, and the marks of their identity, would become familiarised to them. In consequence of this obstacle to the study of entomology, the obligations of the farmer ought to be the greater to those entomologists who daily observe the habits of insects in the fields and woods, and simplify their individual characteristics; and at the same time devise plans to evade their extensive ravages, and recommend easy and effective means for their destrdction. The English farmer, living in a climate congenial to the development of insect life, painfully experiences their destructive powers on crops and woods; and though the entomologists of England are ever vigilant and active, yet their efforts to overcome the tenacity of insect life, with a due regard to the safety of the plant, have hitherto proved but partially availing.

507. Veterinary Science.—A more general diffusion of veterinary science has tended much to improve the treatment of live stock in the hands of farmers. Formerly stock used to be exposed to the changes of weather, and made to subsist on the smallest quantity of food; and the consequence was, that they were overtaken with fatal diseases, which annually swept them away in numbers. Veterinary science has explained to the farmer, that to expose any living animal to a depressing temperature, is to derange the functions of its vital organs; and to stint it at the same time of a due proportion of food, is to deprive it of the power to generate heat within itself, and to protect its body with a covering of flesh and fat against the coldness of the temperature. Veterinary science may now vie with the medical sciences in importance and refinement, and a large number of skilful veterinarians are now qualified to practise the art in every part of the empire.

508. In recommending farmers to acquire a competent knowledge of veterinary science, it is not to be imagined that they should become veterinary surgeons. Let every class of persons adhere to their own profession. But doubtless a knowledge of veterinary science is of great use to the farmer, not in enabling him to administer to the diseased necessities of his live stock—for that requires more professional skill and experience than any farmer can attain, and is the proper province of the regularly bred veterinarian—but to enable him readily to detect a disease by its symptoms, in order to apply immediate checks against its progress, until he can communicate with and inform the veterinary surgeon of the nature of the complaint, whereupon to bring with him materials for treating it correctly on his arrival. The death of a single animal may be a serious loss to the farmer, and if, by his knowledge of the *principles* of the veterinary art, he can stay the progress of every disease, he may not only avert the loss, but prevent the animal being much affected by disease; and disease, though not proving fatal to animals, leaves injurious effects on the constitution for a long time thereafter

509. Epidemical diseases, such as the murrain and pleuro-pneumonia, have of late years ravaged the flocks and herds of many farmers; but the mode of evading or warding off their attacks in no respect differs from that of other diseases. Shelter and abundance of food at all times, and attention to premonitory symptoms of disease, are infalliable means of evasion and cure.

510. *Comparative Anatomy.*—Comparative anatomy explains the internal structure, and the functions of the bodies, of vertebrated animals—that is, of those animals provided with the high organisation of a back-bone, or spinal column. This science is best acquired along with the veterinary art, which particularly has regard to the organisation of all the inferior animals, and especially of the domesticated ones. At the same time, this species of anatomy is only clearly understood after the acquisition of a familiar acquaintance of the human frame. So many opportunities of learning human anatomy exist, that no difficulty need be experienced by any one who passes a little time in any town that forms the seat of a university;

and possessing a general acquaintance of the human frame, a knowledge of the structure of the inferior animals, in all its varieties, will be easily acquired. A knowledge of anatomy may prove useful to the practical farmer, inasmuch as it explains to him the structure of the carcasses of the animals upon which he bestows so much care in rearing. Acquainted with the structure, functions, and seats of the most common diseases of the several parts which constitute the corporeal body, he will be the better able to apportion the food to the peculiar constitution of the animal; and also to anticipate any tendency to disease, by a previously acquired knowledge of premonitory symtoms.

511. These are the physical sciences whose principles seem most applicable to agriculture; and being so, they should be studied by every farmer who wishes to be considered an enlightened member of his profession. That farmers are quite competent to attain these sciences, may be gathered from the observations of Sir John Herschel:—"There is scarcely any well informed person who, if he has but the will, has not the power to add something essential to the general stock of knowledge, if he will only observe regularly and methodically some particular class of facts which may most excite his attention, or which his situation may best enable him to study with effect. To instance one subject which *can* only be effectually improved by the united observations of great numbers widely dispersed—Meteorology, one of the most complicated but important branches of science, is at the same time one in which any person who will attend to plain rules, and bestow the necessary degree of attention, may do effectual service." But in drawing conclusions, great caution is requisite, for, "In forming inductions, it will most commonly happen that we are led to our conclusions by the especial force of some two or three strongly impressive facts, rather than by affording the whole mass of cases a regular consideration; and hence the need of cautious verification. Indeed, so strong is this propensity of the human mind, that there is hardly a more common thing than to find persons ready to assign a cause for every thing they see, and in so doing, to join things the most incongruous, by analogies the most fanciful. This being the case, it is evidently of great importance that these first ready impulses of the mind should be made on the contemplation of the cases most likely to lead to good inductions. The misfortune, however, is, in natural philosophy, that the choice does not rest with us. We must take the instances as nature presents them. Even if we are furnished with a list of them in tabular order, we must understand and compare them with each other, before we can tell which *are* the instances thus deservedly entitled to the highest consideration. And, after all, after much labour in vain, and groping in the dark, accident or casual observation will present a case which strikes us at once with a full insight into the subject, before we can even have time to determine to what class its *prerogative* belongs." *

ON THE INSTITUTIONS OF EDUCATION BEST SUITED TO AGRICULTURAL STUDENTS.

512. No course of elementary education is better taught than at the excellent parochial schools of Scotland. The sons of farmers and of peasants of Scotland have thus a favourable opportunity of acquiring the elements of a sound education, and they do not fail to avail themselves of it. There, also, a classical education, sufficiently extensive and profound for persons in ordinary life, may be obtained. But as to the acquirement of all the sciences enumerated above, it must be sought for in the universities, and some of them are taught in academies.

513. Four universities exist in Scotland, two in England, and one in Ireland, in any one of which is taught all, and more than all, the sciences I have enumerated.

514. There exist, besides, a great number of academies in many of the provincial towns in the kingdom, in which mathematics and natural philosophy are chiefly taught, together with practical mathematics, grammar, and book-keeping.

* Herschel's *Discourse on the Study of Natural Philosophy*, p. 133 and 182.

515. For the study of mathematics and natural philosophy, I prefer the academies to the colleges, because their course occupies twenty months, and two hours are devoted each day to each subject; whereas the college session extends only to six months, and devotes only one hour for five days in the week to one subject. The longer session, and the fuller teaching on each subject, and a smaller fee, are great advantages to students—great inducements for them to attend the academies; while the more fully mathematics and natural philosophy are taught, the more heartily are they appreciated by the student. Two sessions of twenty months, with a vacation of two months intervening between the sessions, might thus be profitably employed at an academy in learning mathematics, natural philosophy, geography, English grammar, and the theory of book-keeping.

516. Natural history and chemistry are best acquired at college, as they are not always taught, and never fully so, at the academies; and without the most ample experiments and illustrations, which cannot be expected to be afforded in provincial towns, these sciences cannot be profitably studied.

517. Many farmers, I dare say, will consider it beyond the reach of their means, and others beyond their station, to bestow on *their* sons so learned an education as that implied in the acquirement of the sciences enumerated. Such an idea is ill-founded; because no farmer who can afford to support his sons at home, without working for their bare subsistence, but possesses the means of giving them such an education; and no farmer, who confessedly has wealth, should grudge to give his sons an education such as will fit them to adorn the profession they are to follow.

518. It cannot be denied that mathematics and natural philosophy are sciences which tend greatly to elevate the mind. Those farmers who have acquired them must be sensible of this tendency; and they must naturally desire their sons to partake in what they themselves enjoy. Those who are not acquainted with these sciences, on being made aware of their tendency, should feel it their duty to put it in the power of their sons to raise themselves in society, and shed a lustre on their profession. The same sort of reasoning applies to a knowledge of natural history and chemistry. Neither the time nor expense of acquiring such an education should deter any farmer's son from attempting it, who desires to occupy a position above that of a farm steward; for without the education, his knowledge of farming is not superior to that of a steward. Besides these considerations, since a good education is the best legacy a parent can leave his child, it is actually better for the young farmer himself to bestow on him a superior education with part of the patrimony destined by his father to stock him a farm, than to plenish for him a larger farm, and stint his education. The larger farm would, probably, enable the half educated son to earn a livelihood more easily; but the well-educated one would be more than compensated by the possession of a cultivated intelligence, which would enable him to draw forth the capabilities of the soil, and make himself an infinitely superior member of society. Were industrious farmers as desirous to improve their sons' minds by superior education, as they too often are to amass fortunes for them, — a boon unprofitably used by uncultivated minds,—they would be regarded as wiser men. No really sensible farmer should hesitate to decide which course to take, when the intellectual improvement of his family is concerned. He should never permit considerations of mere pelf to overcome a sense of right and of duty. Rather than prevent his son raising himself in society, he should economise his own expenditure.

519. I shall show that the time occupied in acquiring these sciences is not lost when compared with the advantages they bestow. *Part of three years* will suffice; but three years are no doubt regarded as an immense time for a young man to *lose!* So it would be were it really lost; and if it be lost, the blame should be imputed to the negligence of the student. But is the young farmer's *time*, who is for years constantly following his father's footsteps over the farm, and only engaged in superintending in his father's absence, not as much *lost* as it could possibly be in acquiring a scientific education at a little distance from home? Insomuch as the young man's *time* is of use to the *farm*, the two

cases are nearly on a par; and in as far as they affect himself, there is no question that science would benefit him the more, —no question that a superior education would enable him to learn the practice of his profession with much greater ease to himself. The question of education is thus narrowed to the consideration of the cost of keeping the son at home, following his father as idly as a shadow, or of sending him to college. In a pecuniary point of view, the difference is between maintenance at home, and that in a town, with the addition of fees; and that this difference is not great, I shall now show.

520. Part of three years, as I have said, would suffice;—the first year to be devoted to mathematics, the second to natural philosophy, and the third to natural history and chemistry; and along with these principal subjects, in the first two years practical mathematics, as surveying, &c., English grammar and composition, book-keeping, and a knowledge of cash transactions. The vacations would be spent at home, and not unprofitably in revising studies.

521. The cost of acquiring all these subjects at the several colleges and academies is not insurmountable, even to the limited purse of a small farmer. In any of the towns possessing an academy, the *two* sessions of twenty months would not exceed in board a guinea a-week, and in fees twelve guineas—say £100; and the short session of six months at college, at a guinea a-week, and fifteen guineas for fees, other £45—making in all, in twenty-six months, say £150. This is a small sum compared with the advantages derived from it; and *from this falls to be deducted the cost of keeping the son at home in idleness*, which, even at ploughmen's usual wages of 10s. a-week, would amount to £54, so that his education would only cost about £100, which economy might reduce to a smaller sum; and, on the other hand, a larger should be given to make the student, if diligent, comfortable. I am quite aware it may be remarked on this subject, that it applies only to the case of one son, whereas the farmer may have more to educate and maintain. But as I am only advocating the cause of the young farmer, by desiring his elevation in society; and as only one son can succeed his father as a farmer, I hold I have made good the proposition I made.

522. Besides the sciences, the agricultural student has the opportunity in Edinburgh of attending the class of agriculture in the university, in which the professor explains the principles and describes the practice of the most approved systems of husbandry. This chair was endowed in 1790 by Sir William Pulteney, with a small salary, and placed under the joint patronage of the Judges of the Court of Session, the Senatus Academicus of the University, and the Magistrates and Town-Council of the City of Edinburgh. The first professor, elected by the patrons to this chair in 1791, was the late Dr Coventry, whose name, at one time, in connexion with the agriculture of this country, stood prominent. He occupied the chair until his death in 1831. The present Professor Low succeeded Dr Coventry. He has rekindled the dying embers of the agricultural class, by lectures suited to the improved state of British agriculture, and by forming a museum of models of agricultural implements, and portraits of live stock, of the most extensive and valuable description. The funds which attained this object, were derived from the revenues under the management of the Board of Trustees for the encouragement of Arts and Manufactures in Scotland, which was instituted by the 15th Article of the Treaty of Union between Scotland and England. Professor Low, during his incumbency, has contributed, in his several publications, much valuable matter to the agricultural literature of the country.

523. Classes for the tuition of practical chemistry exist in the University of Edinburgh under Professor Gregory, and in that of Glasgow under Dr Robert D. Thomson; and, until the end of 1848, in the laboratory of the Agricultural Chemistry Association of Scotland in Edinburgh under the care of Professor Johnston.

524. The Agricultural Chemistry Association of Scotland was established in 1843 for five years certain, and now that that period is about to expire, it will cease to exist in a separate form in November 1848;

the Highland and Agricultural Society of Scotland having undertaken, by the sanction of a special general meeting on the 12th April 1848, to conduct the chemical department of agriculture under its own direction and control.

525. During its existence, the Agricultural Chemistry Association has laboured very assidously in its vocation. It has made elaborate analyses of plants, especially of the oat and potato,—of numerous sorts of grasses—of clays—of manures—of the refuse of manufactories, and of many other substances, consisting altogether of considerably above 2000 analyses ; and all these have been ably and correctly conducted by Professor Johnston.

526. Besides undertaking the chemical department, the Highland and Agricultural Society propose to issue diplomas or degrees to young men whose aim it is to become the managers of farms and estates, and who have acquired a knowledge of practical agriculture, and have also followed such a course of education at any institution or institutions which teach the branches of science having more immediate relation to agriculture, and who have undergone a searching examination by a competent board of persons appointed for the purpose.

527. This will form a new feature, and give a fresh stimulus to the agricultural education of Scotland, and cannot fail to imbue the young agriculturists of Scotland with enlightened ideas, and elevate their character much more than any course of education they can just now pursue.

528. In enumerating the means of obtaining knowledge befitting the agricultural student, I must mention the Veterinary Colleges. Their great object is to teach the veterinary science, in which the anatomical structure of all the domesticated quadrupeds—horses, cattle, sheep, pigs, dogs, and poultry—the diseases to which they are subject, and the remedies proper to be applied for their removal, are investigated and demonstrated; in order that, by their means, enlightened practitioners of liberal education, whose whole study has been devoted to the veterinary art in all its branches, may be gradually dispersed over all the kingdom. The Veterinary College of Edinburgh had its origin in 1818, in the personal exertions of the present Professor Dick, who, after five years of unrequited labour, obtained the patronage of, and a small endowment from the Highland and Agricultural Society of Scotland in 1823. Since then his exertions and success have been equally extraordinary, not fewer than from seventy to one hundred pupils attending the college every session, of whom fully twenty every year, after two years' study of practical anatomy, pharmacy, and chemistry become candidates for diplomas to practise as veterinary surgeons. Their qualifications are judged of by examination by eminent medical and zootric practitioners. At the request of the Highland and Agricultural Society, permission has been obtained for the graduates to enter as veterinary surgeons into her Majesty's cavalry regiments, as well as those of the Honourable East India Company.

529. Some suspicious attempts have lately been made by the Veterinary College of London to obtain an uncalled-for control over the veterinary college in Edinburgh; but I hope the Highland and Agricultural Society will retain the management of their own school in their own hands. Of all institutions this college has given less cause for interference than any other; and there is no man who has elevated the character of a profession, by dint of professional ability, in so short a time and to so high a position, as Professor Dick has done that of veterinary science in Scotland. By his prelections and demonstrations, a number of young men from every quarter of the globe are annually qualified to practise the veterinary art. He is assisted by competent lecturers in chemistry, pharmacy, and the practice of physic.

530. The Veterinary College of London was instituted in 1791, according to the plan of Mr Sain Bel, who was appointed the first professor. Parliamentary grants have been afforded at times to aid this institution, when its finances rendered such assistance necessary. It is supported by subscription. Every subscriber of the sum of £21 is a member of the society for life. Subscribers of two guineas annually are members for one year, and are equally

entitled to the benefits of the institution. A subscriber has the privilege of having his horses admitted into the infirmary, to be treated, under all circumstances of disease, at 3s. 6d. per night, including keep, medicines, or operations of whatever nature that may be necessary: likewise of bringing his horses to the college for the advice of the professor *gratis*, in cases where he may prefer the treatment of them at home.*

531. In regard to attending lectures on agriculture and veterinary science, I should say, from my own experience, that more benefit will be derived from attending them after having acquired a practical knowledge of husbandry, and the treatment of live stock, than before; because most of the operations of farming cannot be understood unless described where they are performed.

532. Other means of obtaining a scientific education in connexion with agriculture exist in the kingdom. The Royal Agricultural College at Cirencester, founded in 1845, admits both in and out students on the nomination of proprietors. The college fee is £50 a-year for resident, and £30 a-year for non-resident students, and the college course extends over two years. The college is situate in the middle of a farm of 400 acres, where an improved system of tillage, consistent with the purposes of the college, is carried out. In addition to practical agriculture, the various sciences connected with it—chemistry, botany, geology, natural history, natural philosophy, surveying, &c., are taught by resident professors. A well appointed laboratory, conducted upon the Giessen system, gives every facility for chemical manipulation.

533. The Agricultural Training School for agriculture and civil engineering was established at Hoddesden, Hertfordshire, a few years ago. An extensive philosophical apparatus, library, museum, laboratory, and a farm, are attached to the school; and the charge for board, lodging, lectures, laboratory, &c., is so arranged by the committee of management as to include every expense, except for washing and books, at 25 guineas the term, the school session being divided into two terms. The course of education embraces the classics, mathematics, mechanics, physics, chemistry, botany, mineralogy, geology, practical land-surveying and levelling, drawing, book-keeping, the French and German languages, practical agriculture, and lectures on the breeds, management, and diseases of cattle.

534. Dr Daubeny holds the agricultural chair in one of the colleges of Oxford University.

535. An agricultural seminary has existed at Templemoyle, in the county of Londonderry, for some years. It originated with the members of the North-west of Ireland Farming Society, and in it the sons of farmers and tradesmen are taught agriculture. "The formation of this establishment has caused its founders an expenditure of above £4000, of which about £3000 were raised at its commencement by shares of £25 each, taken by the noblemen, gentlemen, and members of the North-west Society. The Grocers' Company of London, on whose estate it is situated, have been most liberal in their assistance, and have earned a just reward in the improvement of their property, by the valuable example the farm of Templemoyle presents to their tenantry. In sending a pupil to Templemoyle, it is necessary to have a nomination from one of the shareholders, or from a subscriber of £2 annually. The annual payment for pupils is £10, and for this trifling sum they are found in board, lodging, and washing, and are educated so as to fit them for land-stewards, directing agents, practical farmers, schoolmasters, and clerks. From fifteen to seventeen is the age best suited to entrance at Templemoyle, as three years are quite sufficient to qualify a student possessed of ordinary talents, and a knowledge of the rudiments of reading and writing, to occupy any of the above situations." †

536. On the Continent are several institutions for the instruction of young men in agriculture, among which is the far-famed one at Höfwyl, canton of Berne,

* *Beauties of England and Wales*, vol. x. part iv. p. 181.

† *Irish Farmers' Magazine*, No. 51

Switzerland, founded by the late Fellenberg. "This establishment is not intended so much for a school of agriculture, as that of education and moral discipline. All the pupils are obliged to remain nine years, at least until they attain the age of twenty-one, during which time they undergo a strict moral discipline, such as the inculcation of habits of industry, frugality, veracity, docility, and mutual kindness, by means of good example rather than precepts, and chiefly by the absence of all bad example. The pupils are divided into the higher and lower orders, among the former of whom may be found members of the richest families in Germany, Russia, and Italy. For these the course of study is divided into three periods of three years each. In the first, they study Greek, Grecian history, and the knowledge of animals, plants, and minerals; in the second, Latin, Roman history, and the geography of the Roman world; and in the third, modern languages and literature, modern history to the last century, geography, the physical sciences, and chemistry. During the whole nine years they apply themselves to mathematics, drawing, music, and gymnastic exercises. The pupils of the canton of Berne only pay 45 louis each, and do not cost their parents above 100 louis or 120 louis a-year. Strangers pay 125 louis, including board, clothing, washing, and masters.

"The pupils of the lower orders are divided into three classes, according to their age and strength. The first get a lesson of half an hour in the morning, then breakfast, and afterwards go to the farm to work. They return at noon. Dinner takes them half an hour, and after another lesson of one hour, they go again to work on the farm until six in the evening. This is their summer occupation; and in winter they plait straw for chairs, make baskets, saw logs and split them, thrash and winnow corn, grind colours, knit stockings: for all of which different sorts of labour an adequate salary is credited to each boy's class, until they are ready to leave the establishment. Such as have a turn for any of the trades in demand at Hofwyl—wheelwright, carpenter, smith, tailor, or shoemaker—are allowed to apply to them. Thus the labour of the field, their various sports, their lessons, their choral songs, and necessary rest, fill the whole circle of the twenty-four hours; and, judging from their open, cheerful, contented countenances, nothing seems wanting to their happiness. Hofwyl, in short, is a great whole, where one hundred and twenty, or one hundred and thirty pupils, more than fifty masters and professors, as many servants, and a number of day-labourers, six or eight families of artificers and tradesmen—altogether about three hundred persons—find a plentiful, and in many respects a luxurious subsistence, exclusive of education, out of a produce of one hundred and seventy* acres; and a money income of £6000 or £7000, reduced more than half by salaries, affords a very considerable surplus to lay out in additional buildings."

537. It seems that, since 1807, two convents—one in the canton of Fribourg, and the other in that of Thurgovie—have formed establishments analogous to those of M. de Fellenberg.†

538. An institution for teaching agriculture exists at Möeglin, near Frankfort on the Oder, under the direction of the celebrated M. Von Thäer. There are three professors besides himself — one for mathematics, chemistry, and geology; one for veterinary knowledge; and a third for botany, and the use of the different vegetable productions in the materia medica, as well as for entomology. Besides these, an experienced agriculturist is engaged, whose office it is to point out to the pupils the mode of applying the sciences to the practical business of husbandry —a person difficult to be found in this country. The course commences in September, the best season in my opinion for commencing the learning of agriculture. During the winter months the time is occupied in mathematics, and in summer the geometrical knowledge is practically applied to the measurement of land, timber, buildings, and other objects. Much attention is paid to the analysation of soils. There is a large botanic garden, with a museum containing models of implements of husbandry. The various implements

* This is the number of acres in the farm as stated in the *Edinburgh Review* for October 1819, No. 64; but a correspondent in Hull's *Philanthropic Repertory for* 1832, makes it 250 acres.

† Ebel, *Manuel du Voyageur en Suisse*, tome ii. p. 195.

used on the farm are made by the smiths, wheelwrights, and carpenters residing round the institution—their workshops being open to the pupils. As the sum paid by each pupil is 400 rix-dollars annually, nearly £60 sterling, and they provide their own beds and breakfasts, none but youths of good fortune can attend at Möeglin. Each has a separate apartment. They are from twenty to twenty-four years of age, generally well behaved young men; and their conduct to each other, and to the professors, is polite even to punctilio. The estate of Möeglin consists of twelve hundred English acres.

539. "A number of men distinguished for their learning, and zeal for the prosperity of France, and convinced of the utility of teaching agriculture, formed an association of the nature of a joint-stock company, with 500 shares of 1200 francs each, forming a capital of 600,000 francs (£25,000.) The first half of this sum was devoted to the advancement of superior culture, and the second half to the establishment of two schools—one for pupils who, having received a good education, wish to learn the theory and the application of agriculture, and of the various arts to which it is applicable; and the other for children without fortune, destined to become labourers, instructed as good ploughmen, gardeners, and shepherds, worthy of having confidence placed in them."* This society began its labours in 1826 by purchasing the domain of Grignon, near Versailles, in the valley of Gally, in the commune of Thiverval, and appointed manager M. Bella, a military officer who had gained much agricultural information from M. Thäer, during two years' sojourn with his corps at Celle. Grignon was bought in the name of Charles X., who attached it to his domain, and gave the society the title of the Royal Agricultural Society, for a period of forty years. The statutes of the society were approved of by royal ordinance on the 23d May 1827, and a council of administration was named from the list of shareholders, consisting of a president, two vice-presidents, a secretary, a treasurer, and directors. The domain, which occupies the bottom and the two sides of the valley, is divided into two principal parts: the one is composed of a park of 290 hectares (387 acres,) enclosed with a stone wall, containing the mansion-house and its dependencies, the piece of water, the trees, the gardens, and the land appropriated to the farm; the other, called the outer farm, is composed of 176 hectares (234 acres,) of unenclosed land, to the south of the park. The course of education at Grignon is divided into theoretical and practical — the course to continue for two years. In the first year to be taught mathematics, topography, physics, chemistry, botany and botanical physiology, veterinary science, the principles of culture, the principles of rural economy applied to the employment of capital, and the interior administration of farms. The second year to comprehend the principles of culture in the special application to the art of producing and using products; the mathematics applied to mechanics, hydraulics, and astronomy; physics and chemistry applied to the analysis of various objects; mineralogy and geology applied to agriculture; gardening, rural architecture, legislation in reference to rural properties, and the principles of health as applicable both to man and beast. There are two classes of pupils, free and internal. Any one may be admitted a free pupil that has not attained twenty years of age, and every free pupil to have a private chamber. The pupils of the interior must be at least fifteen years of age. The fee of the free pupils is 1500 francs, about £60 a-year; that of the pupils of the interior 1300 francs. They are lodged in the dormitories in box-beds; those who desire private apartments pay 300 francs more, exclusive of furniture, which is at the cost of the pupils.†

540. It appears to me, from the best consideration I have given to the manner in which agriculture is taught at all these schools, that as means of imparting practical knowledge to pupils, they are inferior to the mode usually adopted in this country, of boarding with farmers. In reference to the results of the education obtained at Möeglin, Mr Jacob says—"It appeared to

* *Rapport Général sur la ferme de Grignon*, Juin 1828, p. 3.
† *Annales de Grignon*, 3e livraison, 1830, p. 108.

me that there was an attempt to crowd too much instruction into too short a compass, for many of the pupils spend but one year in the institution; and thus only the foundation, and that a very slight one, can be laid in so short a space of time. It is however to be presumed, that the young men come here prepared with considerable previous knowledge, as they are mostly between the ages of twenty and twenty-four, and some few appeared to be still older."*

541. It seems to be a favourite notion with some writers on agriculture, that one of the best institutions in which for young men to learn farming is an experimental farm; and they go the length of recommending all the field operations and experiments to be conducted by the pupils. They are nearly unanimous in conceiving that 200 acres, or less, would be a large enough extent for an experimental farm; and that on such a farm 100 pupils could be trained to become farmers, stewards, and ploughmen. A very slight acquaintance with an experimental farm will serve to show how unsuitable a place it is for *learning* farming. The sole object of an experimental farm is, to become acquainted with the best properties of plants and animals by *experiment*, and to ascertain whether or not those objects are worthy of being introduced into an ordinary farm. It is, therefore, obviously needless to follow the *ordinary modes* of cultivating the ordinary plants, and of rearing the ordinary animals on an experimental farm. Either *new* plants, and *other* modes than the ordinary ones, should be tried on an experimental farm, or, if ordinary modes are adopted, it is no *experimental* farm at all. In witnessing new or unusual modes of culture, the pupil would learn nothing of *ordinary farming*. Extraordinary modes of cultivation, which are necessarily attended with the risk of failure, only serve to impress the mind of a *pupil* with experimental schemes, instead of instructing him with the most approved mode of cultivation. To confound the mind of a beginner thus, would do it a lasting injury. Were a pupil, trained on an ordinary farm, to have opportunities of witnessing varieties of experiments on an experimental one, he might benefit by the numerous hints and suggestions he would receive; and, on the other hand, were an experimental farm wrought by inexperienced pupils it would be injured. So far from *pupils* being able to conduct experiments, the most experienced cultivators are baffled by unforeseen difficulties; and were it known that the experiments on such a farm were conducted by pupils, their results would inspire no confidence in farmers.

542. *Model farms.*—Model farms have been recommended to be established with a view to promote the teaching of practical agriculture. I do not comprehend what such a model farm is—for a farm which is laboured by pupils can show a model of farming to no one; and any farming practised by a body of men having the management of a school, will be greatly eclipsed by that of many a single farmer, and it, therefore, in justice to farmers, cannot be recommended as a model. Schools established for teaching agriculture to young men, or boys and girls, should have attached to them what may be termed *instructive*, not *model* farms. There is much meaning in an appropriate name. *Thorough* draining, for example, indicates any system of draining which renders the land *thoroughly* dry in all circumstances; whereas the term furrow, frequent, parallel, shallow, or deep draining, though intended to convey the same idea, only conveys the idea of the specific mode of draining implied in the term.

ON THE EVILS ATTENDING THE NEGLECT OF LANDOWNERS AND OTHERS TO LEARN PRACTICAL AGRICULTURE.

543. There would be no want of pupils of the highest class for such institutions as we have been considering, did landowners learn practical agriculture. The usual succession of young farmers to fill the places of those who retire, would afford the largest proportion of the pupils; but were every son of a landowner, who has the prospect of being an owner himself, to become an agricultural pupil, the number of pupils would not only be increased, but

* Jacob's *Travels in Germany*, &c. p. 185.

the character of landowners as agriculturists would be much elevated.

544. The expectant landlord should undergo tuition in his profession as well as the youth of any other. But instead of the farm-field, the camp and the bar seem to be the favourite arenas for the young scions of the gentry to pursue their youthful career. These are highly honourable professions, and conduce to form the character of the gentleman, but are seldom followed out by the young squire. The moment he obtains the command of a company, or walks the Parliament House for a session or two, he quits the public service, and assumes the fashion of an incipient country gentleman. In rural life he becomes enamoured of field sports; but should these prove too rough for his taste, he leaves the country—travels abroad, peradventure in search of sights—and returns home with new ideas of men and manners. Now, this course of life is quite unexceptionable in itself, but in pursuing it to the neglect of the most important part of *his* duty,—that of learning to become a good and efficient landlord—it is reprehensible.

545. Even though he devote himself to the profession of arms or the law, and thereby confer distinction on himself, if he prefer either to the neglect of agriculture, he is rendering himself unfit to undertake the duties of a landlord. To become a soldier or a lawyer, he willingly undergoes initiatory drillings and examinations; but to acquire the duties of a landlord before he becomes one, he considers quite unnecessary to undergo initiatory tuition. These, he conceives, can be learned at any time, and seems to forget that the conducting of a landed estate is a profession, as difficult of thorough attainment as ordinary soldiership or legal lore. The army is an excellent school for confirming in the young, principles of honour and habits of discipline; and the bar for giving a clear insight into the principles upon which the rights of property are based, and of the relation betwixt landlord and tenant; but a knowledge of practical agriculture is a weightier matter than either for a landlord, and should not be neglected.

546. One evil arising from studying those exciting professions before agriculture is, that however short may have been the time in acquiring them, it is sufficiently long to create a distaste to learn agriculture afterwards practically—for such a task can only be undertaken, after the turn of life, by enthusiastic minds. But as farming is necessarily *the profession* of the landowner, it should be learned, theoretically and practically, before his education is finished. If he so incline, he can afterwards enter the army or go to the bar, and the exercise of those professions will not efface the knowledge of agriculture previously acquired. This is the proper course, in my opinion, for every young man destined to become a landowner to pursue, and who is desirous of finding employment as long as he has not to exercise the functions of a landlord. Were this course invariably pursued, the numerous engaging ties of a country life would tend in many to extinguish the kindling desire for any other profession. Such a result would be most advantageous for the country; for only consider the effects of the course pursued at present by landowners. It strikes every one as an incongruity for a country gentleman to be unacquainted with country affairs. Is it not strange that he should require inducements to learn his hereditary profession,—to become familiar with the only business which can enable him to enhance the value of his estate, and increase his income? Does it not infer infatuation to neglect becoming well acquainted with the condition of his tenants, by whose exertions his income is raised, and by which knowledge he might confer happiness on many families, and in ignorance of which he may entail lasting misery on many more? It is in this way too many country gentlemen neglect their moral obligations.

547. It is a manifest inconvenience to country gentlemen, when taking a prominent part in county matters without a competent knowledge of agriculture, to be obliged to apologise for not having sufficiently attended to agricultural affairs. Such an avowal is certainly candid, but is any thing but creditable to those who have to make it. When elected members of the legislature, it is deplorable to find so many of them so little acquainted with the questions which bear

directly or indirectly on agriculture. On these accounts, the tenantry are left to fight their own battles on public questions. Were landowners practically acquainted with agriculture, such painful avowals would be unnecessary, and a familiar acquaintance with agriculture would enable the man of cultivated mind at once to perceive its practical bearing on most public questions.

548. A still greater evil, because less personal, arises on consigning the management of valuable estates to the care of men as little acquainted as the landowners themselves with practical agriculture. A factor or agent, in that condition, always affects much zeal for the interest of his employer. Fired by it, and possessing no knowledge to form a sound judgment, he soon discovers something he considers wrong among the poorer tenants. Some rent perhaps is in arrear—the strict terms of the lease have been deviated from—the condition of the tenant seems declining. These are favourable symptoms for a successful contention with him. Instead of interpreting the terms of the lease in a generous spirit, the factor hints that the rent would be better secured through another tenant. Explanation of circumstances affecting the actual condition of the farm, over which he has, perhaps, no control,—the inapplicability, perhaps, of peculiar covenants in the lease to the particular circumstances of the farm—the lease having perhaps been drawn up by a person ignorant of agriculture,—are excuses unavailingly offered to a factor confessedly unacquainted with country affairs, and the result ensues in disputes betwixt him and the tenant. To explanations, the landlord is *unwilling* to listen, in order to preserve intact the authority of the factor; or, what is still worse, is *unable* to interfere, because of his own inability to judge of the actual state of the case betwixt himself and the tenant, and, of course, the disputes are left to be settled by the originator of them. Thus commence actions at law,—criminations and recriminations,—much alienation of feeling; and at length a proposal for the settlement of matters, at first perhaps unimportant, by the arbitration of practical men. The tenant is glad to submit to an arbitration to save his money; and in all such disputes, being the weaker party, he suffers most in purse and character. The landlord, who ought to have been the protector, is thus converted into the unconscious oppressor of his tenant.

549. A factor acquainted with practical agriculture would conduct himself very differently in the same circumstances. He would endeavour to prevent legitimate differences of opinion on points of management from terminating in disputes, by skilful investigation and well-timed compromise. He would study to uphold the honour of both landlord and tenant. He would at once see whether the terms of the lease were strictly applicable to the circumstances of the farm, and judging accordingly, would check improper deviations from proper covenants, whilst he would make allowances for inappropriate ones. He would soon discover whether the condition of the tenant was caused more by his own mismanagement than by the nature of the farm he occupies, and he would conform his conduct towards him accordingly—encouraging industry and skill, admonishing indolence, and amending the objectionable circumstances of the farm. Such a factor is always highly respected, and his opinion and judgment entirely confided in by the tenantry. Mutual kindliness of intercourse, therefore, always subsists betwixt such factors and the tenants. No landlord, whether acquainted or unacquainted with farming, especially in the latter case, should confide the management of his estate to any person less qualified.

550. Another evil affecting the landed proprietor's own comfort and interest, may arise in the selection of a steward or grieve for conducting the home-farm. In all cases it is necessary, for personal comfort and convenience, for a landowner to have a home-farm, and a steward to conduct it. But the steward of a squire acquainted, and of one unacquainted with farming, is placed in very dissimilar circumstances. The former, enjoying good wages, and holding a respectable and responsible situation, *will* conduct himself as an honest and skilful manager, as he knows he is overlooked by one who can criticise his management practically: the latter must necessarily have, and will soon take care to have, every thing his own way; and will soon

become haughty to the labourers, regarding himself as their master, and will act towards them as if he dispensed their wages from his own cash. Thus advancing in authority step by step, finding the most implicit reliance placed in him by his master, and regarding his own services indispensable, the temptations of office prove too powerful for his virtue—he aggrandises himself by peculation, and conceals his mal-practices by deception. At length both are detected by, perhaps, some trivial event, the unimportance of which had escaped his watchfulness. Loss of character and loss of place then overtake him at the same time, and his master ever afterwards suspects every one who fills the situation. I could specify instances of both factor and steward, whose mismanagement has come under my own observation; but it should be borne in mind that both species of pests are engendered from the same cause,—the ignorance of landowners in country affairs.

551. An injurious effect is produced by absenteeism. When farming possesses no charms to the country gentleman, and field-sports become irksome by monotonous repetition, his desire for a country life diminishes, and, to escape from it, undergoes voluntary banishment. Were lukewarm landowners, when they go abroad, always to confide the management of their estates to experienced factors, their absence would have little bad effect on the tenants, who would go on with the cultivation of their farms with more zest under a sensible factor, than a landlord who contemns agriculture. But doubtless they farm with much greater *confidence* under a landlord acquainted with farming, who remains always at home, than under the most unexceptionable factor. The disadvantages of absenteeism are chiefly felt by day-labourers, tradesmen, and shopkeepers in villages and small country towns.

552. Now, every one of these evils, and many more I have not alluded to, would be averted, if landowners would make it a point to acquire a knowledge of practical agriculture. This should be done in youth, when it ought to be studied as a *necessary* branch of education, and learned as the most *useful* business country gentlemen can acquire. It would qualify them to appoint competent factors,—to determine the terms of the lease best suited to the nature of each farm, and to select the fittest tenant for each; and such qualifications would ensure landlords their tenants' confidence, which would support them in cultivating their farms in the best manner; and without which no estate, in otherwise the most favourable circumstances, will ever be cultivated with spirit. It would enable them to judge whether the onerous and multifarious duties of a factor are properly fulfilled, and to converse freely, in even technical phraseology, with their tenants on every particular of practice, to criticise work, and to predicate the probability of success or failure of any proposed course of culture. The approbation or disapprobation of such landlords operates beneficially on tenants. How many useful hints may not a landlord suggest to his tenants on skilfulness, economy, and neatness of work; and how many salutary precepts may he not inculcate to cottagers, on the necessity of parental discipline and domestic cleanliness! The amount of good which the direct moral influence of such a landlord effects among the tenantry can scarcely be over-estimated; it is certain to secure respect, and create regard. His good opinion will go much farther in inducing tenants to maintain their farms in the highest order, and in cherishing a desire to remain upon them, than that of the most judicious factor. Were all landlords so qualified, they could command the services of superior factors and skilful tenants. They would find there is not a more pleasing, rational, and interesting study than practical agriculture; and would soon desire to follow every minute portion of every operation to its ultimate results. In practising every minutia, they would find their estates, every year, presenting a fresher and fairer aspect, by the removal of objects that offend the eye or taste, and the introduction of others that afford shelter, produce abundance, and contribute to the beauty of the landscape around. Nor would such rural pursuits interfere with the exercise of manly field-sports, in which it is the pride and boast of our country gentlemen to excel, especially as hunting is prosecuted with the greatest ardour in the season in which field operations are

least practised, and the crops can sustain the least injury.

553. Agricultural shows afford excellent opportunities for landlords and tenants to meet together. They are the most interesting and the most social meetings held in the country; and are now conducted on such well regulated principles, that, in the mixing of all ranks of persons, the respect due to high station is never lost sight of.

554. A personal acquaintance with tenants of all classes presents landlords a wide field for the observation of human nature under different aspects. Landowners who couple the facts thus derived with their own experience of practical agriculture, possess favourable opportunities of collecting a store of truths, ever ready to supply them with the strongest arguments and the best illustrations, in every department of rural economy, and which, when put to the right use, cause their sentiments to command attention in every public assembly in which they choose to give them utterance.

555. It appears extraordinary to those who have experienced difficulty in acquiring a competent knowledge of country affairs, to observe landowners, who have spent their lives in learning every thing else, coolly undertaking to perform all the functions of country gentlemen, without previous preparation. They are entitled, it is true, to the privilege by hereditary birth; but what would be thought of a subaltern who presumed to command an army, or a student of law, to conduct an important cause before the highest tribunal? To command an army, or to plead a great cause, perhaps requires a higher degree of intellect than to perform the functions of a country gentleman in the most perfect manner. Yet, taking the most from this admission, it cannot be maintained that the duties of landownership may be acquired by intuition, anymore than commanding or pleading. No doubt, incomes may be enjoyed without a knowledge of agriculture; but surely the privileges of landownership were bestowed by law for far higher purposes than merely expending an income. Surely they were granted on the condition of performing certain onerous duties. Of those, therefore, who reside on their estates—profess to exercise a hereditary and paternal superintendence over them,—claim a seat on the magisterial bench,—take a share in all public affairs connected with agriculture, in and out of the legislature,—it cannot be unreasonable to expect them to be qualified for the character they have assumed, by possessing a knowledge of agriculture.

556. There is another class of persons connected with agriculture who should become practically acquainted with it ere they embark in it with an outlay of capital. I allude especially to emigrants to our colonies, in Canada and Australia. The plea not unfrequently urged by such persons, of having plenty of time to learn farming in the colony, with the old settlers, or abundance of cash to purchase the services of experienced men in colonial agriculture, is one befitting only the thoughtless and procrastinating; nor should the somewhat correct assumption, that the agriculture of the old country is not exactly suited to the colonies, serve as an excuse; because, however differently field operations may be performed there and here, the nature of land, of vegetables, and of animals, is the same in every country; and if these particulars are well understood here, there is little doubt but the knowledge may be applied with advantage in the colonies. Such are only plausible excuses; for though colonial farming may be learnt from old and experienced settlers, it should be borne in mind, that few young emigrants will have the patience to remain with settlers to acquire a competent knowledge of farming, when they conceive that they themselves may be enjoying the advantages they witness; and besides, should they so determine to learn farming, they cannot take out farm-servants and implements of husbandry with them,—a plan well-suited to emigrants who take capital to the colonies.

557. But colonial agriculture, in the temperate zones, differs little from our own. Wherever the *same kinds of crops* are raised, the *same practice* must be adopted; and wherever the *same sorts of stock* are reared for the *same purposes*, the *same mode* of treatment must be pur-

Stackyard
Gangway
Poultry House
Shed
Corn Barn
Work horse Stable
Riding Stable
Cow
Byre
Calves House
Turnip store
Store
Court for Young Cattle
Straw
Barn
Court for Yearlings
Horse hold
Turnip store
Out house
Shed
Servants Cow Byre
Hammels for Bulls
Boiling House
Court for Pigs
Liquid manure tank
Shed for composts

sued. Superior fertility of soil, amenity of climate, nourishment in the food of animals, but slightly affect principles, and only modify practice. Want of efficient beasts of labour and implements may at first induce settlers to try extraordinary expedients to accomplish their end, but as those means improve, and the ground is brought into tillage, the peculiar colonial practices will gradually yield to the more matured ones of the old country. Eventually the colonies will, most probably, exhibit splendid examples of British agriculture, under the fostering encouragement of a fine climate. The sooner they attain that perfection, the sooner will the prosperity of the settlers be secured; and nothing will delay that consummation so effectually as emigrants quitting this country in breathless haste, in total ignorance of husbandry.

558. Let *every* intending settler, therefore, *learn agriculture thoroughly* before he emigrates; and, if it suits his taste, time, and arrangements, let him study in the colony the necessarily imperfect system pursued by the settlers, before he embarks in it himself; and the fuller knowledge acquired here, will enable him not only to understand the colonial scheme in a short time, but to select the part of the country best suited to his purpose. But, in truth, he has much higher motives for learning agriculture here; for a thorough acquaintance will enable him to make the best use of inadequate means,—to know to apply cheap animal instead of dear manual labour,—to suit the crop to the soil, and the labour to the weather;—to construct appropriate dwellings for himself and family, live stock, and provisions;—to superintend every kind of work, and to show a familiar acquaintance with them all. These are qualifications which every emigrant may acquire here, but not in the colonies without a large sacrifice of time—and time to a settler thus spent, is equal to a sacrifice of capital, whilst eminent qualifications are equivalent to capital itself. This statement may be stigmatised by agricultural settlers who may have succeeded in amassing fortunes without more knowledge of agriculture than what was picked up by degrees on the spot; but such persons are incompetent judges of a statement like this, never having become properly acquainted with agriculture; and however successful their exertions may have proved, they might have realised larger incomes in the time, or as large in a shorter time, had they brought an intimate acquaintance of the most perfect system of husbandry known, to bear upon the favourable position they occupied.

ON OBSERVING THE DETAILS, AND RECORDING THE FACTS, OF FARMING BY THE AGRICULTURAL STUDENT.

559. The only object I have in view in entering into all these particulars, is the preparation of the mind of the agricultural student, to enable him, when he becomes a pupil on a farm, to anticipate what would appear to him insuperable difficulties in farming operations, and which, with an unprepared mind, he could not know existed at all, far less to overcome; but on being thus informed of them at the very outset of his career, he might employ himself in meeting and overcoming them. The difficulties I have alluded to, arise from the pupil not understanding the import of any farm operation, because he always sees it in an incomplete state, and unconnected with the operations of a future period, of which it for the present constitutes only a progressive operation. The only way for the pupil to satisfy his mind is to ascertain by inquiry the *ultimate* purport of every operation he sees performing; and although he may not easily comprehend what he does not see, still the information will *warn* him of a result which, on that account, will not take him by surprise when it actually arrives. I see no better mode of rendering all farming operations intelligible to his mind.

560. Believing that the foregoing observations are competent to give such a direction to the mind of the pupil, as, when he goes to a farm, he will appreciate the importance of his profession, and feel an earnest desire for its attainment, I shall proceed to describe the details of every farm operation as it should come in course through the year. The details, being multifarious, and somewhat intricate to describe, will occupy the largest portion of this work, and constitute the most valuable and interesting one to the pupil.

In the descriptions, I have resolved to go very minutely into detail, that no particular may be omitted in any operation, to give it the appearance of an imperfect work. The resolution may render the descriptions so prolix, as to fatigue the general reader, but, on that very account, these ought to determine the pupil to follow them into their most minute particulars; and to appreciate the value of a series of detailed instructions, which will give him such an insight into the nature of field labour, as will ever after enable him easily to recognise similar work whenever and wherever begun to be executed. Unless, however, he bestow considerable attention on *all* the *details* of the descriptions, he will be apt to pass what may appear to him an unimportant particular, but which may form the very keystone of the whole operation to which it relates. With a tolerable memory, I feel pretty sure that an *attentive perusal of the descriptions* will enable the pupil to identify every piece of work he may afterwards see performing in the field. This result is as much as any book on agriculture can be expected to accomplish.

561. Constant attention to the minutiæ of labour evinces in the pupil an acuteness to perceive the quickest mode of acquiring his profession. He will soon perceive that the larger pieces of work are easily undertaken by the ordinary work-people; but the minuter ones are *best* adjusted by the master or steward. The difference arises from the larger operations being left in a coarse state, when the smaller do not follow and finish them neatly. There are many minor operations, unconnected with the greater, which require the greatest skill to perform; and which are so arranged as to be performed with neatness and despatch. Many of these are frequently performed concurrently with the larger operations; and to avoid confusion both should harmonise. Many of the minuter operations are confined to the tending of live-stock, and the various works performed about the farmstead. Attention to minutiæ, constituting the chief difference between the neat and careless farmer, it is necessary that I bestow due consideration on them. They form a particular which has been too much overlooked by systematic writers on agriculture.

562. In describing the details of farming, it is necessary to adhere to a determinate method; and the method which appears to me most instructive to the pupil is, to follow the usual routine of operations as performed on a farm. To follow that routine implicitly, it will be necessary to describe every operation from the *beginning;* and it should be remembered by the pupil that farm operations are not conducted at random, but on a tried and approved system, which commences with preparatory labours, and then carries them on, with a determinate object in view, throughout the seasons, until they terminate at the end of the agricultural year. The preparatory operations commence immediately after harvest, whenever that may happen, and it will be earlier or later in the year, according as the season is early or late; and as the harvest is the consummation of the labours of the year, and terminates the autumnal season, so the preparatory operations commence the winter season. Thus the winter season takes the precedence in the arrangements of farming, and, doing so, should be the period for the pupil to begin his career as an agriculturist. He will then have the advantage of witnessing every *preparation as it is made* for each crop,—an advantage he cannot enjoy if he enter at any other season,—and it is a great advantage, inasmuch as every piece of work is much better understood when viewed from its commencement, than when seen for the first time in a state of progression.

563. Let me inform the pupil regarding the *length* of the agricultural seasons. In the year of the calendar, each season extends over a period of three calendar months; so that every season is of the same length. The seasons of the agricultural year, though bearing the same names as those of the calendar, vary in length every year according to the state of the weather. The agricultural seasons are thus characterised: The spring revives the dormant powers of vegetables; the summer enlarges their growth; the autumn develops their reproduction; and the winter returns them to the state of dormancy. In the calendar these characteristics are assumed to last three months each, but in the agricultural year they extend as long

as each season continues to exhibit its function. The spring, for example, may be contracted within its three months, either by the protraction of winter on the one hand, or the earliness of summer on the other, or by both combined; a case in which results both a late and short spring, —a state of season which creates very bustling spring work to the farmer. And so with the other seasons. It is this elasticity of the agricultural seasons which contradistinguishes them from those of the calendar. The commencement, continuance, and termination of field-work being thus dependent on the seasons of the agricultural year, and the seasons, in their turn, being dependent upon the weather, it follows that all field operations are dependent upon the weather, and not upon such conventional terms as the seasons of the calendar. But whether an agricultural season be long or short, the work that properly belongs to it *must* be finished in it. If it be of sufficient length, the work is well finished, but if not, the crop runs the risk of failure. If it be shortened by the preceding season encroaching upon it, its work should have been advanced in the prolonged season; and should it be curtailed by the earliness of the succeeding one, and the weather improve, as in the case of summer appearing before its time, no apprehension need be entertained of finishing the work in a satisfactory manner; but if the weather become worse, as in the premature approach of winter upon autumn, extraordinary exertions are required to avert the disastrous consequences of winter weather upon the crops. The unusual protraction of a season is attended with no risk to its work, but may be to a crop; and during a protracted season, much time is often wasted in waiting for the arrival of the succeeding one, in which the particular work in hand is most properly finished; but in a contracted season, a great part of the work, though attended with much labour, is hurriedly gone through, and even slovenly performed. The most perfect field-work is performed when the seasons are each of proper duration.

564. The entire business of a farm necessarily occupies a year; which embraces sometimes more, and sometimes less, than twelve months. The agricultural year, both in its commencement and termination, not corresponding with that of the calendar, its length is determined by the duration of the life of the cultivated vegetables which constitute the chief product of the farm. In the temperate zones, vegetable life becomes dormant, or extinct, according as the vegetable is perennial or annual, at the beginning of winter; and when the dormant state of vegetation occurs again, the labours of the field have gone their annual revolution. The same kind of work is performed year after year upon the same kind of farm.

565. Two modes of describing farm-business may be adopted. One, to arrange it under different heads, and describe all similar operations under the same head, as has hitherto been done in systematic works on agriculture. The other is to describe the operations as they *actually occur, singly, and in succession*, on the farm; as is to be done in this work. Both methods describe the general farm operations, and may be consulted for any particular work. But the relative position any particular work stands in regard to, and influences every other, can only be shown by the latter method, and it does so at a glance; and as one farm-work commences and another terminates at different periods of the year, the latter method only can clearly indicate the period in which every particular work commences, is continued, or terminated, and give the details of it minutely.

566. The agricultural year, like the common, is conveniently divided under the four seasons, and the entire farm business is also conveniently divided into four parts, each bearing the name of the season that influences the operations performed in it. It is by such an arrangement only that every operation, whether requiring longer or shorter time for completion, is described as it takes its turn in the fields. The work that occupies only a short time to finish, in any of the seasons, may be described in a single narrative. Very few of the operations, however, are completed in one of the seasons, some extending over the whole four, and most into two or three. Any work that extends over most of the seasons, can nevertheless be described with accuracy; for although it may occupy a long time to reach its completion, every

season imposes its peculiar work, and terminates it so far; and these cessations of labour are not mere conveniences, but necessary and temporary finishings of work, which would be improperly resumed but at the appropriate season. In this way the extensive works are advanced, in progressive steps, season after season, until their completion; while the smaller ones are concurrently brought onwards and completed in their proper season.

567. Besides observing the details of farm work, the pupil should observe every phenomenon that occurs within the field of his observation. Creation, both animate and inanimate, lies before him, and, being necessarily much out of doors, observation becomes a subject of interest to him rather than otherwise. It is at all times useful to observe facts, and become familiarised with those more immediately connected with his profession; and the relation I have so largely traced as existing between agriculture and the sciences, may show the immense extent of the field of observation in which the student may occupy himself. Nor let him suppose that any fact is too trivial for observation, as the minutest may form a connecting link between greater ones, which may exhibit no relationship to one another, but through the minute one. In course of time, observation will enable him to discriminate between phenomena that influence one another, and that stand in isolation; and the discrimination will only be learned in time, for every fact will appear to him at first as alike valuable and valueless.

568. It should be kept in remembrance that it is no easy matter to observe phenomena with accuracy. There is a tide in their existence, as in the affairs of men, which, when taken at the proper time, may lead to sound conviction; but if not, to erroneous deduction. How many systems of belief have arisen from improper observation! With some persons, if observation confirm not preconceived notions, the phenomenon is neglected or perverted; but the agricultural student should have no prejudiced notions, and regard every occurrence with calmness, and a determination to arrive at the truth. It is only in such a state of mind he can hope to make the results of actual observation in the field subservient to acquiring a practical knowledge of agriculture.

569. The facts to which he should first direct his attention, are the *effects of the weather for the time* on the operations of the fields and their products, and on the condition of the live stock. He should notice every remarkable occurrence of heat or cold, rain or drought, unpleasant or agreeable feeling in the air; the effects following any peculiar state of the clouds, or other meteors in the air—as storms, aurora-borealis, haloes, and the like; the particular effect of rain or drought, heat or cold, in retarding or materially altering the labours of the field, and the length of time and quantity of rain required to produce such an effect; as well as the influence of these on the health or growth of plants, and the comfort and condition of animals.

570. He should mark the *time* each kind of crop is committed to the ground—how long it takes to appear above it, when it comes into ear, and the period of harvest: also try to ascertain the quantity of every kind of crop on the ground before it is cut down, and observe whether the event corroborates previous judgment: estimate the weight of cattle by the eye at different periods of their growth, and check the trials by measurements; the handling of the beasts for this purpose will convey much information regarding their progressive state of improvement: attend to sheep when slaughtered, weigh the carcass, and endeavour to discover the sources of error committed in estimating their weights.

571. He should keep a *register* of each field of the farm: note the quantity of labour it has received, the quantity of manure applied, the kind of crop sown, with the circumstances attending these operations—whether done quickly and in good style, or interruptedly, from the hinderance of weather or other circumstances. He should ascertain in each field the number of ridges required to make an acre, and whether the ridges be of equal length or not. By this he will the more easily ascertain how much dung the field receives per acre, the time taken to perform the same quantity of work on ridges of different length, and the comparative value of the

crop produced on an acre in different parts of the field. The subdivision of the field into acres will enable a comparison to be made of the relative values of the crops produced on varieties of soil in the same field, under the same treatment.

572. The easiest way of preserving facts is in the *tabular form*, which admits of every one being put down under its proper head. A table not only exhibits all the facts at a glance, but records every one with the least trouble in writing. The advantage of *writing* them down is to impress them more strongly on the memory. The tables should consist of ruled columns, in a book of sufficient size of leaf to contain columns for every subject.

573. There should be a *plan of the farm*, with every field, having its figure, dimensions, name, and direction of the ridges, with the number of ridges required to make an acre marked upon it.

574. There should be a *plan of the stack-yard* made every year, with each stack represented by a circle, the area of which should contain the name of the field upon which the crop was grown, the quantity of corn yielded by the stack, how the produce was disposed of, and the cash (if any) which the produce realised.

575. To render the whole system of recording facts complete, a summary of the weather, together with the produce and value of the crop and stock, should be made every year to the end of autumn,—the end of the agricultural year. In all these ways a mass of useful facts would be recorded within the narrow compass of a single book; comparisons could be made between the results of different seasons; and deductions drawn which could not be ascertained by any other means.

576. The only objection that can possibly be urged against this plan, is the time required to record the facts. Were the records to be made twice or thrice a-day, like the observations of a meteorological register, the objection might be well-founded; for it is irksome to be obliged to note down frequently dry and (in themselves) unmeaning details. But the changes of the weather possess a very different interest when they are known to influence the growth of the crops. The records of such, however, are only required occasionally at, perhaps, an interval of days. The only toil would be the drawing up of the abstract of the year; but, when the task is for permanent benefit, the time devoted to it should be cheerfully bestowed.

577. These preliminary remarks I trust will enable the agricultural student to follow the details of farming, as they usually occur, and the kind of farming I shall select as the most perfect system of husbandry known, is the mixed, (53;) whilst, at the same time, I shall make him acquainted with the differences in the corresponding operations in the other modes of farming, adopted on account of peculiarities in the localities in which they are practised. Narrating the operations in the order they are performed, I shall begin with Winter, and proceed in the natural order through Spring, Summer, and Autumn, until we reach the winter season again.

PRACTICE.

WINTER.

SUMMARY OF THE WEATHER, AND FIELD-OPERATIONS IN WINTER.

578. The subjects which court attention in winter are of the most interesting description to the farmer. Finding little inducement to spend much time in the fields at this torpid season of the year, he directs his attention to the more animated work conducted in the steading, where all the cattle and horses are collected, and the preparation of the grain for market affords pleasant employment within doors. The progress of live-stock to maturity is always a prominent object of the farmer's solicitude, and especially so in winter, when they are comfortably housed in the farmstead, plentifully supplied with wholesome food, and so arranged in various classes, according to age and sex, as to be easily inspected at any time.

579. The labours of the field in winter are confined to a few great operations. These are ploughing the soil in preparation of future crops, and supplying food to the live stock. The ploughing partly consists of turning over the ground which had borne a part of the grain crops, and the method of ploughing this *stubble* land—so called because it bears the straw left uncut of the previous crop—is determined by the nature of the soil. That part of the stubble land which was first ploughed is first brought into crop in spring, and the rest is ploughed in succession as the different crops follow each other in the ensuing seasons.

580. The whole land thus ploughed in the early part of winter in each field, where the farm is subdivided into fields, or in each division where are no fences, is then provided with channels, cut with the spade, in places that permit the water that falls from the heavens to run most quickly off into the ditches, and to maintain the soil in a dry state until spring.

581. Towards the latter part of winter, the newest grass land, or *lea*, as grass land is generally termed, intended to bear a crop in spring is then ploughed; the oldest grass land being earliest ploughed, that its toughness may have time to be meliorated before spring by exposure to the atmosphere.

582. When the soil is naturally damp underneath, winter is selected for removing the damp by draining. It is questioned by some farmers whether winter is the best season for draining, as the usually rainy and otherwise unsettled state of the weather renders the carriage of the requisite materials on the land too laborious. By others, it is maintained that, as the quantity of water to be drained from the soil, determines both the number and size of the drains, these are best ascertained in winter; and as the fields are then entirely free of crop, that season is the most convenient for draining. Truth may perhaps be found not to acquiesce in either of these reasons, but rather in the opinion that draining may be successfully pursued at all seasons.

583. Where fields are unenclosed, and are to be fenced with the thorn-hedge, winter is the season for commencing the planting of it. Hard frost, a fall of snow, or heavy rain, may put a stop to the work for a time, but in all other states of the weather it may be proceeded with in safety.

584. When water-meadows exist on a farm, winter is the season for carrying on the irrigation with water, that the grass may be ready to be mown in the early part of the ensuing summer. It is a fact worth keeping in remembrance as to *winter* irrigation, that it produces wholesome, while summer irrigation produces unwholesome, herbage for stock. On the

other hand, summer is the most proper season for forming water-meadows.

585. Almost the entire live stock of an arable farm is dependent on the hand of man for food in winter. Thus bringing the stock into the immediate presence of their owner, they excite a stronger interest than at any other season. The farmer then classifies them in the farmstead by their age and sex, and observes their comparative progress towards maturity. He desires to see them provided with a comfortable bed and sufficient clean food, at appointed hours, in their respective apartments.

586. The feeding of stock is so important a branch of farm business in winter, that *it* regulates the time for prosecuting several other operations. It determines the quantity of turnips that should be carried from the field in a given time, and causes the farmer to consider whether it would not be prudent to take advantage of the first few dry fresh days to store up a quantity of them to be in reserve for the use of the stock during the storm that may be portending.

587. It also determines the quantity of straw that should be provided from the stack-yard for the use of the animals ; and upon this, again, depends the quantity of grain that may be sent to the market in any given time. For, although it is certainly in the farmer's power to thrash as many stacks as he pleases at one time—provided the machinery for the purpose is competent for the task—and he may be tempted to do so when prices are high ; yet as new thrashed straw is superior to old, both as litter and fodder, its thrashing depends mainly on the use made of it by stock ; and as its use as litter is greater in wet than in dry weather, and wet weather prevails in winter, the quantity used in that season is most considerable ; and so must be the grain sent to market. All the cattle in the farmstead in winter are placed under the care of the *cattle-man*.

588. The feeding of sheep on turnips, in the field, is practised in winter ; and it forms fully a more interesting object to the farmer than the feeding of cattle, inasmuch as the behaviour of sheep, under every circumstance, is always attractive. When put on turnips early in winter, sheep consuming only a proportion of the crop, a favourable opportunity is afforded to store the remaining portion for the cattle, in case of an emergency in the weather, such as rain, snow, or frost. The turnips to be used by the cattle determine the quantity that should be taken from the field.

589. The ewes roaming at large over the pastures require attention in winter, especially in frosty weather, or when snow is on the ground, when they should be supplied with clover-hay, or with turnips when the former is not abundant. The *shepherd* is the person who has the charge of the sheep flock.

590. The preparation of grain for sale is an important branch of winter farm business, and should be strictly superintended. A considerable proportion of the labour of horses and men is occupied in carrying the grain to the market-town, and delivering it to the purchasers, — a species of work which jades farm-horses very much in bad weather ; but the railway now presents itself to the assistance of the horse in this laborious work.

591. In hard frost, when the plough is laid to rest, or the ground is covered with snow, and as soon as

> ——— by frequent hoof and wheel, the roads
> A beaten path afford,

the farm-yard manure is carried from the courts, and placed in large heaps on convenient spots near the gate of the fields which are to be manured in the ensuing spring or summer. This work is continued as long as there is manure to carry away, or the weather proves severe.

592. Of the implements of husbandry, only a few are used in winter ; — the plough is constantly so when the weather will permit,—the thrashing-machine enjoys no sinecure,—and the cart finds frequent and periodic employment.

593. The winter is the season for *visiting the market town* regularly, where the surplus produce of the farm is disposed of, —articles purchased or bespoke for the use

of the farm, when the busy seasons arrive,—where intermixture with the world affords the farmer an insight into the actions of mankind,—and where he sees selfishness and cupidity heighten as a foil the brilliancy of honest dealing.

594. *Field sports* have their full sway in winter, when the fields, bared of crop and stock, sustain little injury by being traversed. Although farmers bestow but a small portion of their time on field sports,—and many have no inclination for them at all,—they should harmlessly enjoy the recreation at times. When duly qualified, why should not farmers join in a run with the fox-hounds?—or take a cast over the fields with a pointer?—or sound a whoop with the greyhounds? Either sport forms a pleasing contrast to the week's business, gives a fillip to the mind, and a stimulus to the circulation. The dweller in the country, possessing leisure and a good nag, who can remain insensible to the "joys of a tally-ho," must have a soul "dull as night." These sports are only pursued in fresh weather, and when the ground is not very heavy with wet; but should frost and snow prevent their pursuit, curling and skating afford healthful exercise both to body and mind.

595. Winter is the season for those in the country reciprocating the kindnesses of hospitality, and participating in the amusements of society. The farmer delights to send the best produce of his poultry-yard as Christmas presents to his friends in town, and in return to be invited into town to partake of its amusements. But there is no want of hospitality nearer home. Country people maintain intercourse with each other; while the annual county ball in the market town, or an occasional charity one, to assist the wants of the labouring poor, affords a seasonable treat; and the winter is often wound up by a meeting given by the Hunt to those who had shared in the sport during the hunting season.

596. Winter is the season of *domestic enjoyment*. The fatigues of the long summer day leave little leisure, and less inclination, to tax the mind with study; but the long winter evening, after a day of bracing exercise, affords a favourable opportunity of partaking in conversation, quietly reading, or listening to music. In short, I know of no class of people more capable of enjoying a winter's evening in a rational manner, than the family of the country gentleman or the farmer.

597. Viewing winter in a higher and more serious light,—in the repose of nature, as emblematical of the mortality of man,—in the exquisite pleasures which man in winter, as a being of sensation, enjoys over the lower creation,—and in the eminence in which man, in the temperate regions, stands, with respect to the development of his mental faculties, above his fellow-creatures in the tropics;—in these respects, winter must be hailed by the dweller in the country as the purifier of the mental as well as of the physical atmosphere.

598. The reflections of a modern writer on the wholesome effects of winter on the mind of man, coincide with my own sentiments and feelings:—"Winter," says he, "is the season of nature's annual repose,—the time when the working structures are reduced to the minimum of their extent, and the energies of growth and life to the minimum of their activity, and when the phenomena of nature are fewer, and address themselves less pleasingly to our senses, than they do in any other of the three seasons. There is hope in the bud of Spring, pleasure in the bloom of Summer, and enjoyment in the fruit of Autumn; but, if we make our senses our chief resource, there is something both blank and gloomy in the aspect of Winter. And if we were of and for this world alone, there is no doubt that this would be the correct view of the winter, as compared with the other seasons; and the partial death of the year would point as a most mournful index to the death and final close of our existence. But we are beings otherwise destined and endowed,—the world is to us only what the lodge is to the wayfaring man; and while we enjoy its rest, our thoughts can be directed back to the past part of our journey, and our hopes forward to its end, when we shall reach our proper home, and dwell there securely and for ever. This is our sure consolation,—the anchor of hope to our minds during

all storms, whether they be of physical nature, or of social adversity." *

599. The *weather* in winter being very precarious, is a subject of intense interest, and puts the farmer's skill to anticipate its changes severely to the test. Seeing that every operation of the farm is so dependent on the weather, a familiar acquaintance with the local prognostics which indicate a change for the better or worse becomes incumbent on the farmer. In actual rain, snow, or hard frost, none but in-door occupations can be executed; but, if the farmer have wisely "discerned the face of the sky," he may arrange them to continue for a length of time, if the storm threaten to endure,—or be left without detriment, should the strife of the elements quickly cease. Certain atmospherical phenomena only occurring in winter, they should be noticed here; and these are—aurora borealis, frost, ice, snow, and the like.

600. *Aurora Borealis.*—The only electrical excitation witnessed in winter is the aurora borealis, or northern lights, or "merry dancers," as they are vulgarly called. It mostly occurs in the northern extremity of the northern hemisphere of the globe, where it gives forth almost constant light during the absence of the sun. So intense is this radiance, that a book may be read by it; and it confers a great blessing on the inhabitants of the Arctic regions, at a time they are benighted. The aurora borealis seems to consist of two varieties; one a luminous quiet light in the northern horizon, gleaming most frequently behind a dense stratum of cloud; and the other of vivid corruscations of almost white light, of a sufficient transparency to allow the transmission of the light of the fixed stars. The corruscations are sometimes coloured yellow, green, red, and of a dusky hue: they are generally short, and confined to the proximity of the northern horizon; but occasionally they reach the zenith, and even extend to the opposite horizon, their direction being from NW. to SE. It seems now undeniable, that the aurora borealis frequently exercises a most marked action on the magnetic needle; thus affording another proof of the identity of the magnetic and electric agencies.

601. It is not yet a settled point amongst philosophers, whether the aurora borealis occurs at the highest part of the atmosphere, or near the earth. Mr Cavendish considered it probable, that it usually occurs at an elevation of 71 miles above the earth's surface, at which elevation the air must be but $\frac{1}{148367}$ time the density of that at the surface of the earth—a degree of rarefaction far above that afforded by our best constructed air-pumps. Dr Dalton conceives, from trigonometrical measurements made by him of auroral arches, that their height is 100 miles above the earth's surface. His most satisfactory measurement was made from the arch of 29th March 1826. As the peculiar appearance of the aurora, and its corruscations, precisely resemble the phenomena which we are enabled to produce artificially by discharges of electricity between two bodies in a receiver through a medium of highly rarefied air, Lieut. Morrison, R. N., of Cheltenham conceives, "that these (fleecy) clouds are formed by the discharges and currents of electricity, which, when they are *more decided*, produce aurora." Mr Leithead conjectures that the aurora becomes "visible to the inhabitants of the earth upon their entering our atmosphere."† If these conjectures be at all correct, the aurora *cannot be seen beyond our atmosphere*, and therefore cannot exhibit itself at the height of 100 miles, as supposed by Dr Dalton, since the height of the atmosphere is only acknowledged to be from 40 to 50 miles. This view of the height of the aurora somewhat corroborates that held by the Rev. Dr Farquharson, Alford, Aberdeenshire, and which was supported by Professor Jameson.‡

602. The *prognostics* connected with the appearance of the aurora borealis are these:—When exhibiting itself in a gleam of light in the north, it is indicative of good steady weather; when it corruscates a little, the weather may be changeable; and when the corruscations reach the zenith, and beyond, they augur cold stormy wind and rain. It has been long alleged, that the aurora borealis has the effect of

* Mudie's *Winter*, preface, p. iii.

† Leithead *On Electricity*, p. 263-4.

‡ *Encyclopædia Britannica*, 7th edition; art. *Aurora Borealis.*

producing a certain direction of wind. Mr Winn stated, as long ago as 1774, that the aurora, in the south of England, was constantly followed by a SW. wind and rain, and that the gale always began three hours after the phenomenon;* and in 1833, Captain Winn observed in the English Channel, that the aurora shifted the wind to SW. and S., and that the gale began 24 hours after the phenomenon, accompanied with hazy weather and small rain. The apparent discrepancy in the two accounts, in the same locality, of the time when the gale commenced, may perhaps have arisen from calculating the time from different periods of the phenomenon. Captain Winn further remarks, that the intensity of the storm, and the time it appears, may perhaps depend on the intensity of the aurora.† During long observation of the effects of the aurora borealis in one of the midland counties of Scotland, I never saw any change of the wind effected by it, except in frost, when the aurora seldom occurs, and then a SW. wind followed with gales. Coloured aurora borealis is always indicative of a change of the existing weather, whether from good to bad, or bad to good.

603. *Thunder.* — Thunder-storms are of rare occurrence in winter, owing, probably, to the generally humid state of the atmosphere at that season carrying off the superfluous electric matter silently, and not allowing it to accumulate in any one place. Sometimes, however, they do occur, and then are always violent and dangerous; at times setting fire to dwellings, rending trees, and destroying elevated buildings, such as the storm which occurred on the 3d January 1841. Such storms are almost always succeeded by intense frost, and a heavy fall of snow in the line of their march. Flashes of white lightning near the horizon are sometimes seen in clear fresh nights, when stars are numerous and twinkling, and falling stars plentiful, and they always indicate a coming storm.

604. *Halo.*—A halo is an extensive luminous ring, including a circular area, in the centre of which the sun or moon appears, and is only seen in winter. It is formed by the intervention of a cloud between the spectator and the sun or moon. This cloud is generally the denser kind of *cirro-stratus*, the refraction and reflection of the rays of the sun or moon at definite angles through and upon which cause the luminous phenomenon. The breadth of the ring of a halo is caused by a number of rays being refracted at somewhat different angles, otherwise the breadth of the ring would equal only the breadth of one ray. Mr Forster has demonstrated mathematically the angle of refraction, which is equal to the angle subtended by the semidiameter of the halo. Halos may be double and triple; and there is one which Mr Forster denominates a *discoid* halo, which constitutes the boundary of a large corona, and is generally of less diameter than usual, and often coloured with the tints of the rainbow. "A beautiful one appeared at Clapton on the 22d December 1809, about midnight, during the passage of a *cirro-stratus* cloud before the moon."‡ Halos are usually pretty correct circles, though they have been observed of a somewhat oval shape; and are generally colourless, though sometimes they display the faint colours of the rainbow. They are most frequently seen around the moon, and acquire the appellation of *lunar* or *solar* halos, as they happen to accompany the particular luminary.

605. *Corona.*—The *corona* or *brough* occurs when the sun or moon is seen through a thin *cirro-stratus* cloud, the portion of the cloud more immediately around the sun or moon appearing much lighter than the rest. Coronæ are double, triple, and even quadruple, according to the state of the intervening vapours. They are caused by a similar refractive power in vapour as the halo, and are generally faintly coloured at their edges. Their diameter seldom exceeds 10°. A halo frequently encircles the moon, when a small corona is more immediately around the moon's disc.

606. The *prognostics* indicated by a few of the appearances of the objects in the air and sky may be usefully remarked in winter:—Sharp horns of a new *moon*, and a clear moon at any time, are character-

* Thomson's *History of the Royal Society*, p. 513. † *The Field Naturalist*, vol. i. p. 108.
‡ Forster's *Researches into Atmospherical Phenomena*, p. 101-7.

istics of coming frost. In frost, the *stars* appear small, clear, and twinkling, and not very numerous; but when few in number in fresh weather, it is probable that much vapour exists in the upper portion of the atmosphere; and if very numerous, having a lively twinkle, rain is indicated—the transparent vapour, in the act of subsiding into clouds, causing the twinkling. *Falling stars* are meteors which occur pretty frequently in winter, appearing in greatest number when stars are numerous, and are therefore indicative of a deposition of vapour, accompanied with wind from the point towards which they fall. Dull sun, moon, and stars,—occasioned by a thin cirro-stratus, almost invisible, are indicative of a change to rain in fresh, and to snow in frosty weather. *Coronæ* always indicate the fall of vapour, whether in rain, snow, or hail, according to the warmer or colder state of the air at the time. *Coloured coronæ* and *halos* are sure indications of an approaching fall of rain in fresh, and snow in frosty, weather.

607. *Clouds.*—The *most common cloud in winter* is the *cirro-stratus*, whether in the state of a shrouding veil, more or less dense, across the whole sky for days, or in heavy banked clouds in the horizon before and after sunset. Whenever this form of cloud is present, there must be a large amount of vapour in the air, coming nearer to the ground as the power that suspends it is by any means weakened. Rain mostly falls direct from the cirro-stratus; but ere snow fall in any quantity, the cirro-stratus descends to the horizon into cumulo-stratus, from whence it stretches over the zenith in a dense bluish-black cloud. Cirri in winter are a sure indication of a change of wind in a few hours from the quarter to which their turned up ends point.

608. *Rain.* — The variation in the amount of rain in any season follows, in a great measure, the same law as that expounded by Dalton in reference to the heights of mountains. Of all the seasons the *least* quantity of rain falls in winter. According to M. Flaugergues, taking the mean amount as 1, the quantity that falls in the winter quarter of December, January, and February, is 0·1937 inches. The proportional results of each month of the winter quarter, as I have divided the agricultural year, are for—

November	0·1250
December	0·0693
January	0·0716
	0·2659

This division transfers the minimum of rain from the winter to spring, which is more in accordance with experience in Scotland, than the observations of M. Flaugergues, which refer to France. The number of rainy days in the same winter quarter is thus enumerated, in—

November	15·0 days.
December	17·7 —
January	14·4 —
In all	47·1 — *

609. The character of winter-rain has more of cold and discomfort than of quantity. When frost suddenly gives way in the morning about sunrise, it is said to have "leapt," and rain may be looked for during the day. If it do not actually fall, a heavy cloudiness will continue all day, unless the wind change, when the sky may clear up. If a few drops of rain fall before mid-day after the frost has leapt, and then it fairs, a fair, and most likely a fine day will ensue, with a pleasant breeze from the N. or W., or even E. When the moon shines brightly on very wet ground, it may be remarked how very black the shadows of objects become; and this is a sign of continuance of rain, and of an unsettled state of the wind. Rain sometimes falls with a rising barometer; and when this happens, it is usually followed by fine healthy weather, which is attended with circumstances that indicate a strong positive state of the electricity of the air. This often occurs in winter. "We have," says Mr Forster, "usually a warm and agreeable sensation of the atmosphere with such rain, which is strikingly contrasted to the cold and raw sensation occasioned by the fall of thick wet mists or rain, which happen when, even with a N. or E. wind, the barometer and thermometer sink together, and when the air has previously been

* *Encyclopædia Metropolitana*; art. *Meteorology.*

found to be either negatively or non-electrified; and the cause of this is most probably occasioned by a supervening current of colder or supersaturated air; and the rise of the thermometer, which accompanies the fall of the barometer in this case, may be owing to the increase of temperature produced by the condensation of the vapour in the case of rain." "Gusts of *wind*, in some high windy weather," says Mr Forster, "seem to fluctuate in a manner somewhat analogous to the undulatory motion of waves. This fact may easily be seen by a pendulous anemometer. When the wind is accompanied by the rain, the periods of the gusts may be counted by the intervals of the more or less violent impulses of the water on the windows opposed to the wind, or the leaves of any tree twined across them."*

610. The mean annual fall of rain on the surface of the globe has been taken at 34 inches. On estimating the area of the globe, the quantity of rain that annually falls at this rate will be found to be almost incredible. The mean diameter of the earth is 7913½ miles, its mean circumference of course 24,871 miles, and the area of its surface 196,816,658 square miles, or 5,486,933,518,387,200, square feet, which, at 34 inches of rain, give 15,546,290,603,173,652 cubic feet of water, at 1000 ounces per cubic foot, amount to 431,033,808,959,644 tons 6 cwt. of rain per annum!

611. According to the estimate of Professor Rigaud of Cambridge, the sea bears to the land a ratio of 36: 13, so the land has an area of 52,353,231 square miles, which will receive 155,684.431,013,204½ tons of rain per annum. What renders this result the more surprising is, that all this enormous quantity of rain could not have fallen unless it had at first been evaporated from the ocean, seas, lakes, rivers, and the land by the heat of the sun, and sustained in the air until precipitated.

612. Rain is useful in husbandry by consolidating light soils, and dissolving and carrying down solutions of manure *into* the soil—when sheep are feeding on turnips, for example—and placing them beyond the reach of evaporation; but its chief utility in winter is supplying of thrashing machinery, or irrigation, with abundance of water.

613. *Frost.*—Frost has been represented to exist only in the absence of heat; but it is more, for it also implies an absence of moisture. Sir Richard Phillips defines cold to be "the mere absence of the motion of the atoms called heat, or the abstraction of it by evaporation of atoms, so as to convey away the motion, or by the juxtaposition of bodies susceptible of motion. Cold and heat are mere relations of fixity and motion in the atoms of bodies."† This definition of heat implies that it is a mere property of matter, a point not yet settled by philosophers; but there is no doubt that, by motion, heat is evolved, and cold is generally attended by stillness or cessation of motion.

614. Frost generally originates in the upper portions of the atmosphere, it is supposed, by the expansion of the air carrying off the existing heat, and making it susceptible of acquiring more. What the cause of the expansion may be, when no visible change has taken place in the mean time in the ordinary action of the solar rays, may not be obvious to a spectator on the ground; but it is known, from the experiments of Lenz, that electricity is as capable of producing cold as heat, to the degree of freezing water rapidly.‡ The poles of cold and the magnetic poles probably coincide.§

615. The most intense frosts in this country never penetrate more than one foot into the ground, on account of the excessive dryness occasioned in it by the frost itself withdrawing the moisture for it to act upon. Frost cannot penetrate through a thick covering of snow, or below a sheet of ice, or through a covering of grass on pasture, or the fine tilth on the ploughed land, all which act as non-conductors against its descent.

616. Frost is always present in winter, though seasons do occur in which very little occurs. The winters of 1834-5-6

* Forster's *Researches into Atmospherical Phenomena*, p. 247 and 342.
† Phillips' *Facts*, p. 395.
‡ Bird's *Elements of Natural Philosophy*, p. 232.
§ Kaemtz's *Complete Course of Meteorology*, p. 462.

may be remembered as seasons remarkably free from frost. It is a useful assistant to the farmer in pulverising the ground, and rendering the upper portion of the ploughed soil congenial to the vegetation of seeds. It is obvious that it acts in a mechanical manner on the soil, by freezing the moisture in it into ice, which, on expanding at the moment of its formation, disintegrates the indurated clods into fine tilth. Frost always produces a powerful evaporation of the pulverised soil, and renders it very dry on the surface; by the affinity of the soil for moisture putting its capillary attraction into action, the moisture from the lower part of the arable soil, or even from the subsoil, is drawn up to the surface and evaporated, and the whole soil is thus rendered dry. Hence, after a frosty winter, it is possible to have the ground in so fine and dry a state as to permit the sowing of spring wheat and beans, in the finest order, early in spring, as witnessed in 1847. Frost being favourable to the exhibition of the electric agency, may also prove useful to husbandry, by stimulating the electric influence, not only in the soil itself, but in vegetation, in the manner formerly described in M. Pouillet's experiments (127.)

616. *Snow.*—Rain falls at all seasons, but *snow* only in winter, which is just frozen rain; whenever, therefore, there are symptoms of rain, snow may be expected if the temperature of the air is sufficiently low to freeze vapour. Vapour is supposed to be frozen into snow at the moment it is collapsing into drops to form rain, for we cannot suppose that clouds of snow can float about the atmosphere any more than clouds of rain. Snow is a beautifully crystallised substance when it falls to the ground; and it is probable that it never falls from a great height, otherwise its fine crystalline configurations could not be preserved.

618. "If flakes of snow," observes Kaemtz, "are received on objects of a dark colour, and at a temperature below the freezing point, a great regularity is observed in their forms: this has for a long time struck attentive observers. The crystals of ice are never so regular as when snow falls without being driven by the wind; but temperature, moisture, the agitation of the air, and other circumstances, have a great influence over the forms of the crystals. Notwithstanding their variety, they may be all associated under a single law. We see that isolated crystals unite under angles of 30, 60, and 120 degrees. Flakes which fall at the same time have generally the same form; but if there is an interval between two consecutive falls of snow, the forms of the second are observed to differ from those of the first, although always alike among themselves. Kepler speaks of their structure with admiration—and other philosophers have endeavoured to determine the cause of their regularity—but it is only within the period in which we have learned to know the laws of crystallisation in general, that it has been possible to throw any light on the subject."*

619. The *forms of snow* have been arranged by Scoresby into 5 orders. 1. The *lamellar*, which is again divided into the *stelliform*, *regular hexagons*, *aggregation of hexagons*, and *combination of hexagons* with radii, or spines and projecting angles. 2. Another form is the *lamellar* or *spherical nucleus* with spinous ramifications in different places. 3. Fine *spiculæ* or 6-sided prisms. 4. *Pryamids* with six faces. 5. *Spiculæ*, having one or both *extremities* affixed to the *centre* of a *lamellar* crystal. There are numerous varieties of forms of each class.† All the forms of crystals of snow afford most interesting objects for the microscope, and when perfect no objects in nature are more beautiful and delicately formed. The lamellated crystals fall in calm weather, and in heavy flakes, and are evidently precipitated from a low elevation. The spiculæ of 6-sided prisms occur in heavy drifts of snow, accompanied with wind and intense cold. They are formed at a considerable elevation; and they are so fine as to pass through the minutest chinks in houses, and so hard and firm that they may be poured like sand from one hand into another, with a jingling sound, and without the risk of being melted. In this country these are most frequently accompanied by one of the varieties of the lamellar

* Kaemtz's *Complete Course of Meteorology*, p. 127.

† Scoresby's *Polar Regions.*

crystals, which meet their fall at a lower elevation; but in mountainous countries, and especially above the line of perpetual snow, they constitute the greatest bulk of the snow, where they are ready at the surface to be blown about with the least agitation of the air, and lifted up in dense clouds by gusts of wind, and precipitated suddenly on the unwary traveller like a sand-drift of the torrid zone. These spiculæ feel exceedingly sharp when driven by the wind against the face, as I have experienced on the Alps. How powerless is man when

—— down he sinks
Beneath the shelter of the shapeless drift,
Thinking o'er all the bitterness of death! *

And how helpless is a flock of sheep when overwhelmed under a cloud of snow-drift! Other forms of snow are more rare, yet the total number seen by Scoresby amounted to 96. "Yet I have met," remarks Kaemtz, "with at least 20 he has not figured; but I never found a single one in which the crystals were in planes perpendicular to each other. The varieties probably amount to several hundreds. Who would not admire the infinite power of Nature, which has known how to create so many different forms in bodies of so small a bulk!"

620. All other things being equal, Professor Leslie supposes that a flake of snow, taken at 9 times more expanded than water, descends 3 times as slow.

621. From the moment snow alights on the ground it begins to undergo certain changes, which usually end in a more solid crystallisation than it originally possessed. The adhesive property of snow arises from its needly crystalline texture, aided by a degree of attendant moisture which afterwards freezes in the mass. Sometimes, when a strong wind sweeps over a surface of snow, portions of it are raised by its power, and, passing on with the breeze under a diminished temperature, become crystallised, and by attrition assume globular forms. Mr Howard describes having seen these snow-balls, as they may be termed, in January 1814, and Mr Patrick Shirreff, when at Mungoswells in East Lothian, observed the like phenomenon in February 1830.† I observed the same phenomenon in Forfarshire in the great snow-storm of February 1823.

622. During the descent of snow, the *thermometer sometimes rises*, and the *barometer usually falls*. Snow has the effect of retaining the temperature of the ground at what it was when the snow fell. It is this property which maintains the warmer temperature of the ground, and sustains the life of plants during the severe rigours of winter in the Arctic regions, where the snow falls suddenly, after the warmth of summer; and it is the same property which supplies water to rivers in winter, from under the perpetual snows of the Alpine mountains. "While air, above snow, may be 70° below the freezing point, the ground below the snow is only at 32°.‡ Hence the fine healthy green colour of young wheat and young grass, after the snow has melted off them in spring.

623. In melting, 27 inches of snow give 3 inches of water. Rain and snow-water are the *softest* natural waters for domestic purposes; and are also the purest that can be obtained from natural sources, provided they are procured either before reaching the ground, or from newly fallen snow. Nevertheless, they are impregnated with oxygen, nitrogen, and carbonic acid, especially with a considerable quantity of oxygen; and rain-water and dew contain nearly as much air as they can absorb.§ Liebig says that both rain and snow-water contain ammonia; and it is the probable cause of their great softness.

624. Snow reflects beautifully blue and pink tints at sunset, as I have often observed, with admiration, on the Alps of Switzerland. It also reflects so much light from its surface, as to render travelling at night a cheerful occupation; and in some countries, as in Russia and Canada, when frozen, it forms a delightful highway for man and horse and rein-deer.

625. A heavy fall of snow generally commences in the evening, continues through-

* Thomson's *Seasons,—Winter.*
† *Encyclopædia Metropolitana;* art. *Meteorology.*
‡ Phillips' *Facts*, p. 440.
§ Reid's *Chemistry of Nature*, p. 192.
‖ Liebig's *Organic Chemistry*, p. 45.

out the next day, and at intervals in succeeding days. Snow-showers may fall heavily for the time; and when they fall, and the sky clears up quickly but is again overcome with another shower, it is said to be a "*feeding storm.*" In such a case, the air always feels cold. In moonlight, masses of cumulo-strati may be seen to shower down snow at times, and then roll across the face of the moon with the most beautiful fleecy and rounded forms imaginable. The forms of the flakes of snow are pretty correct indications of the amount of fall to be; as, when large and broad, and falling slowly, there will not be much, and the probability is that a thaw will soon follow; but when they fall thick and fast, and of medium size, there may be a fall of some inches before it fairs, and may lie some time. When the flakes are spicular and fall very thick and fast, a heavy fall, or a "*lying storm*," as it is called, may be expected; and this last sort of fall is always accompanied with a firm breeze of wind, varying from NE. to SE., and constitutes the minute drift, which penetrates into every crevice that is open in doors, windows, or sheds. Neither frost nor snow will last long, if either come when the ground is in a very wet state, in consequence of rain.

626. Snow renders important services to husbandry. If it fall shortly after a confirmed frost, it acts as a protective covering against its farther cooling effects on soil; and, in this way, protects the young wheat and clover from destruction by intense frosts. On the other hand, frost, and rain, and snow, may all retard the operations of the fields in winter very materially, by rendering ploughing and the carriage of turnips impracticable.

627. *Hoar-frost.*—Hoar-frost is defined to be frozen dew. This it not quite a correct definition; for dew is sometimes frozen, especially in spring, into globules of ice which do not at all resemble hoar-frost,—this latter substance being beautifully and as regularly crystallised as snow. The formation of hoar-frost is always attended with a considerable degree of cold, because it is preceded by a great radiation of heat and vapour from the earth, and the phenomenon is the more perfect the warmer the day and the clearer the night have been. In the country, hoar-frost is of most frequent occurrence in the autumnal months and in winter, in such places as have little snow or continued frost on the average of seasons; and this chiefly from great radiation of heat and vapour at those seasons, occasioned by a suspension of vegetable action, which admits of little absorption of moisture for vegetable purposes.*

628. The late Dr Farquharson, Alford, Aberdeenshire, paid great attention to the subject of hoar-frost or rime, which frequently injures the crops in the northern portion of our island long before they are ripe. The results of his observations are very instructive. He observed, that the mean temperature of the day and night at which injurious hoar-frosts may occur, may be, relatively to the freezing-point, very high. Thus, on the nights of the 29th and 31st August 1840, the leaves of potatoes were injured, while the lowest temperatures of those nights, as indicated by a self-registering thermometer, were as high as 41° and 39° respectively.

629. Hoar-frost, at the time of a high daily mean temperature, takes place only during calm. A very slight steady breeze will quickly melt away frosty rime.

630. The air is always unclouded, or nearly all of it so, at the time of hoar-frost. So incompatible is hoar-frost with a clouded state of the atmosphere, that on many occasions when a white frosty rime has been formed in the earlier part of the night, on the formation of a close cloud at a later part, it has melted off before the rising of the sun.

631. Hoar-frosts most frequently happen with the mercury in the barometer at a high point and rising, and with the hygrometer at comparative dryness for the temperature and season; but there are striking exceptions to these rules. On the morning of the 15th September 1840, a very injurious frost occurred, with a low and falling barometer column, and with a damp atmosphere.

* Mudie's *World*, p. 254.

632. In general, low and flat lands in the bottoms of valleys, and grounds that are land-locked hollows, suffer most from hoar-frost, while all sloping lands, and open uplands, escape injury. But it is not their relative elevation above the sea, independently of the freedom of their exposure, that is the source of safety to the uplands; for provided they are enclosed by higher lands, without any wide open descent from them on some side or other, they suffer more, under other equal circumstances, than similar lands of less altitude.

633. A very slight inclination of the surface of the ground is generally quite protective of the crops on it from injury by hoar-frost, from which flat and hollow places suffer at the time great injury. But a similar slope downward in the bottom of a narrow descending hollow does not save the crop in the bottom of it, although those on its side-banks higher up may be safe.

634. An impediment of no great height on the surface of the slope, such as a stone-wall fence, causes damage immediately above it, extending upwards proportionally to the height of the impediment. A still loftier impediment, like a closely-planted and tall wood or belt of trees, across the descent, or at the bottom of sloping land, causes the damage to extend on it much more.

635. Rivers have a bad repute as the cause of hoar-frosts in their neighbourhood; but the general opinion regarding their evil influence is altogether erroneous: the protective effect of *running* water, such as waterfalls from mill-sluices, on pieces of potatoes, when others in like low situations are blackened by frost, is an illustration which can be referred to.

636. The severity of the injury by hoar-frost is much influenced by the wetness or dryness of the soil at the place; and this is exemplified in potatoes growing on haugh-lands by the sides of rivers. These lands are generally dry, but bars of clay sometimes intersect the dry portions, over which the land is comparatively damp. Hoar-frost will affect the crop growing upon these bars of clay, while that on the dry soil will escape injury; and the explanation of this is quite easy. The mean temperature of the damp lands is lower than that of the dry, and on a diminution of the temperature during frost, it sooner gets down to the freezing point, as it has less to diminish before reaching it.

637. Hoar-frost produces peculiar currents in the atmosphere. On flat lands, and in land-locked hollows, there are no currents that are at all sensible to the feelings; but on the sloping lands, during hoar-frost, there is rarely absent a very sensible and steady, although generally only feeble, current towards the most direct descent of the slope. The current is produced in this way: The cold first takes place on the surface of the ground, and the lower stratum of air becoming cooled, descends to a lower temperature than that of the air immediately above, in contact with it. By its cooling, the lower stratum acquires a greater density, and cannot rest on an inclined plane, but descends to the valley; its place at the summit of the slope being supplied by warmer air from above, which prevents it from getting so low as the freezing temperature. On the flat ground below, the cool air accumulates, and commits injury, while the warmer current down the slope does none; but should the mean temperature of the day and night be already very low before the calm of the evening sets in, the whole air is so cooled down as to prevent any current down the slope. Injury is then effected both on the slope and the low ground; and hence the capricious nature of hoar-frost may be accounted for.*

638. "In hoar-frost," observes Kaemtz, "the crystals are generally irregular and opaque; and it seems that great numbers of vesicles are solidified at their surface without having had time to unite intimately with the crystalline molecules. During wind the crystals are broken and irregular; rounded grains are then found composed of unequal rays. In the Alps, and in Germany, I have often seen perfectly symmetrical crystals fall. Should the wind rise, they become grains of the size of millet, or small peas, whose structure is any thing but compact; or even

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 250.

bodies having the form of a pyramid, the base of which is a spherical cup. These bodies may be compared to sleet; yet they are found under the influence of the same meteorological circumstances as the flakes which fall before gales of wind." *

639. *Frost-smoke.*—Clear calm air, admitting much sunshine at the middle of the day, is very bracing, healthy, and agreeable; but in the evening of such a day, the sun usually sets in red, and a heavy dew falls, which is frozen into *rime* or *hoar-frost*, incrusting every twig and sprig of trees and shrubs into the semblance of white coral. When the cold is intense, the dew is frozen before it reaches the objects on which it is deposited, and it then appears like smoke or mist, and is called "*frost-smoke*," which, when deposited on the naked branches of trees and shrubs, converts them into a resemblance of the most beautiful filagree-work of silver. This mist may last some days, during the day as well as night, and then new depositions of incrusted dew take place on the trees and walls every night, until they seem overloaded with it. The smallest puff of winter wind dispels the enchanting scene, as described by Phillips in his Letter from Copenhagen: —

When, if a sudden gust of wind arise,
The brittle forest into atoms flies;
The crackling wood beneath the tempest bends,
And in a spangled shower the prospect ends.

Winter-fog, as long as it hovers about the plains, is indicative of dry weather; but when it betakes itself to the hills, a thaw may be expected soon to follow; and nothing can be more true than "He that would have a bad day, may go out in a fog after frost;" for no state of the air can be more disagreeable to the feelings than a raw rotten fog after frost, with the wind from the SE.

640. *Hail.*—Hail, consisting of soft, snowy, round spongy masses, frequently falls in winter after snow, and may lie for some time unmelted.

641. *Ice.*—Though a solid, ice is not a compact substance, but contains large interstices filled with air, or other substances that may have been floating on the surface of the water. Ice is an aggregation of crystals, subtending with one another the angles of 60° and 120°. It is quickly formed in shallow, but takes a long time to form in deep water; and it cannot become very thick in the lower latitudes of the globe, from want of time and intensity of the frost. By 11 years' observations at the observatory at Paris, there were only 58 days of frost throughout the year, which is too short and too desultory a period to freeze *deep* water in that latitude.

642. The freezing of water is effected by frost in this manner. The upper film of water in contact with the air becomes cooled down, and when it reaches 39°·39 it is at its densest state, and of course sinks to the bottom through the less dense body of water below it. The next film of water, which is now uppermost, undergoes the same condensation; and in this way does film after film in contact with the air descend towards the bottom, until the whole body of water becomes equally dense at the temperature of 39°·39. When this vertical circulation of the water stops, the upper film becomes frozen. If there is no wind to agitate the surface of the water, its temperature will descend as low as 28° before it freezes, and on freezing will start up to 32°; but should there be any wind, then the ice will form at once at 32°, expanding at the same time one-ninth larger than in its former state of water.

643. It is worth while to trace the progress of this curious property—the expansion of ice. In the first place, the water *contracts in bulk* by the frost, until it reaches the temperature of 39°·39, when it is in its state of greatest density and least bulk, and then sinks. After this the water resists frost in calm air, until it reaches 28°, *without decreasing more in bulk*, and it remains floating on the *warmer* water below it, which continues at 39°·39. So placed, and at 28°, it then freezes, and suddenly starts up to 32°, and in the form of ice as suddenly *expands* one-ninth more in bulk than in *its ordinary temperature*, and of course more than that when in its most condensed state at 39°·39. After the water has undergone

* Kaemtz's *Complete Course of Meteorology*, p. 131.

all these mutations, it retains its enlarged state as ice until that is melted.

644. So great is the force of water on being suddenly expanded into ice, that, according to the experiments of the Florentine Academy, every cubic inch of it exerts a power of 27,000 lbs. This remarkable power of ice is of use in agriculture, as I have noticed when speaking of the effects of frost on ploughed land. (620.)

645. It is obvious that no large body of *fresh* water, such as a deep lake or river, can be reduced in temperature below 39°·39, when water is in its densest state, as what becomes colder floats upon and covers the denser, which is also the warmer, portion; and as ice is of larger bulk, weight for weight, than water, it must float above all, and, in retaining its form and position, prevent the farther cooling of the water below it to a lower temperature than 39°·39. On the other hand, *sea*-water freezes at once on the surface, and that below the ice retains the temperature it had when the ice was formed. Frost in the polar regions becomes suddenly intense, and the polar sea becomes as suddenly covered with ice, without regard to the temperature of the water below. The ice of the polar sea, like the snow upon the polar land, thus becomes a protective mantle against the intense cold of the atmosphere, which is sometimes as great as 57° below zero. In this way sea animals, as well as land vegetables, in those regions are protected at once, and securely, against the effects of the intensest frosts.

646. "Water presents a phenomenon analogous to sulphur," observes Kaemtz; "it crystallises under the influence of cold alone. However, on examining the ice of rivers, we do not discover the smallest trace of crystals; it is a confused mass like that of the rolls of brimstone. But in the progress of crystallisation is followed on the banks of a river, needles are seen to dart from the bank, or rather from the ice already formed, and to advance parallel to each other, or making angles with each other from 30 to 60 degrees. Other needles dart from these at the above angles, and so on until a compact uniform mass is the effect of their interlacing. If a sheet of ice thus formed is raised, very irregular crystals are often discovered in its lower surface. Similar phenomena are observed in winter on panes of glass. The secondary crystals are seen to make a constant angle with the crystals which serve as a common axis; and if the glass were a perfect plane, very regular figures would be seen. They occur sometimes when the pane of glass is very thin. The air of the room is moist, then each scratch, each grain of dust, becomes a centre of crystalline formation; and by radiating in all directions, these crystals form a net-work, which excites admiration by its astonishing complication." *

647. Ice *evaporates moisture as largely as water*, which property preserves it from being easily melted by any unusual occurrence of a high temperature of the air, because the rapid evaporation, occasioned by the small increase of heat, superinduces a greater coldness in the body of ice.

648. The *great cooling powers of ice* may be witnessed by the simple experiment of mixing 1 lb. of water at 32° with 1 lb. at 172°—the mean temperature of the mixture will be as high as 102°; whereas 1 lb. of ice at 32°, on being put into 1 lb. of water at 172°, will reduce the mixture to the temperature of ice, namely 32°. This perhaps unexpected result arises from the greater capacity of ice for caloric than water at the temperature of 32°; that is, more heat is required to break up the crystallisation of ice than to heat water.

649. It may be worth while to notice, that *ponds and lakes are generally frozen with different thicknesses of ice*, owing either to irregularities in the bottom, which constitute different depths of water, or to the existence of deep springs, the water of which seldom falls below the mean temperature of the place, 40°. Hence the unknown thickness of ice on lakes and ponds until its strength has been ascertained; and hence also the origin of most of the accidents on ice.

650. *Wind*.—The true character of all

* Kaemtz's *Complete Course of Meteorology*, p. 128.

the phenomena of rain and snow is much modified by the *direction of the wind.* In winter, it may be generally stated as a fact, that when the wind blows from the NW. to SE. by the N. and E., cold and frost may be looked for as certain, and if there are symptoms of a deposition from the air, snow will fall; but if the wind blows from the SE. to NW. by the S. and W., fresh weather and rain will ensue. Heavy falls of snow occur, however, with the wind direct from the S.; but they are always accompanied with cold, and such are usually termed "*Flanders' storms.*" In this case, the wind veers suddenly from the N. or NE. to the S., which causes the lower stratum of vapour to give way by the introduction of warm air, and the cold vapour above then suddenly descends in quantity.

651. The characters of the winds in winter are very well described by old Tusser in these lines:—

> N. winds send hail, S. winds bring rain,
> E. winds we bewail, W. winds blow amain;
> NE. is too cold, SE. not too warm,
> NW. is too bold, SW. doth no harm.*

In winter, the N. wind is firm, powerful, cold, and bracing; the NE. howling, deceitful, cold, disagreeable, and may bring either a heavy fall of snow or rain; the E. wind is cold, piercing, and drying, causing a quick evaporation; the SE. feels cold, damp, and thin, and causes a shiver; the S. wind is soft and undecided, and sometimes causes shivering; the SW. generally blows a loud and steady gale for hours, frequently accompanied with heavy battering showers; the W. wind is bluffy and buoyant; and the NW. pouring and steady, and often cold. Any wind that blows for a considerable length of time, such as two or three days. always brings down the temperature of the air. When any wind blows a good way over-head, it will be fair weather for some time, or until a change of the wind takes place; but when it blows low and very near the ground, and feels raw, cold, and thin to the feelings,—which is frequently the case in winter with the SW., S., and SE. winds,—rain will follow in fresh weather, and thaw in frost. Mostly all winds begin to blow in the upper portion of the atmosphere; and whether they will descend to the earth or not depends on the quantity, first, of the cirri, and then of the cirro-strati, in the air. Very frequently different currents of air, at different elevations, may be seen in winter at the same time by means of the clouds. When this is observed, it may be relied upon that the uppermost current will ultimately prevail. It is characteristic of winds in winter to shift much about,—sometimes to all points of the azimuth in the course of twenty-four hours, and seldom remaining more than three days in one quarter. Winter winds are heavy, overpowering, stormy (242.)

652. A set of rules was published about a hundred years ago, to judge of the changes of the weather, by John Claridge, shepherd, many of which are much akin to those given above; but as a few are expressed in so definite terms in regard to the wind, they must have been the result of observation, and therefore deserve attention. He says:— "When the wind turns to NE. and it continues two days without rain, and does not turn S. the third day, nor rains the third day, it is likely to continue NE. for 8 or 9 days, all fair, and then to come to the S. again. If it turn again out of the S. to the NE. with rain, and continue in the NE. two days without rain, and neither turn S. nor rain the third day, it is likely to continue NE. for two or three months. The wind will finish these turns in 3 weeks. After a N. wind, for the most part two months or more, and then coming S., there are usually 3 or 4 fair days at first, and then, on the fourth or fifth day, comes rain, or else the wind turns N. again, and continues dry. If it return to the S. in a day or two without rain, and turn N. with rain, and return to the S. in one or two days as before, two or three turns together after this sort, then it is like to be in the S. or SW. two or three months together, as it was in the N. before. The wind will finish these turns in a fortnight. Fair weather for a week, with a S. wind, is like to produce a great drought, if there has been much rain out of the S. before. The wind usually turns from N. to S. with a quiet wind without rain, but returns to the N. with a strong wind and rain. The strongest winds are when it

* Tusser's *Five Hundred Points of Good Husbandry,* Introduction, p. xxxviii.

turns from S. to N. by W. When the N. wind first clears the air, (which is usually once a-week,) be sure of a fair day or two."*

653. *Sky.*—A difference in the blue tint of the sky in winter indicates a fall of different states of moisture; for if of a deep blue, in fresh weather, rain will fall; of a yellowish or greenish colour near the horizon in frost, snow will certainly come; and on a clear watery blue opening in the clouds, occurring in fresh weather near the horizon in the S., a heavy rain may soon be expected.

654. Mean of the atmospherical phenomena occurring in winter is as follows:—

Mean of barometer in England, in—

November	29·81 inches.
December	29·90
January	29·97
Mean of Winter	29·89

Mean of thermometer in England, in—

November	42°·6 Fahr.
December	37°·9
January	34°·5
Mean of Winter	38°·3

Tension of vapour for 38°·3=7·04.

Mean fall of rain in November, December, and January, is 1·92 inches.

Prevailing wind in November, December, and January, is the SW.

Number of storms in winter is $\frac{1}{10}$ of those of the year.

Hail and sleet fall most in winter in the proportion of 45·5 in 100.

Aurora-borealis has been seen in—

November	285 times.
December	225
January	229

Number of fire-balls have been seen in—

November	89
December	71
January	69

ON PREPARING FOR, AND COMMENCING THE WINTER OPERATIONS.

655. We shall now direct our attention to the *practice* of farming. I have said, that the agricultural year commences immediately after the completion of harvest, and the sowing of the autumnal wheat; and as these operations may be finished sooner or later, according to the nature of the season, so the agricultural year may commence sooner or later in different years. It seldom, however, commences before the middle of October, which it does when the harvest has been very early, and it is less seldom postponed until the end of November, which it only is when the harvest has been a very late one. The last week of October may be regarded as the average time for commencing winter operations.

656. To join consistency to practice, it is necessary to adopt some regular method of good farming, and as I have recommended the *mixed* husbandry (52,) we shall take that as our model; and it is eminently adapted for such a purpose, since it embraces the raising of grain, as in the farming of heavy carse clays—the raising of green crops, as does the farming in the neighbourhood of large towns,—the rearing of stock, as in pastoral farming,—the making of cheese and butter, as in dairy farming,—and the fattening of cattle and sheep, by grazing in summer, and on turnips in winter, as is practised in ordinary farming in many of the rural districts. Thus the mixed husbandry affords full scope for every species of farming practised in this country, and if there is any peculiarity of farming in any remarkable district, the mixed may be introduced into it if desired; and as a large farm affords a greater scope for displaying the capabilities of management in the arrangement of labour than a small one, I shall suppose that we are about to commence one year's operations on a farm of 500 acres in extent,—a size of farm within reach of most intelligent farmer-capitalists.

657. The winter work does not every year begin with the same operation, this matter being determined by the nature of the preceding season of autumn. When the harvest has been completed early, and the after season so mild as that the live stock may occupy the fields with advantage to themselves, that is to say, have still a full bite of grass, the first winter work is *ploughing;* but when the harvest work is not completed until after the grass

* *The Shepherd of Banbury's Observations*, p. 15-23.

has failed to support the stock, and which is always the case in a late season, the stock must be put upon turnips, and occupy their respective apartments in the steading, before the land is begun to be ploughed. But as the usual occurrence of seasons allows the finishing of harvest before the entire failure of the grass, the common practice is to commence winter operations with ploughing; and I shall therefore adopt this alternative, and describe the manner of ploughing land into the different sorts of ridges, and point out first how the plough itself is harnessed and managed.

ON THE PLOUGH, SWING-TREES, AND PLOUGH-HARNESS.

658. *The plough.*—The plough serves the same purpose to the farmer as the spade to the gardener, both being used to *turn over* the soil; and the object of doing this is, to obtain such a command over the soil as to render it friable, and to enclose the manure within it, so that the seeds sown upon it may grow a crop to the greatest perfection.

659. The *spade* is an implement so simple in construction, that there seems but one way of using it, namely, that of pushing its blade into the ground with the foot, lifting it up with both hands with as much earth upon it as it can carry, and inverting the earth so as to place its upper part undermost. This operation, called *digging*, may be done in the most perfect manner; and every attempt at improving it has failed, and, indeed, seems unnecessary. Hitherto the spade has only been used by the hand, and is thus an instrument entirely under man's *personal* control, though means have been devised to apply horse-power to wield it; but no locomotive machine can compete with the human body in executing work within the sphere of its strength and dexterity.

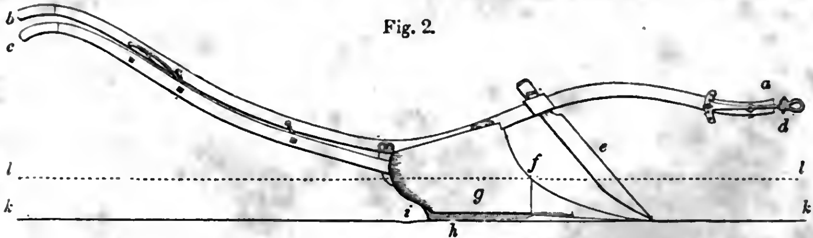
660. The effect intended to be produced on the soil by the *plough*, is to imitate the work of the spade; but the plough being too large and heavy an implement to be wielded by the hand, it is not so entirely under man's control as the spade. He is obliged to call in the aid of horses to wield it, and through the means of appropriate appliances, such as harness, he can command its motions pretty effectively. It is thus not so much man himself, as the horses he employs, that turn over the ground with the plough; and he is thereby a gainer in the end, inasmuch as they can turn over a much greater quantity of soil with the plough, in a given time, than he can with the spade. Turning over the soil with so very simple an instrument as the spade, seems a very simple operation; but, nevertheless, the act of digging is not a simple operation, requiring every muscle of the body to be put into action, so that any machine to imitate it must have a very complex structure. This would be the case even were such a machine always fixed to the same spot; but it is a difficult problem in practical mechanics, to construct a light, strong, durable, convenient instrument, and easily moved about, which shall produce a complicated effect, with a complex structure, by a simple action; and yet the modern plough is an instrument possessing all these properties in an eminent degree.

661. The common plough used in Scotland is made either wholly of iron, or partly of wood and partly of iron. Until a few years ago it was universally made of wood and iron, but is now generally entirely of iron. A wooden plough seems a clumsier instrument than an iron one, though it is lighter. The plough is now made wholly of iron, because iron withstands the vicissitudes of weather better than wood—and this is a desirable property in any implement that must necessarily be much exposed to the weather—and when it becomes old the iron is always worth something; and because good ash timber, of which ploughs were usually made, is now so scarce in many parts of the country, that it fetches the large price of 3s. per cubic foot, whereas iron is daily becoming more abundant. A wooden plough with iron mountings usually weighs 13 stones imperial, and an iron one for the same work 15 stones. The cost of a wooden plough is £3, 16s., that of an iron one £4, 4s., both capable of being serviceable, with repairs, for a lease of 19 years. Some farmers, however, still prefer the wooden one, alleging that it goes more

steadily than the iron. Whatever may be the cause for the predilection, the iron plough executes its work in a very satisfactory manner. In point of economy, both are much alike.

662. There are three different varieties of ploughs used in Scotland, all nearly of the same construction, and I do not know how many in England; and of the three varieties, I give the preference to the one called the East Lothian, or Small's, plough. A *furrow-side* elevation of this plough is represented in fig 2, where the member to which the horses or oxen are yoked, marked *a* in the figure, is the *beam*. Those parts by which the ploughman holds and guides the implement are called the *stilts* or *handles*, *b* being the *greatest stilt* or *left handle*, and *c* the *little stilt* or *right handle*; *d* is the *muzzle* or *bridle* by which the horses are attached to the beam; *e*, the *coulter*, is the cutting instrument that severs the slice from the firm land; *f* the *sock* or *share* which cuts the slice below from the subsoil; *g* the *wrest* or *mould-board*, which receives the slice from the share, turns it gradually over, and deposits it continuously at the proper angle, 45°; *h* is the *sole-shoe* upon which the plough has its principal support, and on which it moves; and *i* is the heel.

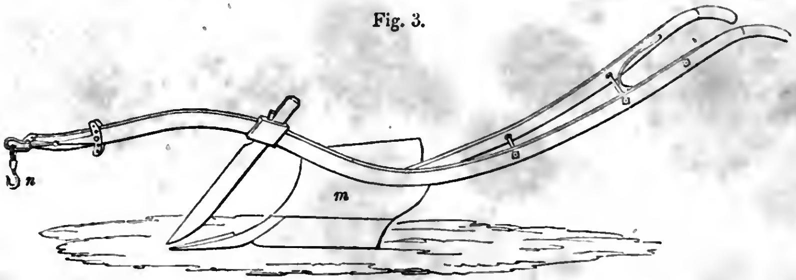
Fig. 2.



A VIEW OF THE FURROW-SIDE OF A PLOUGH.

663. Fig. 3 shows the *land-side* of the plough, in which *m* is the *land-side plate*, only serving to complete the sheathing of the land-side, presenting a uniform smooth surface to the firm land, and preventing the crumbled earth from falling within the body of the plough. These last parts cover the body-frame from view; but all the parts described in fig. 2 may be seen in different perspective in this.

Fig. 3.



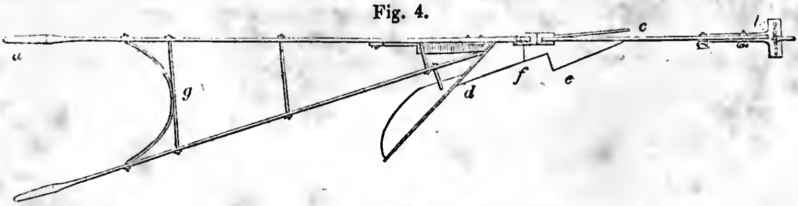
A VIEW OF THE LAND-SIDE OF A PLOUGH.

664. The plough as seen in fig. 2 is supposed to stand upon a level plane, the heel *i* and point of the share *f* touching that plane—these being actually the points on which the plough is supported when in motion, and this plane *k k*, is called the *base-line*. The dotted line *l l* above the base-line is the *surface-line*, which represents the depth of the furrow taken by the plough, and which is seen to intersect the mould-board and coulter at certain points.

665. Fig. 4 represents the plan of the same plough, in which all the parts described will be easily identified, with the additional advantage of showing that the proper lines of the body on the land-side lie all in one plane as from *a* to *b*, which, in working, should be held in the vertical position, or very slightly inclining to the

left. The coulter *c* slightly oblique to the land-side plane, the point standing towards the left: the rake of the coulter varies from 55° to 65°. In the mould-board *d* the vertical sectional lines approximate to straight lines, giving the character of apparent concavity, and it is truncated forward. The share is pointed, with a feather

Fig. 4.



A VIEW OF THE PLAN OF A PLOUGH.

or cutter *e* standing to the right, having a breadth of at least two-thirds the breadth of the furrow, the cutting edge of the feather lying nearly as low as the plane of the sole. The neck of the share *f* is prolonged backward, joining and coinciding with the curve of the mould-board, which curvature is also carried forward on the back of the feather of the share. The character of this plough is to cut a furrow-slice of 10 inches in breadth, by 7 inches in depth, a rectangle, leaving the sole of the open furrow level and clean. It is for this property, which I consider of paramount importance in ploughing land well and thoroughly, that I give it the preference to all others, inasmuch as others cut the slice more or less of a trapezoidal form, and leave the bottom of the open furrow in an inclined, instead of a level position. The resistance to the draught is generally below the average of ploughs, and this plough is employed for every kind of soil.

Fig. 5.

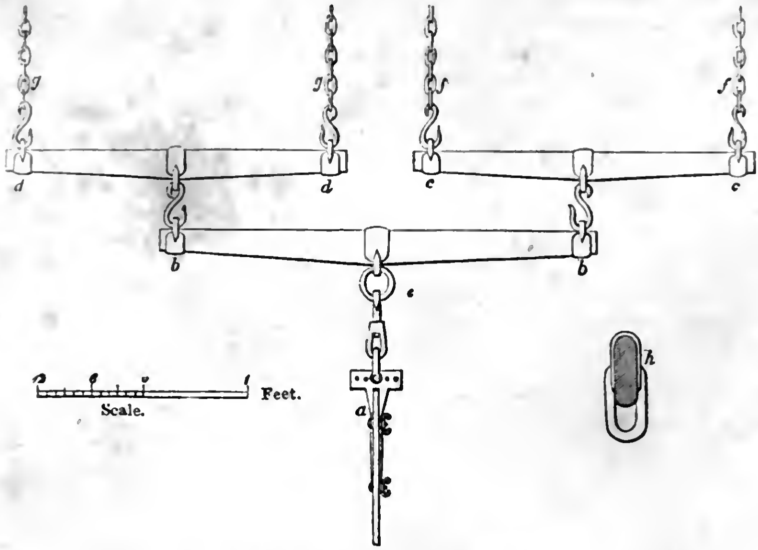
PLOUGH-STAFF.

666. A necessary accompaniment of every plough is the *plough-staff*, or plough-spade, as it is called in some places, fig. 5. Its use consists in shovelling off the mould that may happen to adhere to the front of the mould-board, between *d* and *f*, fig. 4; in pushing away any stubble or weeds that may accumulate in the angle formed by the coulter *e* and beam *a*, fig. 2; and in striking out the stones that may become fixed between the points of the coulter and share. It rests on the plough, when not in use, by its spade being inserted into a staple on the inside of the land-side of the body, and its shank lying on the cross bar, *g*, fig. 4, of the stilts, with its handle quite convenient to the ploughman.

667. *Swing-trees.*—Horses are yoked to the plough by means of a set of levers named swing-trees, arranged as to cause the united strength of the horses employed to be exerted in one point, namely, that formed by linking the ring *e*, fig. 6 of the main lever of the swing-trees *b b*, to the hook of the bridle of the plough *n*, fig. 3. By this contrivance the horses draw the plough from one point only. The swing-trees have various other names in different parts of the country. Such as *swingle-trees*, *whipple-trees*, *draught-bars*, or simply *bars*. The swing-trees are used for attaching horses to other implements besides the plough, such as harrows, small ploughs, &c. In the plough yoke a set of swing-trees consist of 3, as represented in fig. 6, where *a* points out the bridle of the plough, *b b* the main swing-tree attached immediately to the bridle, *c c* the furrow or off-side small swing-tree, and *d d* the land or nigh-side small tree, arranged in the position in which they are employed in working: *h* is a section of a swing-tree at the centre of attachment, with clasp and eye mounting; the scale of which is double the size of the principal figure in the cut. Swing-trees are for the most part made of wood, oak or ash being most generally used; but the former, if sound English oak, is by much the most durable—though good Scotch ash is the strongest, so long as it remains sound, but it is liable, by long exposure, to a species of decay resembling dry-rot. The small trees are furnished

with S hooks, by which they are appended to the ends of the main tree; and end

Fig. 6.

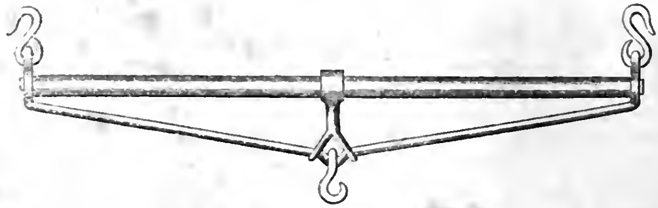


THE SWING-TREES FOR TWO HORSES.

clasps are adapted to receive the hooks of the trace chains, *f f*, *g g*, a small part only of which are shown in the figure.

668. Though wood has hitherto been the material chiefly used for swing-trees, there have been some successful trials of malleable iron for the purpose. These have been variously constructed, in some cases entirely of sheet iron turned round into a form somewhat resembling the wooden trees; but in this form, either the iron must be thin, or the bar must be inconveniently heavy; if the former, durability becomes limited, by reason of the oxidation of the iron acting over a large surface, and soon destroying the fabric. Another method has been to form a diamond-shaped truss of solid iron rods, the diamond being very much elongated, with a stretcher between the obtuse angles. A third has been tried, consisting of a straight welded tube of malleable iron, as in fig. 7. In this tube, acting as a strut, a tension rod, also of malleable iron, is applied with a deflection, the extremities of the tension-rod being brought into contact by welding or riveting with the ends of the tubular strut, and eyes formed at the ends and middle, for the attachment of the

Fig. 7.



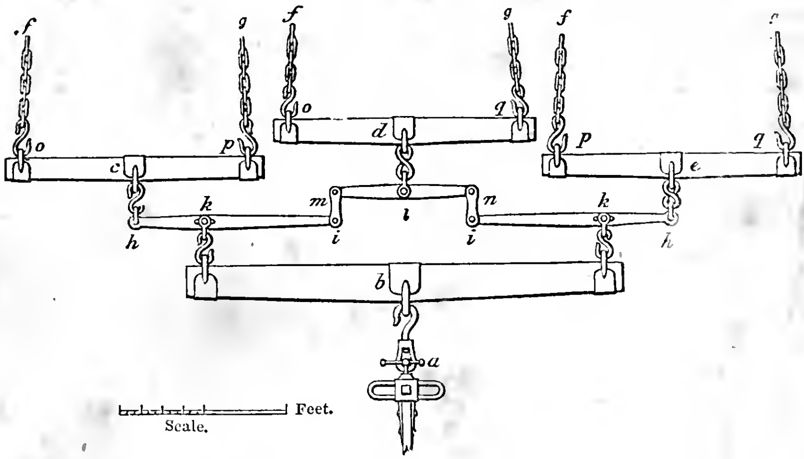
TRUSSED IRON SWING-TREE.

hooks and chains. A tree thus formed is sufficiently strong for every purpose to which it is applied, while its weight does not exceed 7 lb., and the weight of a wooden tree, with its mounting, frequently weighs 8 lb. The price of a set of common wooden trees, with the iron mounting, is 12s., and of the iron trees 16s.

669. This form of swing-trees is adapted for the use of two horses, but ploughing is sometimes performed by three horses, such as in cross-furrowing, or in breaking up stubble in autumn, when the land is clean, or in ploughing old rough lea ground; and sometimes four horses are employed at one time in the plough, when the subsoil or trench plough is used. There are various ways of yoking *three* horses to the plough, the simplest of which is a pair working in the common trees, fig 6; and for the third horse, a light chain is attached by a shackle to the middle of the main bar *b b*. To this chain a third horse is yoked, taking his place in front of the other two, in unicorn fashion. This yoke is defective, inasmuch as there are no means of equalising the draught of the third horse.

670. Perhaps the most perfect method of yoking a 3-horse team, whether abreast or unicorn-fashion, is that by the *compensation levers*, fig. 8—a statical combination, which is at once correct in its equalisation, scientific in principles, and elegant in arrangement. The apparatus in the figure is represented as applied to the subsoil plough; *a* being the bridle

Fig. 8.



THE SWING-TREES FOR THREE HORSES.

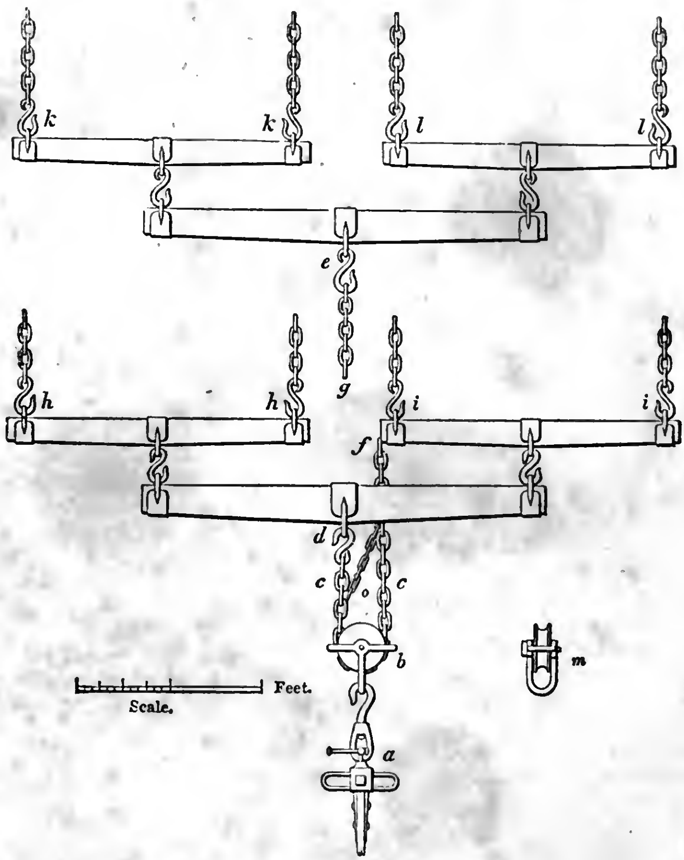
of that plough; *b* is a main swing-tree, of strength proportioned to the draught of 3 horses; and *c d e* are three small common trees, one for each horse. The trace-chains are here broken off at *f*, *g*, respectively. Between the main swing-tree and the three small ones the compensating apparatus is placed, consisting of three levers, usually constructed of iron. Two of these, *h i* and *h i*, are levers of the first order, but with unequal arms, the fulcrum *k* being fixed at $\frac{1}{3}$ of the entire length from the outward end of each; the arms of these levers are therefore in the proportion of 2 to 1, and the entire length of each between the points of attachment is 27 inches. A connecting lever *l*, of equal arms, is jointed to the longer arms *i i* of the former, by means of the double short links *m*, *n*. The two levers *h i*, *h i*, are hooked by means of their shackles at *k* to the main swing-tree *b*; and the three small swing-trees *c*, *d*, *e*, are hooked to the compensation lever at *h*, *h* and *l*.

671. The judicious farmer will frequently see the propriety of lightening the labour of some individual horse; and this is easily accomplished by the compensation apparatus. For this purpose, one or more holes are perforated in the levers *h i*, on each side of the true fulcrum *k*, to receive the bolt of the small shackle *k*. By shifting the shackle and bolt, the relation of the forces *h* and *i* are changed, and that in any proportion that may be desired; but it is necessary to observe that the *distance* of the additional holes, on either side of the central hole or fulcrum of equilibrium in the system,

should be in the same proportion as the length of the arms in which the holes are perforated. Thus, if the distance between those in the short arm is half an inch, those in the longer arm should be an inch. By such arrangement, every increase to the exertion of the power, whether on the long or the short arm, would be equal.

672. The same principle of compensation has been applied to various ways of yoking, one of which is a complicated form of that just described. The main swing-tree and the compensation levers are the same, except that they may be a few inches shorter in all the arms, and the middle one of the three small swing-trees also shorter. The yoking is performed in this manner: The nigh trace-chain of the nigh horse is hooked to the end *o* of the swing-tree *c*, fig. 8, and his off-side trace-chain to the end *o* of the swing-tree *d*. The middle horse has his nigh-side chain hooked to the end *p* of the swing-tree *c*; while his off-side chain goes to the end *p* of the swing-tree *e*, and the off-side horse has his nigh-side chain attached to the end *q* of the middle swing-tree *d*, and his off-side to *q* of the swing-tree *e*. This system of yoking is complicated, and though in principle it equalises the forces so long as all the horses keep equally a-head, yet it is in some degree faulty. Whenever the middle horse gets either behind or before his proper station,—or out of that position which keeps all the swing-trees parallel to each other,—the outside horses have a larger share of the draught upon one

Fig. 9.



THE SWING-TREES FOR FOUR HORSES.

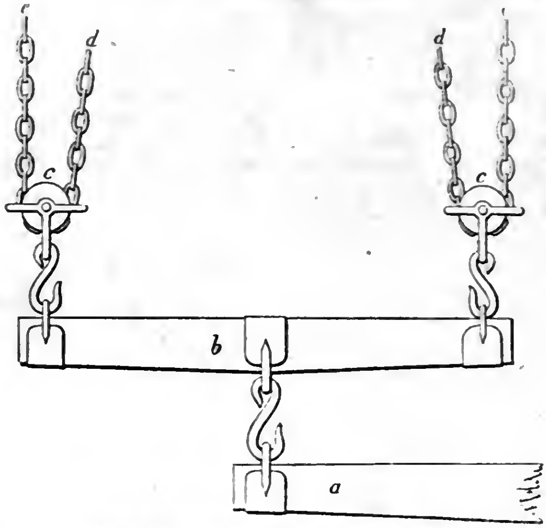
shoulder than upon the other; and as this produces an unnecessary fatigue to the animal, it should be avoided. Such irregularity cannot occur with the simple mode of giving each horse his own swing-tree. There are still other modifications in the yoking of three horses, but these may suffice for every practical purpose.

673. *In the yoking of* 4 *horses*, various modes are also adopted. The old and simple method is for the plough horses to draw by a set of common swing-trees, fig. 6; and to the centre of the main swing-tree at *e* a soam-chain is hooked by means of a shackle or otherwise. The leading horses are thus yoked by a second set of common swing-trees to the end of the soam. This is now seldom employed; but an improved method of applying the soam has been adopted in its place, which is represented by fig. 9, where *a* is the bridle of the plough, with its swivel hook. A pully *b* of cast-iron mounted in an iron frame, of which an edge-view is given at *m*, is attached to the hook of the bridle. A link chain *c* is rove through the frame of the pulley: and to one end of it, the short end, is hooked the main swing-tree *d* of a set of common trees. The other end of the chain passes forward to a sufficient distance to allow the leading horses room to work; and to it is hooked the second set of common swing-trees at *e* for the leaders. In the figure, a part of the chain, from *f* to *g*, is broken off; but the full length is about 11 feet. In this yoke, the trace-chains of the nigh-side hind horse are hooked to the swing-trees at *h h*, and those of the off-side horse at *i i*, the leaders being yoked at *k k* and *l l* respectively. In this arrangement, the balance of forces is perfectly preserved; for the hind horses and the leaders, as they pull at opposing ends of the chain passing round a pulley, which must inevitably be always in equilibrium, each pair of horses has an equal share of the draught; and from the principles of the common swing-trees through which each pair acts, the individual horses must have an equally perfect division of the labour. In order to prevent either the hind horses or the leaders from slipping too much ahead, it is common to apply a light check-chain *o*, of about 15 inches long, connecting the two parts of the main-chain, so as to allow only a short oscillation round the pulley, which is limited by the check-chain. When this is adopted, care should be taken never to allow the check-chain to remain upon the stretch; for if it do so, the advantage of equalisation in the yoke is lost, and it becomes no better than the simple soam. In all cases of using a chain, that part of it which passes forward between the hind horses must be borne up by means of attachment to their back bands, or suspended from their collars.

674. The late Mr Stirling of Glenbervie, Stirlingshire, recommended a method of yoking four horses in pairs, the arrangements of which are represented in fig. 10; *a* is part of a main swing-tree of the common length, *b*, a small swing-tree, a little longer than the usual length, but both mounted in the usual form, except that, at each end of the small swing-trees, cast-iron pulleys, *c c*, and set in an iron frame, are hooked on to the eyes of the swing-tree. The common trace-chains are rove through the frames of these pulleys, as in the figure, the ends, *d d*, of the chains are prolonged forward to the collar of the nigh-hind horse, and the ends, *ee*, are extended to that of the nigh leader. At the opposite end of the main swing-tree, which in this figure is cut off, the same arrangement is repeated for the off-side horses. The principle of action in this yoke is simple and effective, though different in effect from the former. There the two hind horses are equalised through the medium of their set of common swing-trees. The leading horses are alike equalised by their set, and thus the two pairs balance each other through the medium of the soam. Here, on the other hand, the two nigh-side horses have their forces equalised through the trace-chains which are common to both by passing over the pulleys, *cc*, and the same holds in respect to the two off-sides. The couple of nigh-side and of off-side horses, again, are equalised through the medium of the one set of swing-trees. In both, therefore, the principle of equalisation is complete, but there is a trifling difference in their economy. In the yoke, fig. 9, the soam-chain and pulley are the only articles required in addition to the every-day gear. In that of fig. 10, there is, first, the set of swing-trees, which, as they have to resist the force of 4 horses, must in all their

parts be made stronger than the common set; then the 4 pulleys have to be added, all of which are applicable only to this yoke; and lastly, the trace-chain, though

Fig. 10.



THE SWING-TREES ALSO FOR FOUR HORSES.

not necessarily stronger than those for common use, is required about three times longer than single horse-chains, that is to say, 4 horses will require the chains of 6; but, on the other hand, the chains of the leaders are more conveniently supported when they pass along the sides of the hind horses, and it is free of the annoyance of the swing-trees which dangle behind the leaders, of the method fig. 9.

675. In cases where 6, 8, and even 12 horses are required, such as for trenching, subsoil-ploughing, and especially draining with the plough, the yoking is accomplished by modifications and extension of the forms here laid down. For example, a team of 6 can be very conveniently applied with equalised effect by employing the compensation levers of fig. 8, along with 3 single swing-trees with pulleys at each end, and running trace-chains, as in fig. 10; but in all cases where more than 4 horses are yoked together, their strength can seldom be managed to have it simultaneously applied. It is therefore much better to work 2 sets of 4 horses than 1 set of 8.

676. *Plough harness.*—Besides swing-trees, horses require harness to enable them to apply their strength to the plough. The harness, as used in Scotland, is exceedingly simple, and perfectly efficient. It consists of a collar, fig. 11, which surrounds the neck of the horse, and serves as a padding to protect the skin of the neck, and the points of the shoulder, while the horse exerts his strength in the draught. This form of collar is used in the Lothians, and its covering consists of one piece of leather stiffened in its upper part with stripes of whalebone to form the cape. The body of the collar is stuffed with wheat-straw, or what is better, rye-straw, and covered with stout woollen cloth. It will be observed that the under part of the collar is broader than the upper, because the under part of the neck of a horse is thicker than the upper or mane, upon which the collar rests; but as the crown of the head of the horse

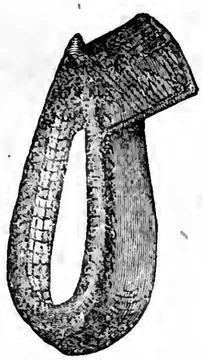
Fig. 11.

THE LOTHIAN DRAUGHT HORSE COLLAR AND HAIMS.

is broader than the muzzle, the collar is slipped over the head in the inverted position, and turned round upon the neck.

677. Another form of cape is seen in fig. 12, which is in use in Forfarshire and the midland districts. If the use of the cape is to prevent rain falling upon the top of the shoulder, and getting between the collar and the shoulder, and heating and blistering the skin there, this cape, which lies flatter and reaches farther back than that of fig. 11, should be preferable to it. It certainly forms a complete protection from rain, but makes the collar rather heavy, and the weight of the cape, from its much inclined position, is apt to cause the sewing to become loose.

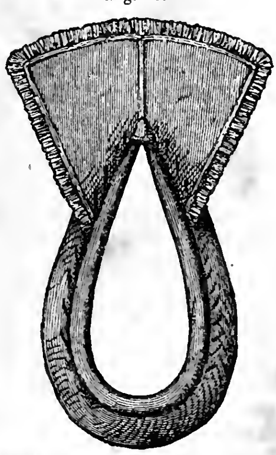
Fig. 12.



THE FORFARSHIRE DRAUGHT-HORSE COLLAR.

678. Fig. 13 is a form of cape common in England, which answers no purpose of

Fig. 13.



THE ENGLISH DRAUGHT-HORSE COLLAR.

protection from rain, but rather to catch the wind, and thereby obstruct the progress of the horse. Such a cape is frequently ornamented with flaring red worsted fringes round the edge, or with large tassels from the corner and middle, and even with bells.

679. The *haims* are placed immediately behind the outer rim of the collar at *a*, fig. 11. They consist of two pieces fixed below the throat of the horse with hooks and a link, and at the upper part at *a* with a leather strap. The pieces are formed entirely of iron, or of wood covered with thin sheet-iron, as in the Lothians, or of wood alone, as in the greater part of Scotland. On each piece above the point of the shoulder of the horse is attached a staple with hook *h*, to which is fastened the trace-chains of the plough, or the draught-chains of the other implements, such as the cart. The haims are never removed from the collar.

680. Another part of the harness is the *bridle*, which serves to guide the horse's head. It is commonly of as simple a form as possible, consisting of a head-stall, nose-band, blinders, bit, throat-lash, and bearing-reins. In some parts of the country, the blinders or blinkers are omitted. The plea for the use of the blinders is, that they prevent the horse looking around and being frightened by distant objects he cannot distinctly see, and they keep his attention steady to his work. Horses accustomed to blinders are easily scared when they are taken off. I knew a horse that became so timid when his bridle was taken off, while in the yoke, that he always attempted to run away from the draught, and to avoid such an accident, the bit was removed from his mouth by means of a buckle and strap, when a feed of corn was given him in the nose-bag while in the yoke; but horses broke in without the bridle, are less likely to be scared by any occurrence in the road, than those accustomed to it, as they see every object near them distinctly; and the want of it keeps the head cooler in summer, and saves the eyes from injury by its pressure.

681. The *bearing reins* are now generally dispensed with in all carriages moved at a fast speed; and the change is a great relief to the horses, for truly it was a painful sight to witness the excessive tightness in which the horses' heads were kept by them. They were used with the view of making the horses look smart, and of preventing

their stumbling on the road ; but the notion was a mistaken one, for a horse never looks better than with the head in its natural position, and as to his being prevented stumbling by any form of rein, when he makes the slightest trip he cannot recover himself with his head bound up, and his fall becomes the more inevitable and severe. But in the case of the draught-horse the bearing reins cannot be dispensed with, as they are the only means of keeping his head steady in the draught, while they are never at all tight braced up, the horse having full liberty to use his head in any direction, though not to the most unlimited extent of turning it round altogether. The complete bridle may be seen in use in fig. 14 in the plough, and still better in the cart in Plate III.

682. Another piece of harness required for the plough-gear is the *back-band*, which consists of a broad piece of leather passing over the horse's back, having a small pad where it rests on the top of the back, and both ends are fastened to the trace-chains of the plough by means of small iron hooks, its office being to support them just *below* the exact line of their draught ; if above that line, the force of the draught would be thrown as a strain upon the groins of the horse, by means of the back-band.

683. A necessary portion of the equipment of a draught-horse in harness is the plough-*reins*, which are made of cord, on purpose light and strong, being fabricated of the best hemp. In some parts of the country, as the midland and northern districts, one rein attached to the nigh-horse only is used in driving a pair of horses in the plough, and the consequence is that most of their motions are performed by the command of the voice of the ploughman—the only use of the rein, in such a case, being to pull the horses to the nigh-side. To give the ploughman a perfect command of his horses, double reins should be used—one passing from the left-hand stilt of the plough by the nigh-side of the nigh-horse, through one ring on the nigh-side of the back-band, then through another ring on the nigh-side of the haims, to the ring of the bridle-bit, to which it is fastened : the other rein goes from the right hand stilt of the plough by the off-side of the off-horse, through rings in the back-band and haims to the bridle-bit on the off-side of the off-horse. The ends of the reins are looped upon the handles of the stilts of the plough.

684. With regard to ornamenting farm harness, it never appears, in my estimation, to greater advantage than when quite plain, and of the best materials and workmanship. Brass or plated buckles and brow-bands, worsted rosettes, and broad bands of leather tattooed with filigree sewing, serve only to load and cover the horses when at work, to create trouble, collect dirt, and at best display a wasteful and vulgar taste in the owner. Whatever temptation there may be in towns to show off the grandeur of the teams of rival establishments, such displays of vanity are incompatible with the country.

685. Thus harnessed, each horse has not much weight to bear, nor is its harness costly, though made of the strongest harness leather, as this statement will show :—

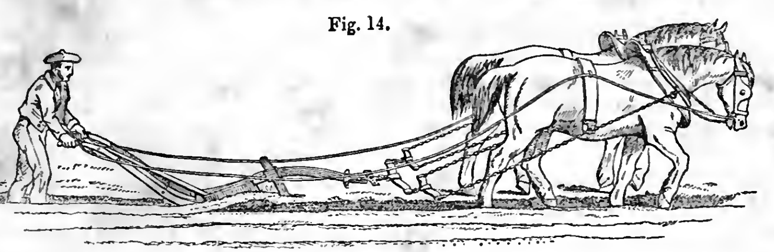
	Weight.		Value.		
Collar, ...	15 lbs.		£1	0	0
Haims, when covered with plate-iron, and with a strap,	7		0	5	6
Bridle, . . .	4½		0	10	0
Back-band, . .	3½		0	8	0
Chains, . . .	8	at 7d. per lb.	0	4	8
Making a total weight for each horse of	38 lbs., and of cost,		£2	8	2

When compared with the weight of English harness, these constitute little more than feather-weight.

686. The English farmer is not unfrequently recommended by writers on agriculture to adopt the two-horse plan of working the plough ; but the recommendation is never accompanied with such a description of the plough as any farmer may understand, who had never seen a plough with two horses at work ; and it is not enough to tell people to adopt any new plan, without putting it in their power to understand what is recommended. To enable the English farmer, who may never have chanced to see a two-horse plough at work, and to facilitate the understanding of its arrangements by those who may have seen, but not have paid sufficient attention to it, fig 14 is here given, of a Scotch plough with swing-trees, horses and

harness complete, and of a ploughman holding it. The extreme simplicity of the whole arrangement of the horses, harness, plough, and man, cannot fail to impress a conviction that no part of it can go wrong. On examining the particulars, the

Fig. 14.



A SCOTCH PLOUGH AT WORK.

collar will be found round the horses' necks, serving as a padding to preserve the shoulders from injury while pressing forward in the draught. Embracing a groove in the anterior part of the collar, are the *haims.* The horses are yoked to the swing-trees by light *trace-chains*, linked on one end to the hooks of the haims, and hooked at the other into the eyes of the swing-trees. *Back-bands* of leather across the back, near the groins of the horses, support the trace-chains by means of simple hooks. The *bridles* have blinders, and the *bearing-reins* are supported on the top of the haims. The *swing-trees* are hooked to the draught-swivel of the bridle of the plough, enabling both horses to exercise their united strength on that single point; and being yoked abreast, they are enabled to exert their united strength much more effectually than if yoked a-trip—that is, one before the other. The two horses are kept together either by a *leather-strap*, buckled at each end to the bridle-ring, or by short rein-*ropes* or *tugs*, passed from the bridle-ring to the shoulder of each horse, where they are fastened to the trace-chains by a knot. The strap only prevents the horses separating beyond its length, and allows their heads to move about loosely; but the short reins not only prevent them separating, but keep their heads steady; and on this latter account, horses fastened with them can be turned round more quickly and simultaneously than with the strap. The *reins* proceed from the ploughman's hands to the horses' heads. The off-side horse—that is, the one nearest to the spectator of the above figure—is seen to walk in the *last* made open furrow—the nigh-horse walking on the *firm land.* The plough is in the act of turning over a *slice* of land, and the ploughman is walking in the *new*-made open furrow.

687. *Language to horses.*—Besides the use of the reins, it is always customary to desire the horses to go through their accustomed motions when yoked to the draught, with the voice. It would be quite possible to cause the horses to perform all their motions by means of the double reins alone, but the voice enlivens the monotony of a day's work both to the men and the horses. It is not practicable to make horses at the plough go through the proper motions with a single rein, unassisted by the voice; nor is the single rein at all commendable, inasmuch as ploughmen accustomed to it, fall into the practice of incessantly bawling to their horses, which at length become regardless of the noise, and make the turns at their own leisure.

688. The language addressed to horses varies as much as do the dialects in different parts of the country. One word, *Wo*, to stop, seems, however, to be in general use. The motions required to be performed by the horse at work, are, to go forward, to go backward, to go from you, to come towards you, and to turn round, and the cessation from all these, namely, to stop or stand still.

689. *To lessen or cease motion.*—The word *Wo* is the common one for a cessation of motion; and it is also used to the making any sort of motion slower; and it also means to be careful, or cautious, or not be afraid, when pronounced with a protracted tone, such as *Wo-o-o.* In some parts, as in Forfarshire, *Stand* has a similar signification; but there, when it is

desired of the horse to stand without any movement at all, the word *Still* is added—*stand, still.* In England, *Wo* is to stop.

690. *To go forward.*—The name of the nigh-horse is usually pronounced, as also the well-known *Chuck, Chuck*, made with the side of the tongue at one side of the mouth, while inhaling the breath in impulses.

691. *To step backward.*—*Back* is the only word I can remember to have heard for this motion.

692. *To come towards you.*—*Hie* is used in all the border counties of England and Scotland; *Hie here, Come ather*, are common in the midland counties of Scotland. In towns one hears frequently *Wynd* and *Vane.* In the west of England *Wo-e* is used.

693. *To go from you.*—*Hup* is the counterpart to hie in the southern counties, whilst *Haud aff* is the language of the midland counties; and in towns, *Haap* is used where wynd is heard, and *Hip* bears a similar relation to vane. In the west of England *Gee agen* is used.

694. In all these cases, the speaker is supposed to be on what is called the *nigh* or *near-side* of the horse—that is, on the horse's left side. As a single word is more convenient to use than a sentence, I shall employ the simple and easily pronounced words *hup* and *hie* when having occasion to describe any piece of work, in which horses are employed.

695. The plough, as it is now made, consists of a number of parts; but, how well soever these different parts may be put together, if not *tempered*, as it is termed, to one another, that is, if any part has more to do than its own share of the work, the entire implement will go unsteadily. It is easy to ascertain whether or not a plough will go steadily.

ON PLOUGHING, AND PLOUGHING MATCHES.

696. *Ploughing.*—On holding a plough by the handles with both hands, while the horses are drawing it through the land, if it have a constant tendency to go deeper into the soil than the depth of the furrow-slice previously determined on, it is not going steadily. The remedy is twofold, either to press harder upon the stilts with the hands, and, by their power as levers, bring the share nearer the surface of the ground, or to put the draught-bolt of the bridle a little nearer the ground, and thus give the plough less "*earth.*" The pressure upon the stilts should first be tried, as being the most ready at command; but should it fail of effecting the purpose, and holding the stilts be then too severe upon the arms, the draught-bolt should be lowered; and should both these expedients fail, there must be some error in another part of the plough. On examining the share, its point may possibly be found to dip too much below the base line, which will cause it to go deeper than it should. This error in the share can only be rectified at the smithy.

697. Again, the plough may have a tendency to come out of the ground. This cannot be remedied by supporting the stilts upwards with the arms, because the body having no support cannot walk steadily in the furrow. Hence, a very short man can scarcely hold a plough steady at any time; and does not make a desirable ploughman. The draught-bolt should, in the first instance, be placed farther from the ground, and give the plough more "*earth.*" Should this not effect the purpose, the point of the share will probably be above the base-line, and must therefore be brought down to its proper level by the smith.

698. It may be difficult to make the plough turn over a furrow-slice of the breadth desired. This tendency is obviated by moving the draught-bolt a little to the right, which gives the plough more "*land;*" but in case it arises from some casual obstruction under-ground, such as direct collision against a small stone, or a piece of unusually hard earth, it may be overcome by leaning the plough a little over to the right.

699. The tendency, however, may incline to take a slice broader than is wanted; in which case, for permanent work, the draught-bolt should be put a little to the left, which gives the plough less "*land;*"

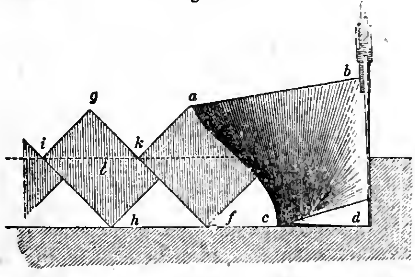
and for a temporary purpose the plough may be leaned a little over to the left.

700. These are the ordinary causes of unsteadiness in the *going* of ploughs; and though narrated singly, any two of them may combine to produce the same result, such as the going deeper or coming out along with a narrow or broad furrow-slice. The most obvious remedy should first be tried; but both may be adopted at the same time if a compound error is apprehended.

701. Some ploughmen habitually make the plough lean a little over to the left, thus giving it less land than it would naturally have, and to counteract the consequent tendency to a narrow furrow-slice, they move the draught-bolt a little to the right. This ploughing with a lean to the *left* is a bad custom, because it makes the lowest side of the furrow-slice thinner than the upper, which is exposed to view when turned over, and gives the appearance to the land of being ploughed equally deep; and it gives the horses a lighter draught than those which have turned over a deeper furrow-slice. Old ploughmen, becoming infirm, are very apt to practise this deceptive mode of ploughing. The plough should always move level upon its sole, and turn over a rectangular furrow-slice.

702. The difference in the inclination of the bottom of the furrow, here referred to, is made by ploughs of different construction, as well as practised by cunning ploughmen in the manner just described. The East Lothian or Small's plough, fig. 2, makes a rectangular furrow; the Lanarkshire or Wilkie plough makes a trapezoidal or crested furrow, and, as we are considering the subject, it may be well to illustrate it at once. Fig. 15 is an example of the rectangular slice of 10 by 7 inches: *a b c d* may be taken as a transverse section of the body of the plough, the line *a c* being the terminal outline of the mould-board, *a f* a section of the slice which is just being laid up, and *g h* a slice previously deposited. In the triangle *i g k* the base *i k* is 10 inches, being always equal to the breadth of the slice, the angle at *g* a right angle, and the sides *i g*, *g k* each equal to 7·071 inches, the perpendicular height *g l* being 5 inches.

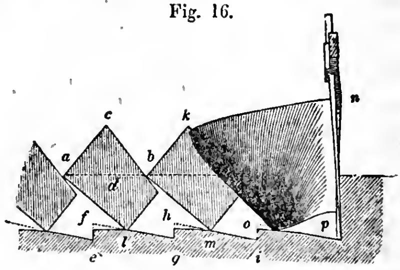
Fig. 15.



THE EFFECTS OF A RECTANGULAR FURROW-SLICE.

703. Fig. 16 is a similar representation of a cresting plough, with its effects on the slice and the subsoil; *k n p o* is a section of the plough, *k m* a section of a slice in the act of being deposited on the preceding slice *l c*. Here the slices are trapezoidal, as they are always cut by this species of plough; and from this configuration of the slice, the broader sides are not parallel, nor do the conterminous sides of the adjacent slices lie parallel to each other in the transverse direction; the side *b c* lying at an angle of 48° with the base *a b*, while the side *b m* makes the opposite angle at *b* only 41°, the angle at *c* being 84°, and the triangle *a b c* isosceles. The base *a b* of the triangle *a b c* is now supposed to be 8½ inches, and the side *a c* 6½ inches, the opposite side *l h* being 4½ or 5 inches. The base, *a b* when bisected in *d*, gives $a\ d = 4{\cdot}25$ inches, and since $a\ c^2 - a\ d^2 = c\ d^2$, *c d* will be 4·918 inches; but cases occur still more extreme, *a b* being only 7½ inches, but the angle at *c* becomes as acute as 75°, yet with these dimensions *c d* is still under 5 inches; hence, in all practical cases, with a furrow less than 9 inches in breadth, the result

Fig. 16.



THE EFFECTS OF A TRAPEZOIDAL OR CRESTED FURROW-SLICE.

will be a reduction in the quantity of the land as a cover for seed.

704. Another point remains to be noticed in reference to these two forms of slice. We have seen that the rectangular slice necessarily implies that the bottom of the furrow shall be cut upon a level in its transverse section, fig. 15, while the slice that is cut by the cresting plough leaves the bottom of the furrow with a sloping rise from the land-side towards the furrow-side at every slice, and this rise may range from 1 to 1½ inch or more. Returning to fig. 16, the serrated line *f h o*, exhibits a transverse section of the surface of the subsoil, from which the soil has been turned up by the cresting plough. The triangular spaces *e f g*, *g h i* represent the quantity of soil left by such ploughs at the lifting of each slice. Each quantity may amount to one-seventh of what the slice ought to be, and is robbed from it, and left adhering to the subsoil, except in so far as it may be rubbed down by the abrading action of the lower edge of the mould-board, as at *f* and *h*, and the portion of soil so rubbed off is thrust into the space under the edge of the slice as it is successively laid up. This last process may be readily observed at any time when the plough is working in tough land or in lea. With a cresting plough, the spaces *f*, *h*, *o* will be seen more or less filled up with crumbled soil; while, with the rectangular plough, the corresponding spaces will be left nearly void. Whether or not the filling in of these voids is beneficial to the land in a greater degree than if the seventh here left below had been turned up with the slice, I should say it was not; but it is certain, that it is more frequently left adhering to the subsoil than to be found stuffed under the edge of the slice. Under any view, the system of the crested furrow ploughing is not equal in value to the rectangular.

705. In considering this question, there are two points deserving attention. 1st, The immediate effects upon the labour of men and horses. It may be asserted generally, that all ploughs adapted to form a crested furrow are heavier in draught than those that produce the rectangular furrow. This seems a natural inference from the manner in which they work; the tendency that they all have to *under*-cut by the coulter; the narrow feather of the share leaving more resistance to the body in raising and turning the slice; and, not least, the small ridge left adhering to the bottom of the furrow, if rubbed down and stuffed under the slice, is performed by an unnecessary waste of power, seeing that the mould-board is not adapted for removing such adhering obstructions. 2d, The loss of time and labour arising from the breadth of furrow, compared with those ploughs that take a 10-inch furrow. Thus, in ploughing an imperial acre with a 10-inch furrow, — leaving out of view the taking up of closings, turnings, &c,—the distance walked over by the man and horses will amount to 9·9 miles nearly; with a 9-inch furrow the distance will be 11 miles; with 8½-inch furrow, it will be 11½ miles or thereby; and with a 7½-inch furrow 13¼ miles nearly.

706. But to resume our more immediate subject, no ploughman assumes the habit of leaning the plough over to the *right*, because it is not so easy to hold it in that position.

707. Other ploughmen, especially tall men, are in the habit of constantly leaning hard upon the stilts; and as this has the tendency to lift the plough out of the ground, they are obliged to put the draught-bolt higher up to keep it in the ground. A slight leaning of the hands upon the stilts is requisite at all times, to retain a firm hold of them, and give a quick guidance to the plough.

708. A *good* ploughman will use none of these expedients to make his plough go steadily; for, he will temper the irons so, as there shall be no tendency in the plough to go too deep or too shallow into the ground, or make too wide or too narrow a furrow-slice, or cause less or more draught to the horses, or less or more trouble to himself, than the work requires to be performed in the best manner; and he will also temper them so, as to hold the plough with ease to himself, have plenty of leisure to guide the horses aright, and execute the work in a creditable manner. I have known such ploughmen, and they invariably did their work the best; but I never yet saw a ploughman do so, who

had not acquired the art of tempering the irons. Until this art is acquired, the best-made plough will be comparatively worthless in the hands of any ploughman.

709. In the attempt to temper the irons, many ploughmen place the coulter in a position which increases the draught of the plough. When its point is brought down as far as that of the share, and much asunder from it, to the left or land side, (fig. 4) a stone in light land is very apt to be caught between the points of the coulter and share, which will have the effect of throwing the plough out of the ground. Such an accident is of little consequence in ploughing land to be ploughed again; but it disfigures the land in ploughing lea, and must be rectified instantly; but in doing this, time is lost in backing the horses to the spot where the plough was thrown out. To avoid such an accident on lea-ploughing, *on such land*, the point of the coulter should be put immediately above, and almost close upon, that of the share. In smooth soils, free of small stones, the relative positions of the points of the coulter and share are not of much importance as regards the steadiness of the plough; but the best practice is always to cut the soil clean.

710. The *state of the irons* themselves has a material effect on the temper of the plough. If the cutting edge of the coulter, and the point and cutting edge of the share, are steeled, the irons will cut clean, and go long in smooth soil. This is an economical treatment of plough-irons for clay-soils. But in gravelly, and all sharp soils, (355) the irons wear down so very quickly, that farmers prefer them of cold iron, and have them laid anew every day, rather than incur the expense of steeling them, which perhaps would not endure the work much longer. Irons are now seldom if ever steeled; but whether steeled or not, they are always in the best state when sharp, and of the requisite dimensions.

711. An imperfect state of the mould-board is another interruption to a perfect temper of the plough. When new and rough, the soil adheres to it, and, pressing against the turning furrow-slice, causes the plough to deviate from its right course. On the other hand, when the mould-board is worn away much below, it leaves too much of the crumbled soil on the bottom of the furrow, especially in loose soils. Broken side-plates, or worn into holes, easily admit the soil through them into the body of the plough, and cause a rough and unequal edge to the firm land; and when soil accumulates in the body, it affects the plough, both in temper and draught. These remarks are made on the supposition that all the ploughs are equally well made, and may, therefore, be tempered equally well; but ploughs are sometimes so ill constructed, that the best tempering the irons are capable of receiving will never make them do good work.

712. When all the particulars which ploughmen should attend to in executing their work—in having their plough-irons in a proper state of repair, in tempering them according to the kind of ploughing to be executed, in guiding their horses, and in ploughing the land in a methodical way—are considered, it ceases to surprise one that so few ploughmen become first-rate workmen. Good ploughmanship requires greater powers of observation than most young ploughmen possess,—greater judgment than most will take time to exercise,—more patience than most will bestow to become familiarised with all these particulars,—and greater skill than most can acquire to use them all to the best advantage. To be so accomplished, implies the possession of talent of no mean order. The ship has been aptly compared to the plough, and the phrase "ploughing the deep," is as familiar to us islanders as ploughing the land: to be able to put the ship in "proper trim," is the perfection aimed at by every seaman—so, in like manner, to "temper a plough" is the great aim of the good ploughman; and to be able to do it with judgment, to guide horses with discretion, and to execute ploughing correctly, imply a discrimination akin to sailing a ship.

713. But want of attention is the great bar to young men becoming good ploughmen; and if they do not acquire the art when comparatively young, they will never do so in an advanced period of life. It is want of attention at first that makes some ploughmen bunglers all their days, and the great majority exhibit but medi-

ocre attainments. The latter class no doubt is preferable to the former, because the injurious effects of *bad* ploughing are obvious; but the effects of mediocre compared with first-rate ploughing not being so easily ascertained, must nevertheless be considerable. "It is well known," says Sir John Sinclair, "that the horses of a good ploughman suffer less from the work than those intrusted to an awkward and unskilful hand; and that a material difference will be found in the crops of those ridges tilled by a bad ploughman, when compared to any part of the field where the operation has been judiciously performed." * Marshall contends that "one-fourth of the produce of the arable lands of the kingdom is *lost* through a *want of tillage*," † which may have been an approximation to the truth in his day; but ploughing is certainly now better performed in Scotland than it was then, though it must be owned that by far the greatest part of that work is yet of a mediocre description; and other reasons than I have given for its mediocrity are not difficult to adduce. Thus—

714. *Ploughmen* cannot learn their profession at a very early age, and every profession ought to be acquired then, to reach a high attainment in it; because ploughing requires a considerable degree of strength, even from grown-up men, and it bears much harder on the learner; but even after young men possess sufficient strength to hold the plough, they are left to acquire a knowledge of ploughing more through sheer experience than by tuition from those better acquainted with the art. Experience cannot be transmitted from father to son more in this than in any other art; and in this, as in other arts, improvement is more generally effected by imitation of a better style of work than by individual ingenuity.

715. To teach a young beginner to plough, it has been recommended, "to put a cross-bar between the cheeks of the bridle, so as to keep the horses precisely at the same distance from each other, and then, setting up a pole at the end of a furrow, exactly measured to the same line as that from which he starts, fixes his eye steadily upon it, and carries the plough in a direction precisely to that point." ‡ To do all this implies that the beginner has sufficient strength to hold a plough, which, if he have, he must be a stout lad; and to "fix the eye steadily" upon a pole at a distance, while holding the plough with a staggering gait, and unable for want of breath to speak even a word to the horses, far less to guide them with the reins, is much beyond the power of any lad, and far more of a boy. In fact, it would require a very good ploughman to do all this, for it is nothing short of feering, and none but the expertest of the ploughmen is intrusted to feer land on a farm. No single pole, besides, can possibly guide any ploughman in a straight line: he may imagine he is moving to it in a straight line, while all the while he may be forming a very devious route. The truth is, the young man, desirous of becoming a ploughman in a short time, ought to be taught day by day by an experienced ploughman to temper the irons, and guide the plough according to his strength. Very few young men have, or are permitted to have, such opportunities of learning; and the consequence is, and my observation confirms it, the best ploughmen are generally those who have been taught directly by their fathers, and work constantly upon their fathers' farms; and they make, besides, the best stewards, because they have been accustomed to command servants, and have not associated freely with them. A steward promoted from the rank of common ploughmen is apt to continue on too familiar a footing with them to sustain the authority due to his situation.

716. In England boys are not unfrequently sent to *tend* the plough, for they cannot be said to hold it, which is so constructed with wheels and apparatus as to turn over the soil without the aid of man, and his aid is only required for the turnings at the ends of the ridges. The work performed by such implements is a mere skimming of the ground, not ploughing it.

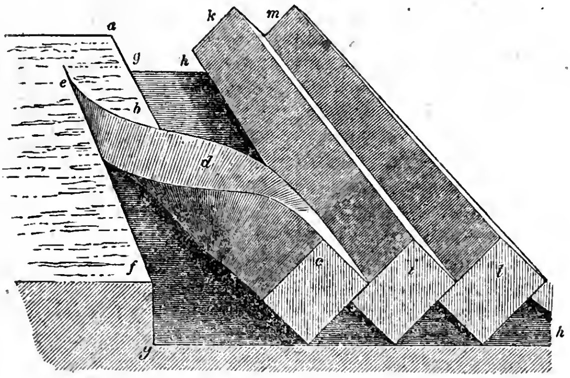
717. As I have adverted to the English

* Sinclair's *Code of Agriculture*, p. 298, fifth edition. † Marshall's *Gloucestershire*, vol. i. p. 72.
‡ *British Husbandry*, vol. ii. p. 39.

mode of ploughing, it may be worth while to show the great difference in the weight of soil turned over in a deep and shallow furrow. If 10 inches are taken as a fair width for a furrow-slice, there will be 18 such slices across a ridge of 15 feet in breadth; and taking 7 inches as a proper depth for such a furrow-slice, a cross section of the slice will have 70 square inches. A cubic foot of earth is thus turned over in every 24·7 inches of length of such a slice; and taking 1·48 as the specific gravity of common earth, (119) the 24·7 inches of slice will weigh 6 stones 8 lb. imperial. If a furrow of only 4 inches in depth is taken, and its breadth should only be 9 inches, the area of the slice will be 36 square inches, and its weight will be $\frac{36}{70}$ of 6 stones 8 lb., or 3 stones 5 lb., a considerable difference of weight for horses to turn over in the same distance travelled.

718. The proper form and position of the furrow-slice are essential requisites in good ploughing. The furrow-slice should always be of such dimension, and laid in such position, that the two exposed faces in a series of slices shall be of equal breadth, and any departure from this rule is a positive fault. Laid up agreeably to this rule, furrow-slices will not only present the maximum of surface to the atmosphere, but also contain the maximum of cubical contents. Fig. 17 represents the movement of the furrow-slice, as well as its position after it is laid by the plough, where *a b* is the edge of the land as cut by the preceding furrow; *c d* the slice in the act of turning over, but from which the plough has been removed; *e f*, the edge of the land from which the slice *c d* is being cut; *g h*, *g h* the sole of the furrows, and *i k l m*, slices previously laid up. A consideration of this figure will also show, that the extension of the slice takes place along the land-side edge *e d* only, from *e* to where the backward flexure is given to it when rising on the mould-board; and where it is again compressed into its original length, by the back parts of the mould-board in being laid down. The slices *c i l*, are laid over at an angle of 45 degrees; and in slices of 7 inches in depth and 10 inches in breadth, the altitude of the triangle at *c*, *i*, and *l*, is 5 inches, each of their sides 7·071 inches, and the sum of the two exposed faces 14·142 inches.

Fig. 17.



A VIEW OF THE MOVEMENT OF THE FURROW-SLICE.

719. *Correct ploughing* possesses these characteristics:—The furrow-slices should be quite straight; for a ploughman that cannot hold a straight furrow is unworthy of his charge. The furrow-slices should be quite parallel in length, and this property shows that they have been turned over of an uniform thickness; for thick and thin slices lying together present irregularly horizontal lines. The furrow-slices should be of the same height, which shows that they have been cut of the same breadth; for slices of different breadths, laid together at whatever angle, present unequal vertical lines. The furrow-slices should present to the eye a similar form of crest and equal surface; because where

one furrow-slice exhibits a narrower surface than it should have, it has been covered with a broader slice than it should be; and where it displays a broader surface than it should have, it is so exposed by a narrower slice than should be upon it. The furrow-slices should have their back and face parallel; and to discover this property after the land has been ploughed requires rather minute examination; but it is easily ascertained at the time of ploughing. The ground, on being ploughed, should feel equally firm under the foot at all places, for slices in a more upright position than they should be, not only feel hard and unsteady, but will allow the seed-corn to fall down between them and become buried. Furrow-slices in too flat a state always yield considerably to the pressure of the foot; and they cover each other too much, affording insufficient mould for the seed. Furrow-slices should lie over at the same angle, 45°, thus presenting crests in the best possible position for the action of the harrows. Crowns of ridges formed by the meeting of opposite furrow-slices, should neither be elevated nor depressed in regard to the rest of the ridge; although ploughmen often commit the error of raising the crowns too high into a crest, the fault being easily committed by not giving the first furrow-slices sufficient room to meet, and thereby pressing them upon one another. The last furrow-slice should be uniform with those of the rest of the ridge; but ploughmen are very apt to miscalculate the width of the slices near the sides of the ridges; for if the specific number of furrow-slices into which the whole ridge should be ploughed are too narrow, the last slices of the open furrow will be too broad, and will therefore lie over too flat; and should this too broad space be divided into two furrows, each slice will be too narrow, and stand too upright. When the last furrows are ill made, the open furrow cannot be proportionately ploughed out; because, if the space between the last furrows is too wide, the open furrow must be made too deep to fill up all the space; and, if too narrow, there is not sufficient mould to make the open furrow of the proper size. If the last furrow-slices are laid too flat, the open furrow will throw too much mould upon the edges next the open furrow, and thus make them too high. When the last furrows of adjoining ridges are not ploughed alike, one side of the open furrow will require more mould than the other.

720. The usual *speed* of horses at the plough may be ascertained in this way. A ridge of 5 yards in breadth requires a length of 968 yards to contain an imperial acre; to plough which at 9 bouts, (a bout being a walk along a ridge and back again,) of 10-inch breadth of furrow-slice, counting no stoppages, will make the horses walk 9·9 miles, which in 10 hours gives a speed of 1742 yards per hour; and at 10 bouts of 9-inch furrow-breadth, gives 11 miles of travel to the horses, or 1936 yards per hour. But as ridges are not made of 968 yards in length, and as horses cannot draw a plough that distance without being affected in their wind, and as allowance must be made for time lost in turning at the ends of the ridges, as well as for affording rest to the horses, those speeds will have to be considerably increased to do that quantity of work in the time. By an experiment, which is related by Sir John Sinclair as having been made by a late Earl of Mar, it was found, that 1 hour 19 minutes out of 8 hours are lost by turnings while ploughing an acre on ridges of 274 yards in length, with an 8-inch furrow-slice.* Hence, in ploughing an acre on ridges of 250 yards in length, which is the length of ridge I consider the best for horses in draught, the time lost by turnings, in ploughing 10 hours, with a 10-inch furrow-slice, is 1 hour 22 minutes. I presume that the experiment alluded to does not include the necessary stoppages at times for rest to the horses, but which should be included; for however easy the length of ridge may be for the draught, horses cannot go on walking in the plough for 5 hours together (one yoking) without taking occasional rests. Now 250 yards of length of ridge give 3·8 ridges to the acre, or 34 bouts of 10-inch furrows; and allowing a rest of one minute in every other bout, 17 minutes will have to be added to the 1 hour 22 minutes lost—that is, 1 hour 39 minutes lost out

* Sinclair's *Code of Agriculture*, p. 306, fifth edition.

of every 10 hours, for turnings and rest. Thus 17,424 yards will be ploughed in less than $8\frac{1}{3}$ hours, or at the rate of rather more than $1\frac{1}{2}$ mile per hour, or nearly 13 miles of walking in ploughing an acre in $8\frac{1}{3}$ hours. These results are perhaps near the truth in ploughing lea in spring; they are too little in ploughing red land in summer, and perhaps too much in ploughing stubble land in winter; but, as lea-ploughing is the criterion by which all others are estimated, they may be taken as an approximation to the truth.

721. Taking further data from the same experiment, the quantities of land ploughed in different speeds, at given breadths of furrow-slices, will be as under:—

Speed. Rate per Hour.	Distance walked in $8\frac{1}{3}$ hours.		Breadths of furrows ploughed.	Quantity of land ploughed in $8\frac{1}{3}$ hours at that speed.		
Miles.	Miles.	Yards.	Inches.	A.	R.	P.
1	8	1284	9	0	3	1
	8	440	10	0	3	14
$1\frac{1}{2}$	12	642	9	1	0	21
	12	220	10	1	0	34
2	17	808	9	1	2	2
	16	880	10	1	2	28
3	26	332	9	2	1	3
	24	1320	10	2	1	42

722. I have alluded to the time lost in turnings while ploughing land of any description. The following table shows the comparative amount of time lost in turning on ploughing long and short ridges derived from the same experiment.

Length of ridge.	Breadth of furrow-slice.	Time lost in turning.		Time devoted to ploughing.		Hours of work.
Yards.	Inches.	H.	M.	H.	M.	H.
78	10	5	11	4	49	10
149	...	2	44	7	16	...
200	...	2	1	7	59	...
212	...	1	$56\frac{1}{2}$	8	$3\frac{1}{2}$	...
274	...	1	22	8	32	...

Thus it appears that a ridge of no more than 78 yards in length requires 5 hours 11 minutes out of every 10 hours for turnings at the landings, with a 10-inch furrow-slice; whereas a ridge of 274 yards in length only requires 1 hour 22 minutes for turnings—making a difference of 3 hours 49 minutes in favour of the long ridge as regards the saving of time. Consequently, in the case of the shortest ridge, only 4 hours 49 minutes out of the 10 can be appropriated to ploughing; whereas, in that of the long ridge, 8 hours 32 minutes may be devoted to that purpose. Hence so very short ridges involve great loss of time to plough, and are therefore a decided loss to the farmer. This is a subject worthy of agricultural students to experiment on, in order to ascertain the exact time taken in ploughing and turning and resting on ridges of different lengths, in the different seasons, and in different soils. A watch with a good seconds-hand will be required to mark the time, and the observations should be made, unknown to the ploughmen, when at their usual rate of work; for any one constantly in the presence of the men, will cause more work than usual to be done, less than the usual rests taken, and less time lost.

723. Experiments on this subject were undertaken by a friend of mine in the spring of 1847. The standard of ploughing was taken at 4840 square yards, or 1 acre in 10 hours, on ridges of medium length, including the time consumed in the turnings. In comparing the ploughing of lea on ridges of 329 yards in length with those on 78 yards, it was found that the distance lost in ploughing the latter, in 10 hours was 1680 yards, the equivalent loss of which, in time, is rather more than 58 minutes. But as 329 yards is much longer than a medium length of 250 yards, and as the former actually incurred in ploughing a loss in time of 58 minutes, it follows that the entire loss of time incurred in ploughing an acre of ridges of 78 yards in length was 1 hour 45 minutes out of the 10 hours. This is a very different result from that obtained by the experiments of the Earl of Mar, related above.

724. In other fields the results were these, also in lea-ploughing:—

Ridges.	Length of ridge.	Time taken to plough one acre.		Loss of time.		Gain of time.	
	YDS.	H.	M.	H.	M.	H.	M.
No. 1	78	11	53	1	53	0	0
— 2	87	12	16	2	16	0	0
— 3	112	10	35	0	35	0	0
— 4	118	9	31	0	0	0	29
— 5	170	10	15	0	15	0	0

No. 1 ridges were on a steep hill, with thin clay soil resting on a tilly subsoil. The ridges on Nos. 3 and 5 were of the same clay soil, the upper part resting on till, the lower part on a light gravel. The results are too variable and contradictory to be depended on; but the subject is worthy of farther investigation and experiment, on ridges of various lengths, and on soils of different consistency.

725. When *horses are driven in the plough beyond their step*, they draw very unequally together, and, of course, the plough is held unsteadily. In that case, the plough has a tendency to take too much land; to obviate which the ploughman leans the plough over to the left, in which position it raises a thin broad furrow-slice, and lays it over at too low an angle. On the other hand, when the ploughman allows the horses to move at too slow a pace, he is apt to forget what he is about, and the furrow-slices will then, most probably, be made too narrow and too shallow; and though they may be laid over at the proper angle, and the work appear externally well enough executed, there will be a deficiency of mould in the ploughed soil.

726. There is another circumstance which greatly affects the speed of horses at work on some farms, I mean the *great steepness of the ground;* and it is not unusual to see the ridges traversing such steeps straight up and down. Ridges in such a position are laborious to plough, to cart upon, to manure, and for every operation connected with farming. The water runs down the furrows when the land is under the plough, and carries to the bottom of the declivity the finest portion of the soil. In such a position a ridge of 250 yards is much too long to plough without a breathing to the horses. Although the general rule of making the ridges run N. and S. is the correct one, in such a situation as a steep acclivity, they should be made to slope along the face of the hill, instead of running up and down the acclivity; and the slope will not only be easier to labour in every respect, but the soil will be saved being washed so much away in the furrows; but the direction of the slope should not be made at random, it should fall away to the right hand in looking up the acclivity, because then the plough will lay the furrow-slice down the hill when it is in the act of climbing the steep, and on coming down the hill the horses will be the better able to lay the slice up against the inclination of the ground. What the exact length of the ridges on such an acclivity ought to be, even with the assistance of the slope, I cannot say, but should imagine that 100 or 150 yards would be sufficient for the horses; but, at all events, there is no doubt it would be much better for the labour of the farm, as well as the soil, to have 2 fields 100 yards long each, one higher up the slope than the other, than the whole ground in one field of 200 yards in length.

727. *Ploughing matches.*—This seems to me a fitting place to say a few words on *ploughing matches.* I believe it admits of no doubt that, since the institution of ploughing matches throughout the country, the character of our farm-servants, as ploughmen, has risen to considerable celebrity; not but that individual ploughmen could have been found before the practice of matches existed as dexterous as any of the present day, but the general existence of good ploughing must be obvious to every one who is in the habit of observing the arable condition of the country. This improvement is not to be ascribed to the institution of ploughing matches alone, because superior construction of implements, better kept, better matched, and a superior race of horses, and superior judgment and taste in field labour in the farmer himself, are too important elements in influencing the conduct of ploughmen, to be overlooked in the consideration of this question.

728. But be the primary motive for improvement in the most important branch of field labour as it may, doubtless a properly regulated emulation amongst workmen of any class, proves a strong incentive to the execution of superior workmanship; and the more generally the inducement is extended, the more generally the improvement arising from it may be expected to be diffused; and on this account the *plough medals* of the Highland and Agricultural Society of Scotland, being open in competition to all

parts of Scotland every year, have perhaps excited a spirit of emulation among ploughmen, as a reward to those who excel, beyond any thing to be seen in any other country. Wherever 15 ploughs can be gathered together for competition at any time and place, there the ploughman who obtains the first premium offered by those interested in the exhibition, is entitled to receive, over and above, the Society's silver plough medal, bearing a suitable inscription, with the gainer's name engraved upon it. About 60 applications are made for the medals every year, so that at least 900 ploughmen annually compete for them; but the actual number far exceeds that number, as, in many instances, matches comprehend from 40 to 70 ploughs, instead of the minimum number of 15. Besides stated competitions, such matches are occasioned by the welcome which neighbours are desirous of giving an incoming tenant to his farm, and its heartiness is shown in the extent of the ploughing given him before he has collected a working stock sufficient for the purpose.

729. Ploughing-matches are generally very fairly conducted in Scotland. They usually take place on lea ground, the ploughing of which is considered the best test of a ploughman's skill, though I hold drilling to be much more difficult of correct execution. The best part of the field is usually selected for the purpose, if there be such, and the same extent of ground, usually from 2 to 4 ridges, according to the length, is allotted to each portion of the ground to be ploughed. A pin, bearing a number, is pushed into the ground at the end of each lot, of which as many are marked off as ploughs are entered in competition. Numbers, on slips of paper corresponding to those on the pins, are drawn by the competing ploughmen, who each takes possession of the lot he has drawn. Ample time is allowed to finish the ploughing of the lot, and in this part of the arrangements, I think too much time is allowed, to the wearisome annoyance of the spectators. Although quickness of time in executing the same extent of work is not to be compared to excellency of execution, it should enter as an important element in deciding the question of skill. Every competitor is obliged to feer his own lot, guide his own horses, and do every other thing connected with the work, such as assorting his horses and trimming his plough-irons, without any assistance.

730. The judges, who have been brought from a distance, and have no personal interest in the exhibition, are requested to inspect the ground after all the ploughs have been removed, having been kept away from the scene during the time the ploughs were engaged. This appears to me an objectionable part of the arrangements, which is made on the plea that, were the judges to see the ploughs at work, some particular ones might be recognised by them as belonging to friends, and their minds might thereby be biased in their favour. Such a plea pays a poor compliment to the integrity of a judge; and any farmer who accepts that responsible and honoured office, and would allow himself to be influenced by so pitiful a consideration, would deserve not only to be rejected on any such occasion, but scouted out of society. One consequence of the exaction of this rule is, loss of patience by the spectators, while the judges are occupying no more than the necessary time for deciding the ploughing of, it may be, a large extent of ground. The judges ought, therefore, to be present all the time of the competition, when they could find leisure calmly and minutely to ascertain the position and depth of the furrow-slices, and mature their thoughts on points which may modify first impressions. That the bare inspection of the finished surface cannot furnish satisfactory information as to the land having been correctly ploughed, but which must be obtained by comparing the soles of the furrows while the land is ploughing, I shall endeavour to show.

731. It has been seen (702) that the East Lothian plough lays over a slice of a rectangular form, and the Lanarkshire one of a trapezoidal form, and that the high-crest form of slice, and serrated furrow-sole, contain one-seventh less earth than the other. Now, were the surface-work only to be judged of, which must be the case when judges are prohibited seeing the work done in the course of execution, the serrated extent of the furrow-sole cannot so well be ascertained by removing portions of the ploughed ground here and

there, as by constant inspection. As equal ploughing consists in turning over equal portions of soil in the same extent of ground, other things being equal, a comparison of the quantity of earth turned over by these two kinds of ploughs can only be made in this way: In a space of 1 square yard turned over by each, taking a furrow-slice in both cases at 10 inches in breadth and 7 inches in depth, and taking the specific gravity of soil at 1·48, the weight of earth turned over by the East Lothian plough would be 34 st. 9 lbs., while the Lanarkshire plough would only turn over 29 st. 10 lbs., making a difference of 4 st. 13 lb. in the small area of 1 square yard. In these circumstances, is it fair to say that the horses yoked to the East Lothian plough have done no more work than those yoked to the Lanarkshire, or that the crop for which the land has been ploughed will receive the same quantity of loosened mould to grow in in both such cases? The prohibitory rule against the judges making their inspection during the ploughing has been relaxed in several instances; but, I fear, more from the circumstance of the spectators losing their patience while waiting for the decision, after the excitement of the competition is over, than from regard to the justness of principle. Thus may originate these and other common-sense remarks on the usual mode of conducting ploughing-matches; but the matter which follows will be found more important as affecting the character of good ploughing.

732. The primary objects of the institution of ploughing-matches must have been to produce the best examples of ploughmanship—and by the best, must be understood that kind of ploughing which shall not only *seem* to be well done, but must be throughout and properly done. To be particular, the award should be given to the plough that produces not only a proper surface finish, but exhibits, along with that, the power to cut and turn over the greatest quantity of soil in the most approved manner. That this combination of qualities has ceased to be the criterion of merit, is now sufficiently apparent to any one who will examine for himself the ploughing which has been rewarded in recent ploughing-matches; and the causes of such awards is this:—

733. The introduction of the Lanarkshire plough by Wilkie, gave rise, as is supposed, to the high-crested furrow-slice, fig. 16. It cannot be denied that the ploughs made on this principle produce work on lea land highly satisfactory to the eye of a ploughman, or to that of any person, indeed, who appreciates regularity of form; and as there are many minds who dwell with pleasure on beauty of form, but combine not the idea with usefulness, it is no wonder that work which thus pleases the mind, and satisfies the judgment through the sense of sight only, should become a favourite one. While the crested system of ploughing kept within bounds it was well enough, but, in course of time, the taste for the practice became excessive; and at length, losing sight of the useful, a depraved taste sacrificed utility to beauty, in as far as ploughing is concerned. This taste gradually spread itself over certain districts, and plough-makers vied with each other in producing ploughs that should excel in that particular quality. A keen spirit of emulation amongst ploughmen kept up the taste amongst their own class, and frequently the sons of farmers became successful competitors in the matches, which assisted to give the taste a higher tone. Thus, by degrees, the taste for this mode of ploughing spread wider and wider, until in certain districts it became the prevailing method. At ploughing-matches in those districts, the criterion of good ploughing was generally taken from the appearance of the surface; furrow-slices possessing the highest degree of parallelism, exposing faces of unequal breadth, and, above all, a high crest, carried off the palm of victory. I have seen a quorum of ploughing judges "plodding their weary way" for two hours together over a field, measuring the breadths of faces, and scanning the parallelism of slices, but who never seemed to consider the under-ground work of any importance, in enabling them to decide correctly. Under such regulations, it is not surprising that ploughmen devote their abilities to produce work to satisfy this vitiated taste, and that plough-makers find it their interest to encourage the desire, by exaggerating more and more the construction of those parts of the plough which produce the desired results. Thus have valuable institutions of ploughing-matches, in the districts alluded to, been unwittingly made

to engender an innovation which, though beautiful enough, and, when practised within due bounds, is also useful, has induced a deterioration in really useful and sound ploughing.

734. But it is not yet too late to retrieve what has been lost. Let the Highland and Agricultural Society of Scotland, and all local agricultural associations, institute a code of rules to guide the judges of ploughing-matches in delivering their awards. Let these rules direct the land to be thoroughly ploughed to the bottom of the furrow, as well as satisfactorily to the sight. When such rules shall be promulgated from competent authority, we may hope to see ploughing-matches exceed their pristine integrity—doing good to every one concerned in them, and restoring the confidence in them which is at present on the wane, but distrust in which has only arisen from an accidental misdirection of their proper object. Let, in short, *Small's* plough (fig. 2) be the only one patronised in all cases of ploughing in public competition, and individual farmers and ploughmakers will then find it their interest to use and make no other.

ON PLOUGHING DIFFERENT FORMS OF RIDGES.

735. One might imagine, that as the plough can do nothing else but lay over the furrow-slice, ploughing would not admit of any variety; but a short course of observation will show any student *the many forms in which land may be ploughed.*

736. The several modes of ploughing have received characteristic appellations, such as gathering up; crown-and-furrow ploughing; casting or yoking or coupling ridges; casting ridges with gore-furrows; cleaving down ridges; cleaving down ridges with gore-furrows; ploughing two-out-and-two-in; ploughing in breaks; cross-furrowing; angle-ploughing, ribbing, and drilling; and the preparative operations for all kinds of ploughing is termed feering or striking the ridges.

737. These various modes of ploughing have been contrived to suit the nature of the soil and the season of the year. Clay soil requires more caution in being ploughed than sandy or gravelly, because of its being more easily injured by rain; and greater caution is required to plough all sorts of land in winter than in summer. The precautions consist in providing facilities for surface-water to flow away. Though the different seasons thus demand their respective kinds of ploughing, some modes are common to all seasons and soils. Attention to the various methods can alone enable the agricultural student to understand which kind is most suitable to the circumstances of the soil, and the peculiar states of the season. To give the best idea of all the modes, from the simplest to the most complicated, let the ground be supposed to be even on the surface.

738. The supposed flat ground, after being subjected to the plough, is left either in *ridges or drills*, each of which occupy areas of similar breadth. Ridges are composed of furrow-slices (fig. 17) laid beside and parallel to one another, by the going and returning of the plough from one side of the field to the other. The middle part of the ridge receives the name of the *crown*,—the two sides, the *flanks*,—the divisions between the ridges, the *open furrows*,—and the edges of the furrow-slices next the open furrows, the *furrow-brows;* and the last furrows ploughed in the open furrows are named the *mould or hint-end furrows.*

739. The ridges are usually made in the direction of N. and S., that the crop growing upon both their sides may receive the light and heat of the solar rays in an equal degree throughout the day; but they, nevertheless, are made to traverse the slope of the ground, whatever its aspect may be, with the view of allowing the surface-water to flow most easily away.

740. Ridges are formed of different breadths, of 10, 12, 15, 16, and 18 feet, in different parts of Scotland; and in England they are formed as narrow as 8 and 6 feet, and even less. These various breadths are occasioned partly by the nature of the soil, and partly by local custom. As regards the soil, clay soil is formed into narrow ridges, to allow the rain to flow off very quickly into the open furrows, and in many parts of England, is ridged at only 10

and 12 feet in width, and in some localities are reduced to ridglets of 5 or 6 feet. In Scotland, even on the strongest land, they are seldom less than 15 feet, in some localities 16, and on light soils 18 feet. In Berwickshire and Roxburghshire, the ridges have for a long period been 15 feet on all classes of soils—being considered the most convenient width for the ordinary manual and implemental operations. In other districts 18 feet are most common. More than half a century ago ridges were made very broad, from 24 to 36 feet, high on the crown—from an idea that an undulated surface affords a larger area for the crop to grow on—and crooked like the letter S, from another mistaken notion that a crook always presents some part of the ridge in a right direction to the sun; which, although it did, removed other parts as far from it. In the Carse of Gowrie such broad crooked ridges may be still seen; but the common practice is to have the ridges of moderate breadth, straight, and pointing to noonday. In many parts of Ireland the land is not ploughed into ridges at all, being made with the spade into narrow stripes called *lazy-beds*, separated by deep narrow trenches. Where the plough is used, however, narrow ridges of 12 feet are mostly formed. For uniformity of description, let it be understood that I shall only speak of a ridge of 15 feet in width.

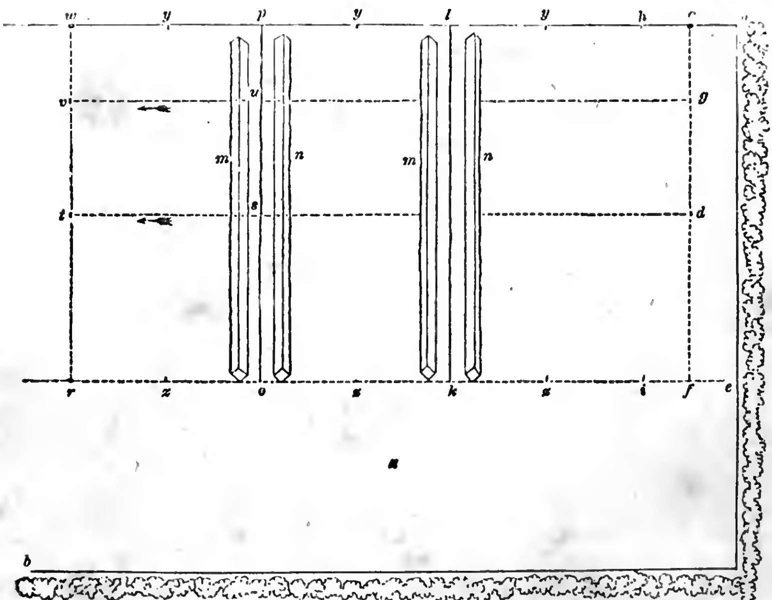
Fig. 18.

A FEERING POLE.

741. The first process in the ridging up of land from the flat surface is the *feering* it, which is done by placing upright, in the direction of the ridges, three or more poles (fig. 18) 8½ feet in length, graduated into feet and half-feet, and each painted at the top of a different colour, such as blue, red, white, to form decided contrasts with one another when set in line, and they should not be green, to be confounded with trees and hedges, nor brown, to be mistaken for the red land.

742. To make the important preliminary process of feering land more easily understood, let us suppose *a* and *b*, fig, 19, to present the S. and E. fences of a field, of which let *x* be the *headridge* or *headland*, of the same width as the ridges, namely 15 feet. To mark off the width of the headridge distinctly, let the plough pass in the

Fig. 19.



MODE OF FEERING RIDGES.

direction of *r e*, with the furrow-slice lying towards *x*. Do the same along the other headland, at the opposite side of the field. Then take a pole and measure off the width of a quarter of a ridge, viz. 3 feet 9 inches from the ditch lip, *a* to *c*, and plant a pole at *c*. With another pole set off the same distance from the ditch, *a* to *d*, and plant it there. Then measure the same distance from the ditch, at *e* to *f*, and at *f* look if *d* has been placed in the line of *f c*; if not, shift the poles, at *d* and *f* only, a little until they are all in a line. Make a mark on the ground with the foot, or set up the plough-staff, fig. 5, at *f*. Then plant the pole at *g*, in the line of *f d c*. Before starting to feer, measure off $1\frac{1}{4}$ ridge, namely, 18 feet 9 inches, from *f* to *k*, and plant a pole at *k*. Then start with the plough from *f* to *d*, where stop with the pole standing between the horses' heads, or else pushed over by the tying of the horses. Then measure with it, at right angles to *f c*, a line equal to the breadth of $1\frac{1}{4}$ ridge, 18 feet 9 inches, towards *s*, in the line of *k l*, where plant the pole. In like manner proceed from *d* to *g*, where again stop, and measure off $1\frac{1}{4}$ ridge, 18 feet 9 inches, from *g* towards *u*, still in the line of *k l*, and plant the pole there. Proceed to the other headridge to the last pole *c*, and measure off $1\frac{1}{4}$ ridge, 18 feet 9 inches, from *c* to *l*, and plant the pole at *l*. From *l* look towards *k*, to see if the intermediate poles are in the line of those at *l* and *k*, if not, shift them till they are so. On coming down *c f*, obviate any deviation which the plough may have made from the straight line. In the line of *f c*, the furrow-slices of the feering have been omitted, to show more distinctly the setting of the poles. The furrow-slices are shown at *m* and *n*.

743. As a means of securing perfect accuracy in measuring off the breadths of ridges at right angles to the feerings, lines at right angles to *f c*, from *d* and *g*, should be set off in the direction of *d t* and *g v*, by a cross-table and poles, and marked by a furrow drawn by the plough in each of these lines, before the breadths of the feerings are measured from *d* and *g*, along them. Most people do not take the trouble of doing this, and a proficient ploughman renders it the less necessary; but every careful farmer will do it, even at a little sacrifice of time and trouble, to ensure perfect accuracy of work.

744. It is essential to the correct feering of the whole field to have the two first feerings *f c* and *k l*, drawn correctly, as an error committed there will be transmitted to the other end of the field; and, to attain this correctness, two persons, the ploughman and the farm-steward, or farmer himself, should set the poles. An experienced ploughman, and a steady pair of horses, should alone be entrusted with the feering of land. Horses accustomed to feering will walk up of their own accord to the pole standing before them within sight.

745. Proceed in this manner to feer the line *k l*, and so also the line *o p*; but in all the feerings after the first, from *f* to *k*, the poles, of course, are set off to the exact breadth of the ridge determined on—in this case 15 feet, as from *k* to *o*, *l* to *p*, *s* to *t*, *u* to *v*, *p* to *w*, in the direction of the arrows. And the reason for setting off *c l* at so much a greater distance than *l p* or *p w* is, that the half-ridge *a h* may be ploughed first and without delay, and that the rest of the ridges may be ploughed by half-ridges.

746. The first half-ridge *a h* is, however, ploughed in a different manner from the other half-ridges; it is ploughed by going round the feering *f c* until the open furrow comes to *a e* on the one side and to *h i* on the other. Were the feering set off the breadth of a half-ridge, $7\frac{1}{2}$ feet, in the line of *i h*, from *a* to *h*, instead of the quarter ridge, 3 feet 9 inches, from *a* to *c*, the half-ridge *a h*, would be ploughed with all the furrow-slices turned towards *h i*, and the plough would have to return back empty, at each furrow-slice, thus losing half its time.

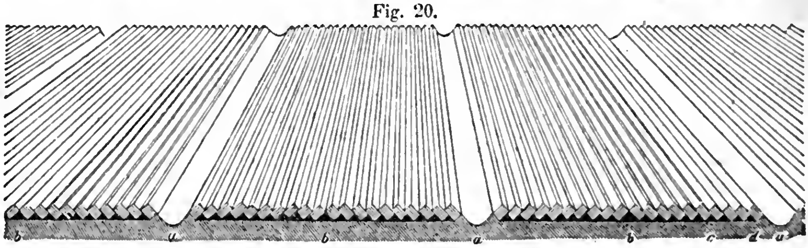
747. The line *h i* thus becoming the feering along with *k l*, for ploughing the 2 half-ridges *z i* and *z k*, the open furrow is left in the line *z y*, corresponding to that in the line *e a*, and between these open furrows is embraced and finished the full ridge of 15 feet *e z*, having its crown along *i h*.

748. As the plough completes each feering, the furrow-slices are laid over as at *m* and *n*. While one ploughman proceeds in this manner to feer each ridge across the field, the other ploughmen com-

mence the ploughing of the land into ridges; and to afford a number of them space for beginning work at the same time, the feering-ploughman should be set to work more than half a day in advance of the rest. In commencing the ploughing of the ridges, each ploughman takes two feerings, and begins by laying the furrow-slices, *m* and *n* together, of both the feerings, to form the crowns of two future ridges. One ploughman thus lays together the furrow slices of *f c* and *k l*, whilst another is doing the same with those of *o p* and *r w*. I have just described how the half-ridge *a h* is ploughed, and also stated that the rest of the ridges are ploughed in half-ridges. The advantage of ploughing by half-ridges is, that the open furrows are left exactly equidistant from the crowns, whereas, were the ridges ploughed by going round and round the crown of each ridge, one ridge might be made narrower than the determinate breadth of 15 feet, and another broader.

749. After laying the feering furrow-slices so as to make the crowns of the ridges, at *f c*, *k l*, *o p*, and *r w*, the mode of ploughing the ridges from the flat ground is to hie the horses towards you, on reaching the headridges, until all the furrow-slices between each feering are laid over as far as the lines *y z*, which become the open furrows. This method of ploughing is called *gathering up*, the disposition of the furrows in which is shown in fig. 20, where *a a a* embrace two whole ridges and three open furrows, on the right sides of which all the furrow-slices lie one way, from *a* to *b*, reading from the right to the left; and on the left sides they all lie in the opposite direction, from *a* to *b*, reading from the left to the right, and both sets of furrow-slices meet in the crowns *b b b*. The open furrows *a a a* are finished off with the mould or hint-end furrows, the method of making which is described in the next figure.

Fig. 20.

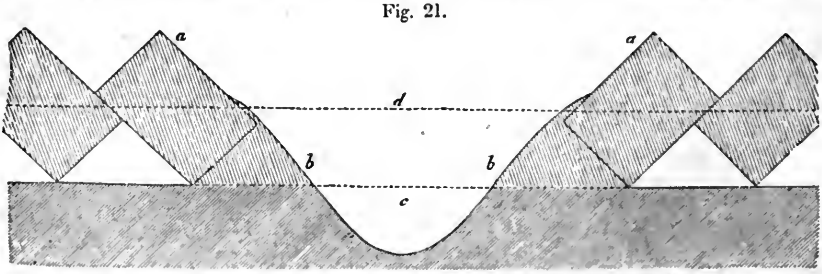


GATHERING UP RIDGES FROM THE FLAT.

750. Were the furrow-slices counted in fig. 20, they would be found to amount to 20; whereas 10 inch furrow-slices across a 15 feet ridge would only count 18, which would be the number turned over in loose mould; but the above figure is supposed to represent gathered-up ridges in lea ground, and the mould-furrows are shown as correctly formed as the others—which they ought always to be; but in ploughing lea, or grass, the slices scarcely ever measure 10 inches in breadth, and most ploughmen do not regard the mould-furrows as forming a part of the regular ridge, but only a finishing to it.

751. The *mould* or *hint-end* furrow is made in this way: When the last two furrow-slices of the ridges *a a*, fig. 21, are

Fig. 21.



AN OPEN FURROW WITH MOULD OR HINT-END FURROW-SLICES.

laid over, the bottom of the open furrow is as wide and flat as represented by the dotted line *c*, and extending above from *a* to *a*. The plough goes along this wide space and first lays over the triangular furrow-slice *b* on one side, and another of the same form *b* on the other side, up against and covering the lowest ends of the furrow-slices *a a*, by which operation the ground is hollowed out in the shape represented below *c* by the sole of the plough. The dotted line *d* shows the level of the ground in the state it was before it was ridged up, and the furrow-slices *a a* show the elevation attained by the land above its former level by ploughing.

752. *Crown-and-furrow* ploughing can easily be performed on land which has been gathered up from the flat. No feering is required, the open furrows answering the purpose. Thus, in fig. 20, let the furrow-brow slices *d* be laid over into the open furrows *a*, and it will be found that they will just meet, since they were formerly separated by the same means; and in ploughing the ridges in half-ridges, *a* will become the crowns of the ridges, and *b* the open-furrows,—hence the name of this mode of ploughing. Its effect is to preserve the ploughed surface of the ridges in the same state they were when gathered up from the flat.

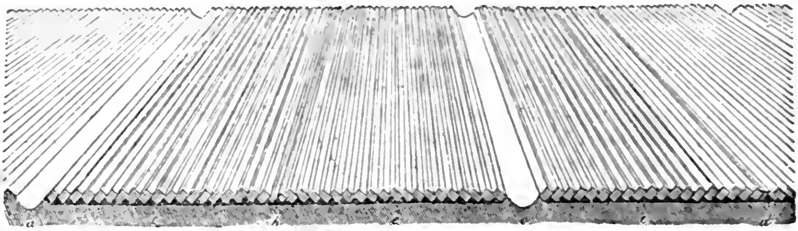
753. When no surface-water is likely to remain on the land, as in the case of light soils, both these are simple modes of ploughing land; and they form an excellent foundation for drills for turnips on stronger soils, and are much practised in ploughing land for barley after turnips. But when the land for barley after turnips is to be twice ploughed, and it is inconvenient to cross-furrow the land,—which it will be when sheep on turnips occupy a field having long ridges, or the season is too wet to leave the land in a cross-furrow,—then the land should be so feered as, in gathering up from the flat, the crown-and-furrow ploughing may afterwards complete the ridges.

754. On looking at fig. 20, where the ridges are complete, it is obvious that, were they ploughed into crown-and-furrow, thereby making the open furrows *a a a* the future crowns, a half-ridge would be left at each side of the field,—a mode of finishing off a field displaying great carelessness and want of forethought. The feering, therefore, should be so made as the gathering up from the flat should leave a half-ridge on each side of the field, and the subsequent crown-and-furrow ploughing will convert them into whole ridges. Thus, the first feering should be made at *e a*, fig. 19, instead of *f c*, and every other at the width of one ridge, 15 feet. On ploughing these feerings, the open furrows will be left at *i h*, *k l*, *o p*, and *r w*; and these will form the feerings of the subsequent crown-and-furrow ploughing.

755. Another mode of ploughing land from the flat surface is *casting* or *yoking* or *coupling* the ridges. The feering for this is done in a different manner from the two foregoing. The first feering is made in the line of *e a*, fig. 19, close to the ditch, and every other is measured off of the width of 2 ridges, 30 feet—as at *y z*, betwixt *k l* and *o p*, and again at half a ridge beyond *r w*. Casting is begun by laying the furrow-slices of the feerings together, and then laying the first furrow-slice towards *e a*, on going up, and towards *y z*, betwixt *l* and *p*, on coming down, the bout; and so on, furrow after furrow, hieing the horses on the headridges always towards you, until the open furrow is left at *y z*, betwixt *k l* and *i h*. The effect of casting is to lay the entire number of furrow-slices, 20 of every ridge, in one direction, and in opposite directions on adjoining ridges. The proper disposition of the furrow-slices is seen in perspective in fig. 22, which exhibits three entire ridges, *a b*, *b c*, and *c d*, two of which are cast or yoked together, that is, the furrow-slices of *a b* meet those of *c b* in *b*, which forms the crown of the coupled ridge, and those of *c d* lie in the opposite direction from *c b*, and are ready to be met by those of the adjoining ridge beyond *d* at *d*, and they leave the open furrow between them at *c*: and so on, an open furrow between every two ridges. Ridges lying thus yoked can easily be recast, by reversing the furrow-slices of *b c* and *c d* into the open furrow *c*, and converting *c* into the crown of the yoked ridge *b d*, and making the crowns *b* and *d* open furrows. Casting keeps the land in a level state, and can most conveniently be formed on dry soils. It forms

a good foundation for drilling, and makes an excellent seed-furrow on dry land. Lea and seed-furrow for barley, on light land, are always thus ploughed. It is an economical mode of ploughing land in regard to time, as it requires but few feerings; the furrow-slices are equal, and the horses are always turned inwards, that is, towards you. It is best performed upon the flat surface, and should the land be ploughed again, it may be recast, and no half-ridges left.

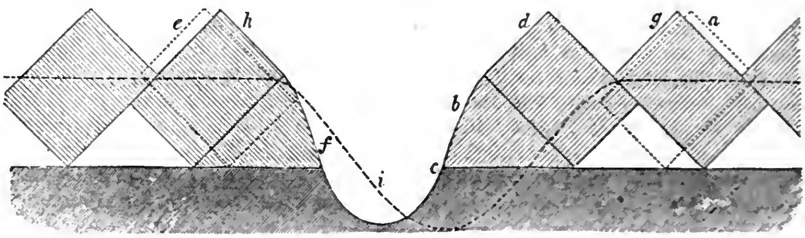
Fig. 22.



CASTING, YOKING, OR COUPLING RIDGES.

756. Casting ridges is as suitable ploughing for strong as light land, provided the ridges are separated by a *gore-furrow*. A gore-furrow is a space formed to prevent the *meeting* of two ridges, and a substitute for an open furrow between them; and it can only be formed where a feering or an open furrow exists. It is made as shown in fig. 23. Let the dotted furrow-slices *a* and *e*, and the dotted line *i* form an open furrow, of which *c* is a point in the middle, and let it be converted into a gore-furrow. Make the plough pass between the centre of the open-furrow *c* and the left-hand dotted furrow-slice *e*, and throw up to the right the triangular-shaped mould-furrow-slice *b*, with the mould seen below *c*. Then turn the horses sharp from you on the headridge, and lay the dotted furrow-slice *a* upon *b*, which will thus become the furrow-slice *d*. Again turning the horses sharp from you on the headridge, take the plough lightly through part of the dotted furrow-slice *e*, and lay it of a triangular-shape for the mould-furrow-slice *f*, the upper end of *e* being left untouched: but a portion of *f* will trickle down towards *i*, and so will also a portion of *d* when it was ploughed. Turn the horses on the off headridge still from you, and bring the plough down behind *d*, and lay upon it the ordinary furrow-slice *g*. Turning the horses again from you on the nigh headridge, lay the ordinary furrow-slice *h* upon the triangular-shaped mould-furrow *f*, by destroying the remainder of the dotted furrow-slice *e*, and some more earth; and then turn the horses *from* you again on the off headridge for the last time, and come down the open furrow *i*, pushing the soil up with the mould-board from *i* against *f*, and clearing the furrow of any loose soil in it, and the gore-furrow is completed. A gore-furrow is most perfectly formed and preserved in clay-soil, for in tender soil it is apt to moulder down by the action of the air into the open furrow, and prevent it being a channel for running water; but, indeed, gore-furrows are of little use, and are seldom formed on light soils.

Fig. 23.



MODE OF MAKING A GORE-FURROW.

757. Casting with a gore-furrow upon a gathered ridge always makes the open furrow barer of earth than the gore-furrow;

but it is not so correct to say that this is an imperfection unavoidable in casting a ridge, as it is so only in casting after gathering it up from the flat, and more so, of course, after two gatherings up. Casting, in my opinion, should never be practised on gathered ridges, to remain in a permanent form, though it may be used for a temporary purpose, as in fallowing to stir the soil and overcome weeds; for, observe its necessary consequences: Suppose the two gathered ridges between *a a a*, fig. 20, were cast together towards the middle open furrow *a*, the effect would be to reverse the position of the furrow slices from *a* to *b*, on either side of *a*, and they would remain as flat as formerly; but what would be its effect on the furrow slices on the other halves of the ridges from *b* to *d*? They would be gathered up twice, and the coupled ridge would have two high furrow-brows by two gatherings, and two low flanks by one gathering. It would, in fact, be unevenly ploughed, and the open furrow on each side would, of course, be much bared of soil, from being twice gathered up. No doubt the distortion might be partially obviated by making the furrow-slices between *a* and *b* on each side of the middle open furrow *a* deeper and larger than those between *b* and *d*, and a uniform shape to the coupled ridge might be thus preserved; but it would be done by the sacrifice of substantial ploughing; and it is much better to confine casting within its own sphere, than practise it in circumstances unfavourable to the proper ploughing of the land.

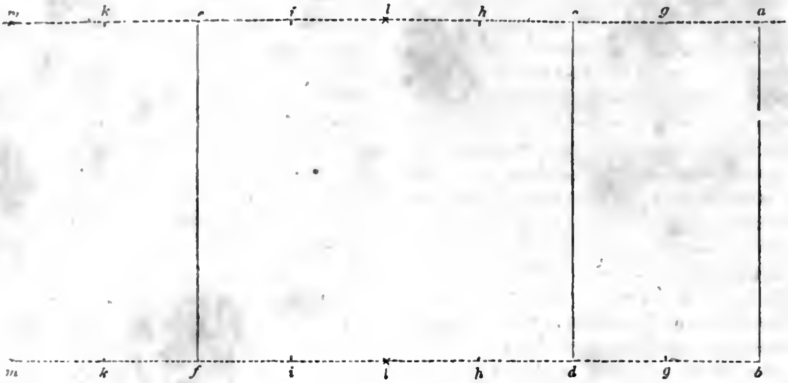
758. The open furrow in casting does not necessarily bare the earth more than a gore-furrow. It is broader, certainly, from the circumstance of the furrow-slices being laid away from each other; but its furrow-sole is not actually ploughed deeper than the gore-furrow. I would also observe that casting is almost impracticable after two gatherings, because the effect would be to cleave down the sides *a b*, fig. 20, on both sides of *a*, again to the level of the ground; whilst it would gather up the two sides actually corresponding with *d b* three times, thereby giving very unequal heights to the two sides of each coupled ridge, or making the furrow-slices on the same ridge of very unequal size, in order to preserve their level—practices both to be deprecated. An author, in speaking of casting, and showing how it may be performed by ploughing the furrow-slices of two adjoining ridges in opposite directions, states that "the inter-furrow, which lies between the two ridges, unavoidably leaves a shoulder or hollow place, of more or less width, according to the expertness of the ploughman, in the centre of the crown, which defect can only be completely relieved by reploughing;"* and informs us, that the defect may be partly prevented by using two ploughs of different widths of mould-boards. I do not see why ploughing two furrow-slices into the open furrow in casting should be more difficult or less substantial than in any other mode of ploughing. A good ploughman will leave in the future crown of the ridge, in every case, neither a shoulder nor a hollow place.

759. Nearly allied to casting is the ploughing named *two-out-and-two-in*, which may also be executed on the flat ground, and requires a particular mode of feering. The first feering should be measured of the breadth of 2 ridges, or 30 feet, from the ditch *a e*, fig. 19; and every subsequent feering of 4 ridges breadth, or 60 feet. The feerings are thus but few. The land is ploughed in this manner: Let *a b*, fig. 24, be the side of the field, and let *c d* be the first feering of 30 feet from *a b*; and also, let *e f* be the next feering of 60 feet. After returning the feering furrow-slices, begin ploughing round the feering *c d*, which always keep on the right hand, and *hupping* the horses from you, on both the head-ridges, until about the breadth of a ridge is ploughed on each side of *c d*, to *g g* and *h h*. While this is doing, 2 ridges to *i i* and *k k* are ploughed around *e f* by another ploughman. At this juncture, open furrows occur at *h k* and *i i*, embracing between them 2 ridges, or 30 feet, from *h* to *i*. Then let the ploughman who has ploughed round *c d* plough from *h* to *i*, laying the furrow-slices first to *h* and then to *i*, by *hieing* the horses towards him, on both headridges, until the ground is all ploughed to *l l*, which becomes the permanent open furrow. The

* *British Husbandry*, vol. ii. p. 46.

next permanent open furrow made by the other ploughman, will be at *m m*, 60 feet or 4 ridges breadth from *l l*. But as yet the ridge *g a* has not been ploughed; it is so along with the headridges *m a* and *b m*, after all the ridges of the field

Fig. 24.

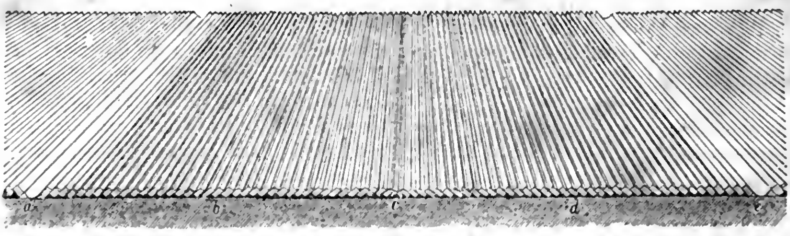


FEERING FOR PLOUGHING RIDGES TWO-OUT-AND-TWO-IN.

have been ploughed, laying its furrow-slices towards *g g*, and making the open furrow at *a b*. The effect of ploughing two-out-and-two-in, is to lay all the furrow-slices across two ridges in one direction from *a* to *c*, and across two ridges in the opposite direction, from *l* to *c*, both double ridges meeting in *c d*, which becomes the crown of the 4 ridges from *l* to *a*. In like manner the furrow-slices over the 4 ridges from *l* to *m*, meet in their crown *e f*. In ploughing this mode, every ploughman takes in a feering of 4 ridges, which he completes before he goes to another. The reason, I suppose, that this mode of ploughing has received its peculiar appellation is, that *two* ridges are ploughed with the horses turning *out*wards, and two by their turning *in*wards.

760. The appearance of the ground on being ploughed two-out-and-two-in is seen

Fig. 25.



PLOUGHING RIDGES TWO-OUT-AND-TWO-IN.

in fig. 25, where the space from *a* to *e* is 60 feet, comprehending 4 ridges, between the open furrows *a* and *e*, two of which, *a b* and *b c*, have their furrow-slices lying to the right, and those of the other two, *e d* and *d c*, lying to the left, meeting the former at *c*, which becomes the crown of the whole division of 4 ridges.

761. This method of ploughing places the land in large flat spaces, and as it dispenses with many open furrows, it is only suitable for light soils—in which it may be used for seed furrowing, and for drilling turnips and potatoes—or for any well-drained land.

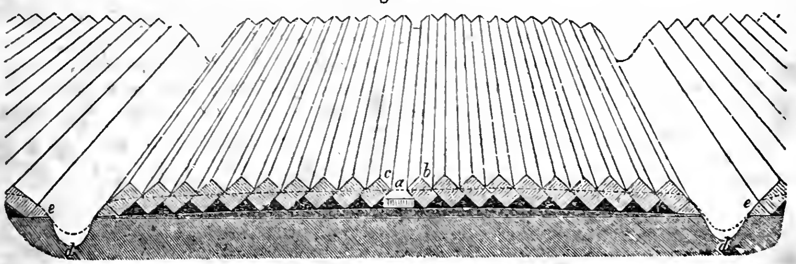
762. The gore-furrow, described in fig. 23, might be applied to this ploughing on the stronger classes of soils; but its introduction would change the character of the ridges altogether, inasmuch as the crown *c*, fig. 25, would not only be converted into an open furrow, but its actual centre transferred from *c* to *b*, and *d*, where, the fur-

row-slices *not meeting* from opposite directions, but lying across it, there would be no true crown. Exactly in a similar manner, when the gore-furrow is introduced into cast ridges, as in fig. 22, the crowns at *b* and *d* are converted into open furrows, and transmuted into a centre *e*, which, the furrow-slices lying across the ridges, would therefore not be a true crown.

763. A nearly allied ploughing to the last is that of *ploughing in breaks* or *divisions*. It consists of making feerings at indefinite distances, and ploughing large divisions of land without open furrows. Some farmers plough divisions of 8 ridges or 40 yards; but so great a distance incurs considerable loss of time in travelling from furrow to furrow at the landings. Instead, therefore, of the breadth of a given number of ridges being chosen, 30 yards are substituted; and this particular breadth has the advantage of causing deviations in ploughing from that of the ordinary ridges, and of loosening any hard land that may have been left untouched by the plough in ploughing the ordinary ridges. Land is ploughed in breaks only for temporary purposes, such as giving it a tender surface for seed-furrowing or drilling up immediately thereafter. The time lost in ploughing wide breaks might be easily estimated in figures by fig. 24, where, the feerings *c d* and *e f* being supposed to be 60 yards asunder, the ploughs have to go round *c d* and *e f* until they reach *h* and *i* respectively, thus travelling in a progressive increasing distance to 30 yards *for every furrow-slice* of 10 inches in breadth *laid over*.

764. Another mode of ploughing is *twice-gathering-up*. Its effect may be seen in fig. 26, where the twice-gathered-up furrow-slices are seen to rest upon the solid ground. It may be practised both on

Fig. 26.



TWICE-GATHERING-UP RIDGES.

lea and red-land. On red-land that has been already gathered up from the flat, it is begun by making feerings in the crowns of the ridges, as at *b*, fig 20. The furrow-slices of the feerings are laid together, and the ridges ploughed by half-ridges, in the manner of gathering up from the flat. The half-ridge left by the feerings at the sides of the field must be ploughed by themselves, even at the risk of losing time, because it would not do to feer the first ridge so as to plough the half-ridge as directed to be done in the first-gathering-up, in fig. 19, around the feering of the quarter-ridge *f c*, because the furrows betwixt *f* and *i*, when ploughed in the contrary direction they were before, would again lower the ground; whereas the furrow-slices from *e* to *f* and from *z* to *i*, being ploughed in the same direction as formerly, the ground would be raised above the level of *i f*, and disfigure the ploughing of the entire ridge *z e*. Gathering up from the flat preserves the flatness of the ground; and the second gathering-up would preserve the land in the same degree of flatness, though more elevated, were there depth enough of soil, and the furrow-slices made in their proper form; but a roundness is usually given to a ridge which has been gathered up, both by harrowing down the steep furrow-brows, and by ploughing the furrow-slices of unequal size, from want of soil at the furrow-brows and open furrows.

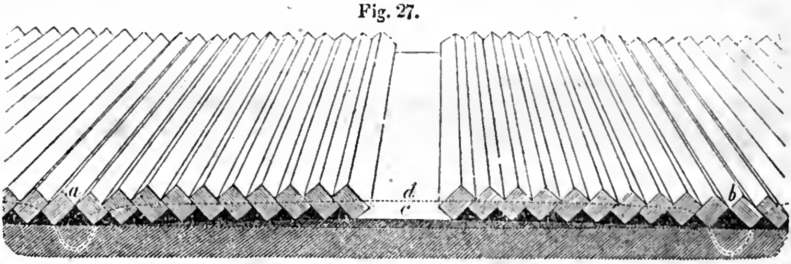
765. In gathering up *lea* the second time, no feering is required. The plough goes a little to the left of the crown of the ridge, and lays upon its back a thin and narrow furrow-slice, *a*, fig. 26, to serve as a cushion upon which to rest the future crown furrow-slices. The horses

are then *hupped* sharp round from you, and the furrow-slice *b* is laid so as to rest, at the proper angle of 45°, upon *a*. *Hupping* the horses again sharp round from you, the furrow-slice *c* is also laid at the same angle upon the other side of *a*; but *c* and *b* should not approach each other so near as to cover *a*, but leave a space of about 3 or 4 inches between them, the object of which is to form a receptacle for the seed, which, were *c* and *b* to make a sharp angle, would slide down when sown, and leave the crown, the best part of the ridge, bare of seed. The ridges are ploughed in half-ridges to the open furrows *d*, which are finished with mould-furrow-slices, but these are obtained with some difficulty, for want of soil. Twice-gathering-up is only practised in strong land and its object is to lift the mould above the cold and wet subsoil. On dry land no such expedient is required, nor on strong land drained. In fig. 26 the dotted line *e* represents the configuration of the ground before the second gathering-up was begun, and it may be seen that the open furrow at *d* is now deeper than it was with once gathering-up.

766. The mode of ploughing exactly opposite to twice-gathering-up is *cleaving* or *throwing down*. The open furrows of twice-gathered-up land constitute deep feerings, which are filled up with the slices obtained from the mould-furrows and furrow-brows of the adjoining ridges; and in order to fill them fully, the plough takes as deep a hold of these as it can. The furrow-slices are ploughed exactly the reverse way of twice-gathering-up, and in half-ridges. The effect of cleaving down is to bring the ground again to the level from which it had been elevated by the twice-gathering-up. The open furrows are left at the crowns, at *a*, fig. 26, the mould-furrows being seldom ploughed, cleaving down being usually practised to prepare the land for cross-ploughing in the spring.

767. But when clay land is cleaved down in winter, it is always so with gore-furrows, and these, with the open furrows, afford a convenient channel, at every half-ridge, for the water to flow off to the ditches; and as twice-gathering-up is only practised on clay soils, and cleaving down

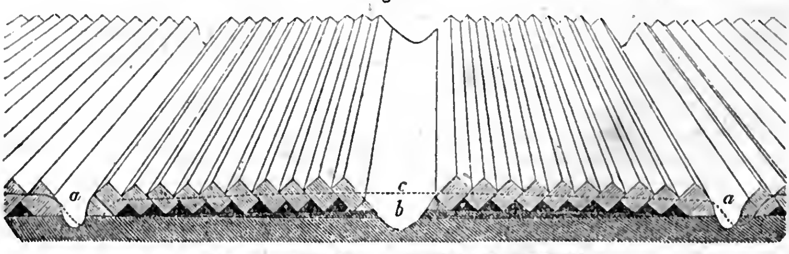
Fig. 27.



CLEAVING DOWN RIDGES WITHOUT GORE-FURROWS.

can only be practised after twice-gathering-up, it follows that cleaving down is only suitable to clay soils. The effect of cleaving down ground is seen in fig. 27, which represents it without gore-furrows at *b* and mould-furrows at *c*; but in fig. 28, the gore-furrows are shown at *a*, and the open and mould-furrows at *b*. The dotted line *d*, fig. 27, showing the surface of the former state of the ground, as

Fig. 28.



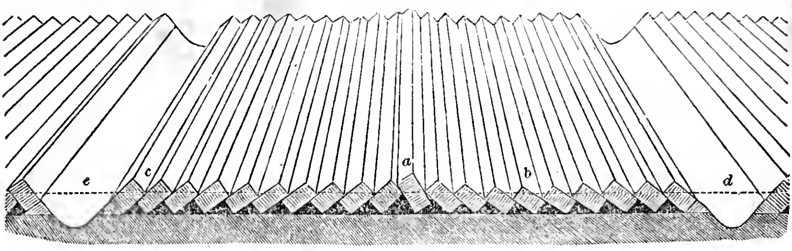
CLEAVING DOWN RIDGES WITH GORE-FURROWS.

does the dotted line *c*, in fig. 28. Below *a* and *b*, fig. 27, are shown the former open furrows by the dotted line, as also does the dotted line below *a*, in fig. 28. In fig. 28, the ground upon which the furrow-slices rest is made somewhat rounded, to show the effect of twice-gathering it up. In strict practice, a ridge can only be cleaved after it has been twice gathered up, because it is scarcely correct to say that a ridge is cleaved down after one gathering-up from the flat, when it is, in fact, ploughed crown-and-furrow. With a strong furrow, a twice-gathered-up ridge can be made flat by one cleaving down.

768. What is called *cross-ploughing*, or the *cross-furrow*, derives its name from ploughing right across the furrow-slices in the ridges, in whatever form these may have been formerly ploughed. Its object is to cut the furrow-slices into small pieces, so that the land may be easily pulverised. It is commonly executed in the spring, and should never be attempted in winter; because the position of the furrow-slices would retain the rain or melting snow, and render the land wet. But, even if cross-furrowing were executed quickly in winter, and the weather would allow the soil to be safely ridged up, the soil would become so consolidated during winter that it would have to be again cross-furrowed in the spring before it could be rendered friable. The object of cross-furrowing being to pulverise land, it is practised on every species of soil, and exactly in the same manner. It is ploughed in divisions, the feerings being made at 30 yards asunder, and ploughed in the same manner as two-out-and-two-in, fig. 24; that is, by going round the feerings, *hupping* the horses constantly from you, until about half the division is ploughed, and then *hieing* them towards you, still laying the furrow-slices towards the feerings, until the division is ploughed. In cross-ploughing, however, the open furrow is never left open, and is closed with two or three of the last furrow-slices being returned, and all mark of a furrow obliterated by the plough pushing the loose soil into it with the mould-board, which is purposely laid over and retained in that position by a firm hold of the large stilt only. The obliteration should be complete, otherwise the hollowness at these furrows would be shown across the future ridges.

769. Another mode, having a similar object to cross-ploughing in pulverising the furrow-slices by cutting them into pieces, is called *angle-ploughing*, and is so named because the feerings are made in a diagonal direction across the ridges of the field. The ploughing is conducted in divisions of 30 yards each, and in exactly the same manner as cross-ploughing, with the same precautions as to the season, and the obliteration of the open furrows. It is never practised but *after* cross-ploughing, and not always then, and only in clay soil, unless the cross-ploughing has failed to produce its desired effect of pulverisation on the soil.

Fig. 29.



EXAMPLE OF A RIDGE ILL PLOUGHED.

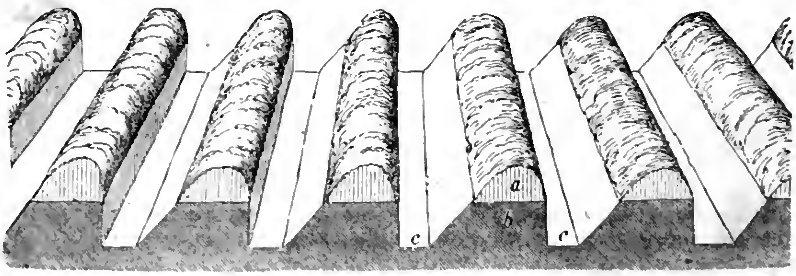
770. These are all instances of good substantial ploughing with rectangular furrow-slices; and were they constantly practised, there would be no instances of bad ploughing as in fig 29, no high-crowned ridges as at *a*, caused by bringing the two feering-slices or the two open furrows too close together from opposite directions; no *lean* flanks, as at *b*, by making the furrow-slices broader than they should be, with a view to ploughing the ridge fast, and constituting hollows which become recep-

tacles for surface-water to sour the land. When the soil is strong, lean flanks become so consolidated, that they are almost sure to resist the action of the harrows, when passed across the ridge; and in light soil they are filled up with the loose soil by the harrows, at the expense of the surrounding heights. No *proud furrow-brows* as at *c*, by setting up the furrow-slices more upright than they should be, to the danger of being drawn entirely into the open furrows on the harrows catching them too forcibly on leaving the ridge in cross-harrowing. And no *unequal*-sided open furrows, as at *d*, by turning over one mould-furrow flatter than the other. Not to extend this lengthened catalogue of evils accompanying bad ploughing, I will only mention that every sort of crop grows unequally on an ill-ploughed ridge, because they grow better on the spots where the soil is most kindly; but the bad effects of bad ploughing are not confined to the season in which it is performed, as it renders the soil unequal when broken up again, and the thinner and harder parts do not yield so abundantly as the deeper and more kindly. The line *d e*, fig. 29, shows the position of the surface before the land was ploughed, and the irregular relation of the furrow-slices to that line, show the unequal manner in which the ridge had been ploughed.

771. It is the opinion of some agricultural writers,* that land when ploughed receives a curvature of surface; whereas, correct ploughing—that is, making the furrow-slices on the same ridge all alike—cannot possibly give the surface any other *form* than it had before it was ploughed. If the former surface were curved, then the newly ploughed surface would also be curved; and if it were flat, the new surface will be flat also. In gathering up a ridge from the flat ground, the earth displaced by the plough occupies a smaller area than it did by the extent of the open furrows, the feering-slices being only brought again together; but the displacement only elevates the soil above its former level, and the act of elevation cannot impart a curvature to it. It is true that ridges on being harrowed become curved, because the harrows draw the soil into the open furrows, where the least resistance is presented to them, and thereby alter the uniformity of the surface as left by the plough; but the curvature thus acquired had no connexion with the ploughing. Seeing a curvature thus produced without knowing its cause, most ploughmen endeavour to give the ridge a curvature, and accomplish it by bad ploughing; that is, they give a slight cresting to the crown, then plough the flanks with narrow and rather deep slices set up at too high an angle, for about four bouts, giving the last of these rather less depth and height than the rest, and the remaining three bouts next the open furrows they plough flatter, and finish off the desired curve with the mould-furrow slices. This artful device produces a ridge of pleasing enough curvature, and it is practised by the ploughmen with no intention to deceive; for they conceive they are thereby displaying their greatest skill. A really good ploughman, however, will resort to no such expedient.

772. There is a kind of ploughing practised in parts of the country in autumn and winter, which bears the name of

Fig. 30.



RIB-PLOUGHING STUBBLE LAND.

* *British Husbandry*, vol. ii. p. 45.

ribbing in Scotland and of *raftering* in England. I notice it only to condemn it. It consists of turning the furrow-slices on their backs upon as much of the firm soil as they will cover, as in fig 30, where *a* are the furrow-slices turned over upon the firm soil *b*, and *c* are the plough-tracks. The figure represents the work done in a more compact, clean, regular, and straight manner than is usually to be found in practice; for the ploughing not unfrequently causes the furrow-slices to lap over the firm soil, and the plough-tracks are seldom straight. The land lies in this state all winter, and dry enough; but the greatest proportion of the soil remaining unploughed, can be no better for the treatment. This ploughing can be done quickly, and without care, and is generally taken in a diagonal direction across the ridges, without a feering. It is chiefly practised on land in a very foul state, with the view of destroying the weeds; and it is believed their destruction is quickly effected by exposing the under surface of the furrow-slices, where the roots of the weeds are most abundant, to the action of frost, and the opinion no doubt is correct; but if the exposed part of the ground is thus benefited, it is evident the unploughed part can receive none, since it is not exposed at all, and it constitutes the largest proportion of the land; so that any advantage attending the practice is more than counterbalanced by its disadvantages. It is practised on all sorts of soils, and whether of stubble or lea ground; but in Scotland is confined to the north of the Firth of Forth, where it is now abandoned on the large farms, and confined to the fields of the small tenants; and here it may maintain its ascendency, for certainly no where are weeds more conspicuous.

ON PLOUGHING STUBBLE AND LEA GROUND.

773. Although we have entered on the consideration of the winter operations of the farm, we have hitherto confined our observation to a few preliminary subjects, the nature of which must be understood by the agricultural student at the outset of his career, or he will fail to appreciate what is to follow. The time is now arrived, however, when we must commence in earnest the actual work of the farm, in all its departments. You are now quite prepared for this. You have been made acquainted with the plough, its mode of attachment to the horses, the different methods in which the land is ploughed into ridges, and all the classes of persons required to execute the work of a farm conducted on the system of mixed husbandry.

774. As agricultural students, take an attentive view of the fields immediately after harvest, when the crop has been gathered into the stackyard, and you will perceive that a large proportion of them are in stubble, whilst others are occupied by grass, turnips, and young wheat. On examining the stubbled fields particularly, you will observe young grass amongst the stubble in some fields, and none in others. You cannot, of yourself, discover at once that the varied states of those fields bear a certain proportion to one another; and the reason why they bear any proportion is, that they are cultivated under a "regular rotation of crops," which necessarily causes every field, in its turn, to carry the same series of crops. The numbers composing the series depend on the nature of the soil, and it shall be my duty to make you acquainted with the relation of soil and crop in due time. Meantime, suffice it to intimate, that when the stubble is in the state you find it, in the beginning of the agricultural year, the parts which contain no grass must undergo an immediate change, to prepare them to receive the crops which are to occupy them, in their appointed time. The immediate change alluded to is effected by the plough, not at random, but by those fixed rules which determine the "various modes of ploughing land into ridges," according to the nature of the soil and the crop. Of the stubble-land, the part which is to bear the earliest crop is ploughed first, and so on progressively, until that to be occupied by the latest. For this reason, the land which is to bear the bean-crop is ploughed first, then that for the potatoes, then for the turnips, and, last of all, for the bare fallow. The stubble is generally all ploughed before the older grass or lea is ploughed.

775. On *clay soil* you will find the

stubbled ridges of a rounded form, having been twice gathered up, fig. 26; and the way to plough them so as to keep them dry during winter is to cleave them down without either a gore-furrow, fig 27, or a mould-furrow, fig. 21, when on a considerable declivity; or with gore-furrows, and mould-furrows, fig. 28, when the land is flat. On *less strong soil*, casting with a gore-furrow will preserve the land dry whether flat or on a declivity. On *light loams*, casting without gore-furrows, fig. 22, will serve the purpose. And on *sandy* and *gravelly soils*, crown-and-furrow is the most appropriate mode of ploughing stubble. It is rare that stubble-land is subjected to any other mode of ploughing in winter; but the mode of ploughing adopted in the particular case depends on the mode in which the land had been previously ploughed on the particular class of soil. If it had been twice gathered up, fig. 26, on clay soil, it should now be closed down with gore-furrows, fig. 28; if so ploughed on loam, cleaving down without gore-furrows, fig. 27, answers best. If it had been cast on strong soil, it should now be recast with gore-furrows; but if it had been cast on loam, recast it without gore-furrows. If it had been ploughed two-out-and-two-in, renew the furrow-slices, with gore-furrows between every two ridges. And if it had been ploughed crown and furrow, reverse the furrow-slices. A good general rule for all winter-ploughing, is to reverse the former furrow-slices with gore-furrows on heavy, and without them on lighter soils: and the rule should be applied even to thorough-drained land, until the ultimate effects of the draining have been ascertained.

776. Strong clay soil should never be ploughed in a wet state, as it will become very hard in spring, and of course difficult to work.

777. Snow should never be ploughed in under any pretext, nor the soil ploughed at all, when in a frozen state. The frost and snow thus concealed remain a long time unaltered under the soil, and the spring may be far advanced ere its warmth will reach them so as to melt it, and relieve the soil from its chilled condition.

778. When the soil is tolerably clean, and dry, either by thorough-draining or a naturally porous subsoil, it is sometimes desirable to plough the stubble-land deep with three horses instead of two, in winter, especially when the spring-work may be anticipated to be unusually pressing. The horses are yoked according to the arrangement given in fig. 8. The form of ploughing may either be crown-and-furrow, if the soil is light, or cast together with a gore-furrow, when somewhat heavy. One ploughman may direct the three horses well enough; but the assistance of a boy to turn the leading horse at the land-ends, and keep the coulter clear of rubbish with the plough-staff, fig. 5, would greatly expedite the work. The three horses may easily turn over a furrow-slice of 9 or 10 inches in depth, which being taken of proportionate breadth, but few slices across an ordinary ridge of 15 feet would be required.

779. In every variety of soil, ploughed in the forms just described for winter, care should be taken to have plenty of channels, or *gaws* or *grips*, as they are usually termed in Scotland, cut in the hollowest places, so as the surface-water may find them at every point by which to escape into the nearest open ditch. The gaws are first drawn by the plough laying them open like a feering, taking, in all cases, the hollowest parts of the ground, whether these happen to cross the ridges or go along the open furrows; and they are immediately cleared out by the hedger with the spade of the *loose earth*, which is spread over the surface. The fall in the gaws should tend towards a point, or points, best adapted to carry off the surface-water by the shortest route, and do the least injury to the soil. The ends of the open furrows which terminate at the open furrow along the side of the lowest headridge, as well as this furrow itself, should be cleared out with the spade, and cuts formed across the hollowest places of the headridge into the ditch. The precaution of gaw-cutting should never be neglected in winter in any kind of soil, the stronger, no doubt, requiring more gaws than the lighter; but as no foresight can anticipate the injuries consequent on a single deluge of rain, it should never be neglected, and never is by the provident farmer, though many small

farmers pay little heed to its observance, and, of course, to their own loss.

780. The most common form of ploughing *lea ground* in *strong soil* is to cast it with a gore-furrow, fig. 22, and on *less strong soil* the same form of ploughing without a gore-furrow; whilst on the lightest soils the crown and furrow is most suitable. Gathering up is a rare form of ploughing lea, though it is occasionally practised on strong soil on gathered-up or cast ridges, when it is rather difficult to plough the furrow-brows and open furrows as they should be. The oldest lea is first ploughed, that the tough slices may have time to mellow by exposure to the winter air, and for the same reason the strongest land should be ploughed before the light. Lea should never be ploughed as long as it is at all affected by frost or snow, or when rime is on the grass, or when the ground is soft with rain. Ice or rime ploughed down chills the ground to a very late period of the season, and when the rain softens the ground much, the horses cut the turf with their feet, and the furrow-slice will be squeezed into an improper shape by the mould-board. Nor should lea be ploughed when hard with drought, as the plough will take too shallow a furrow, and raise the ground in broad thin slabs. A semi-moist state of ground in fresh weather is the best for ploughing lea.

781. Gaws should never be neglected to be cut after lea-ploughing, especially in the first ploughed fields, and in strong land, whether early or late ploughed.

782. It is a slovenly practice to allow the headridges to remain unploughed for a considerable time after the rest of the field, and the neglect is most frequent on stubble ground. The reason in support of the neglect is, that as all the ploughs cannot be employed on the headridges, it is inexpedient to neglect another entire field for them; and the reason would be a good one were there little chance of bad weather occurring; but in winter it should be remembered that gaws cannot be cut until the headridges are ploughed. To leave a ploughed field to be injured by wet weather, shows little regard to future consequences, which may turn out to be serious. No doubt, on thorough-drained land, less dread of ill consequences from the neglect of gaw-cutting may be felt; but even in the best drained land, I think it imprudent to leave isolated hollows in fields in winter without a ready means of getting rid of every torrent of surface-water that may fall unexpectedly. Let, therefore, as many ploughs remain in the field as will plough the headridges in a proper manner, with the assurance that the ground which lies dry all winter may be worked a week, or even two, earlier in spring.

783. The ploughing of headridges for the winter requires some consideration. In stubble, should the former ploughing have been casting with or without a gore-furrow, reversing it will leave a ridge on each side of the field, which will be most conveniently ploughed along with the headridges by the plough going round parallel to all the fences of the field, and laying the furrow-slices towards them. The same plan might be adopted in ploughing lea in the same circumstances. Should the ploughing in stubble have been a cleaving down with or without gore-furrows, the headridges should be cloven down with a gore-furrow along the ends of the ridges, and mould-furrowed in the crowns. On the ridges being ploughed crown-and-furrow, the headridges may be gathered up in early and late lea-ploughing, and in stubble, cloven down without a gore-furrow along the ends of the ridges. The half-ridge on each side of the field may be ploughed by going the half of every bout empty; but a better plan would be, *if the ridges were short*, to plough half of each headridge towards the ends of the ridges, going the round of the field, and passing up and down the half-ridges at the sides empty, and then to plough the half-ridges with the other half of the headridges in a circuit, laying the furrow-slice still towards the ridges, and which would have the effect of casting the headridges towards the ends of the ridges, and of drawing the soil from the ditches or fences towards the ridges. When the ridges have been ploughed in a completed form in lea, the headridges of clay soils should be gathered up, by making an open feering along the crowns.

784. A difference of opinion is entertained by agricultural writers, of the

manner in which a species of headridge should be formed, whose site is where, by reason of irregularities in the fences or surface of the ground, or length of the ridges, the ridges from other directions than one meet in a common line. The question is, whether those ridges should meet in an imaginary line or at a common headridge? It is the opinion of some that the part where the opposite sets of furrows meet, may be made an open furrow, or a raised up ridge or headland, as circumstances may require. When ridges meet from opposite directions, it is clear they cannot be ploughed at the same time without the risk of the horses encountering one another upon a common headridge; and where no headridge exists, should one set of ridges be ploughed before the other, in the ploughing of the second set, the end of the ploughed land of the first will be completely trampled upon. There should, therefore, be one headridge at least between two sets of ridges, that one set may be ploughed before the other. But the most independent way, in all respects, with such an arrangement of ridges, is to treat each set as if it belonged to a separate field, and give each a headridge of its own.

785. Whatever mode of ploughing the land is subjected to, you should take care, when ploughed for a winter-furrow, that the furrow-slice is of the requisite depth, whether of 5 inches on the oldest lea, or 7 inches on the most friable ground; and also of the requisite breadth of 9 inches in the former and 10 in the latter; but as ploughmen incline to hold a shallow and broad furrow, to make the labour easier to themselves, and to go over the ground quickly, there is no likelihood of their making too narrow a furrow. A furrow-slice in *red* land should never be less than 9 inches in breadth and 6 inches in depth on the strongest soil, and 10 inches in breadth and 7 inches in depth on lighter soils. On clay soil, that has lain long in grass, 9 inches in breadth and 5 inches in depth is as large a furrow-slice as may be obtained; but on lighter soil, with younger grass, one of 10 inches by 6, and even 7, is easily turned over. At all seasons, especially in a winter-furrow, you should establish for yourself a character of a deep and correct plougher.

786. I have sufficiently evinced my preference for the rectangular furrow-slice, and this I do on the broad principle that deep-ploughing ought to be the rule, and any other practice the exception. According to the rule of some farmers, the exception may be practised in many cases.

787. Shallow ploughing is considered admissible in the case of a field that has been depastured by sheep, and is simply to be ploughed for the seed-furrow. The reason usually assigned for this is, that the droppings of the sheep, forming only a top-dressing, would be buried so deep that, as a manure, they would be placed beyond the reach of the plants composing the crop that had been sown upon the field. While I allow that a shallow furrow is admissible in such a case, the reasons assigned for it by practical men, though seemingly plausible, may be called in question. Thus, it is well known that the roots of vegetables in general push themselves out in pursuit of their nutriment, and with an instinctive perseverance will pass over or through media which afford little or no nutriment, in order to reach a medium in which they can luxuriate at will. With the largest vegetable productions this is remarkably the case; and though, amongst those plants which the farmer cultivates, the necessity of hunting, as it were, for food cannot occur to a great extent, yet we are aware that the roots of the cereal grasses extend from 6 to 12 or more inches; and there is good reason to believe that their length depends upon the depth of the penetrable soil, and that the luxuriance of growth in the plant will in general be in proportion to that depth, soil and climate being the same.

788. Another plea of exception to deep ploughing, is in some parts of fallow ploughing, where a deep furrow might be injurious; and these occur in the later part of the process.

789. A third is for a seed-furrow, though in many cases this is doubtfully beneficial.

790. A fourth exception is when the soil is naturally thin, and the subsoil inferior. A shallow *seed*-furrow is allowable in such a case.

791. In some of the clay districts, a system of shallow and narrow ploughing is practised, under the impression that the exposure of the soil, thus cut up in thin slices, tends more to its amelioration than when cut deep and broad. The impression may, to a certain extent, be correct, as a certain portion of the soil thus treated will doubtless undergo a stage of improvement; but, allowing that it does so, the improvement is but a half measure. Soils of this kind are frequently deep, and, though apparently poor, they afford the stamina out of which may be formed the best artificial soils—the clay loam—which may be brought about by the due application of manure, and a proper, well-directed, and continued system of ploughing. On lands of this kind, deep ploughing will always be attended with beneficial effects; and instead of the apparently thin and hungry soil which the shallow system is sure to perpetuate, the result might be a deep and strong clay loam. To effect this, however, no expense or labour should be spared; the draining should be efficient, and the manure, especially those substances which tend to sharpen and render clay porous, should be abundantly supplied.

792. The most extensive departure from the rule of deep ploughing is admissible in those lands where a naturally thin soil rests on a subsoil of sand or gravel variously impregnated with oxides of iron. To plough deep at *once* in such situations might run the risk of injury to the scanty quantity of soil naturally existing. But it is to be observed of soils of this kind, that the subsoil has always a tendency to *pan;* and if such does exist, deep ploughing alone, in the form of subsoil ploughing, will destroy the pan,—the frequent cause of sterility in soils of this kind,—by breaking it up and exposing it to the air, a way of ameliorating both soil and subsoil.

793. There appears, in short, every reason for inculcating deep ploughing, not only where existing circumstances admit of its adoption, but where its ultimate effects are likely to induce a gradual improvement of the soil and all its products, admitting always that a variation in depth is proper and necessary under the varying circumstances of crops and seasons.

ON THE OCCUPATION OF THE STEADING IN WINTER.

794. Long before the ploughing of the stubble-land has been finished, the grass will have failed to support the live-stock, and accommodation must be afforded them in the steading, where they require constant attention and care.

795. As a farm of mixed husbandry comprises every variety of culture, so its steading should be constructed to *afford accommodation for every variety of produce.* The grain and its straw, being important and bulky articles, should be accommodated with room as well after as before they are separated by thrashing. Room should also be provided for every kind of food for animals, such as hay and turnips. Of the animals themselves, the horses being constantly in hand at work, and receiving their food daily at regular intervals of time, should have a stable which will not only afford them lodging, but facilities for consuming their food. Similar accommodation is required for cows, the breeding portion of cattle. Young cattle, when small of size and of immature age, are usually reared in enclosed open spaces, called courts, having sheds for shelter and troughs for food and water. Those fattening for sale are either put into small courts with troughs, called hammels, or fastened to stakes in byres or feeding-houses, like the cows. Young horses are reared either by themselves in courts with sheds and mangers, or get leave to herd with the young cattle. Young pigs usually roam about every where, and generally lodge amongst the litter of the young cattle; whilst sows with sucking pigs are provided with small enclosures, fitted up with a littered apartment at one end, and troughs for food at the other. The smaller implements of husbandry, when not in use, are put into a suitable apartment; whilst the carts are provided with a shed, into which some of the larger implements, which are only occasionally used, are stored by. Wool is put into a cool clean room. An apartment containing a furnace and boiler, to heat water and prepare food when required for any of the animals, should never be wanting in any steading. These are the principal accommodations required in a

steading where live-stock are housed; and even in the most convenient arrangement of the apartments, the entire building will cover a considerable space of ground.

796. The leading *principle* on which these arrangements is determined is very simple, and it is this—and it may be easily understood by placing before you Plate II., containing the ground-plan of a steading suited to a farm of 500 acres, occupied in the practice of the mixed husbandry, with the names of the several apartments written in them:—Straw being the bulkiest article on the farm, heavy and unwieldy, in daily use by every kind of live-stock, and having to be carried and distributed in small quantities by bodily labour, should be centrically placed, and at a short distance from the apartments of the stock. Its receptacle, the *straw-barn*, should thus occupy the central point of the steading; and the several apartments of the live-stock be placed equidistant from it.

797. That so bulky and heavy an article as straw should in all circumstances be moved to short distances, and not at all, if possible, from any other apartment but the straw-barn, the *thrashing-machine*, which supplies the straw from the grain, should be so placed as to throw the straw into the straw-barn.

798. The *stack-yard*, containing the unthrashed straw with its corn, should be placed contiguous to the thrashing-machine.

799. The passage of straw from the stack-yard to the straw-barn through the thrashing-machine being directly progressive, the stack-yard, thrashing-mill, and straw-barn should be placed in a line, and in the order just mentioned.

800. Different classes of stock require different quantities of straw, to maintain them in the same degree of cleanliness and condition. *Those* requiring the *most* should therefore be placed *nearest* the *straw-barn*. The younger stock requiring most straw, the courts they occupy should be contiguous to the straw-barn, and most conveniently one on each side of it.

801. The older or fattening cattle requiring the next largest quantity of straw, the hammels they occupy should be placed next to these courts in nearness to the straw-barn.

802. Horses in the stables, and cows in the byres, requiring the smallest quantity of straw, the stables and byres may be placed next farthest in distance to the hammels from the straw-barn. The relative positions of all these apartments are thus determined by the comparative use made of the straw by their occupants.

803. There are two apartments whose positions are necessarily determined by that of the thrashing-machine, the one the upper, or thrashing-barn, which contains the unthrashed corn received from the stack-yard, and ready for thrashing by the mill; and the other the corn-barn, below the mill, which receives the corn immediately after its separation from the straw by the mill to be cleaned for market.

804. It is a great convenience for the granaries to be in direct communication with the corn-barn, to save the labour of carrying the clean corn to a distance when laid up for future use. To confine the extent of ground occupied by the steading in as small a space as practicable, and at the same time secure the good condition of the grain, the granaries should be elevated above the ground, and their floors form convenient roofs for cattle or cart-sheds.

805. The elevation which the granaries thus give to a part of the buildings should cause this part to shelter the cattle-courts from the N. wind in winter; and, to secure a still greater degree of warmth for the cattle, their courts should be open to the sun. The courts being open to the S., and the granaries forming a screen from the N., it follows that the granaries should stand E. and W. on the N. side of the courts; and as it has been shown that the cattle-courts should be placed one on each side of the straw-barn, it also follows that the straw-barn should stand N. and S., that is, at right angles to the S. of the granaries. The fixing of the straw-barn thus to the S. of the granaries and the thrashing-machine, the stack-yard is

necessarily fixed to the N. of both; and its northern aspect is highly favourable to the preservation of the corn in the stacks.

806. Many existing steadings have a very different arrangement from this; but I may safely assert, that the greater the deviation from the *principles* above inculcated, the less suitable are they as habitations for live-stock in winter. It seems unnecessary to refer farther to the steading for the present. I shall describe the particulars of its construction as they occur in the course of observation.

807. When the evenings become cold before the grass is entirely consumed in the fields, the cattle are housed in the steading for the night, and let out into the fields during the day. Cows, giving milk, are housed at night as soon as the evenings feel cool, as a low temperature is injurious to the functions of the secretory organs, exposed as these are to so large an extent in the udder of the cow; while the same temperature would not affect the other classes of cattle, though the younger cattle are commonly allowed to remain too long in the field after the grass has failed.

ON PULLING AND STORING TURNIPS, MANGOLD-WURTZEL, CARROTS, PARSNIPS, AND CABBAGE FOR CONSUMPTION IN WINTER.

808. As soon as the grass has failed, and it is found necessary to keep any portion of the cattle constantly in the steading, turnips should be provided for them in requisite quantities, and the method of supply should be gone about in a systematic manner.

809. When different sorts of live-stock are supported on the same farm, as is the case in the mixed husbandry, the sheep are provided with the turnips they consume upon the ground on which they grow. This saves the trouble of carrying off a large proportion of the crop, so the labour of removing it is confined to the proportion consumed in the steading by the cattle. The proportion thus carried off is not taken from the ground at random, but according to a systematic method, previously determined on, and which requires your attention to understand.

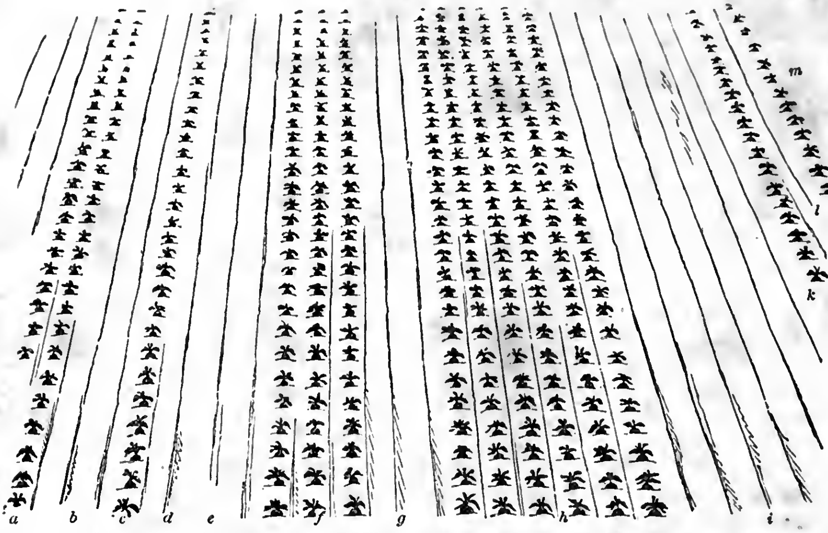
810. One object in leaving turnips on the ground for sheep is, to afford a greater quantity of manure to the soil than it received in its preparation for the turnip crop; and as sheep can withstand winter weather in the fields, and they are not too heavy for the ground, they are selected to consume them on it; and it is a convenient method of feeding sheep, affording them ample accommodation, giving them their food on the spot, and returning it again to the land in the form of manure.

811. It has been found, by experience, that more than half of a fair crop of turnips consumed on the ground by sheep leaves more manure than is proper for the ground to receive at one time for the succeeding grain crop; and the too great effect is evinced by the crop being laid to the ground for want of strength in the straw, and the ears not being filled with sound grain; but the proportion removed is entirely regulated by the state of the soil and crop, as may be seen by this statement. The usual proportion pulled of a good crop is one-half, but should the soil be in low condition, a third only is removed, and if in fine condition, two-thirds or even three-fourths may be pulled; but the quantities thus pulled depend upon the bulk of the crop. If the crop is very large, and the ground in fine condition, two-thirds may be pulled; but it is rarely the case that the soil is so rich, and the crop so large, as to make a half too large a proportion to be left on the ground. If the crop is poor. one-third only should be pulled, and a very poor crop should be wholly eaten on, whatever condition the soil may be in. Another consideration, materially affecting the quantity to be left on the ground, is, the occurrence of a poor crop of turnips over the whole farm. Hitherto I have only been speaking of that part of the crop of turnips to be used by the sheep, but when the entire crop is so bad as to be insufficient to maintain all the stock fully, the proportion to be consumed by the sheep and cattle respectively should be determined on at once, and maintained throughout the season. In such a case, neither the sheep nor cattle can be fattened on turnips; and other expedients must be resorted to to do so, if desired; and, if not desired, the stock must be left in a lean state. The economical plan is, to allow the sheep to get as many turnips as

will feed them, and to feed the cattle on the remainder of the crop, along with oil-cake or corn, because oil-cake can be more easily carried to the steading than turnips. Thus, considerations are required to determine the proportion of the turnip crop to be pulled; but the standard proportion is one-half, and when that quantity is deviated from, it should be from such urgent circumstances as those mentioned.

812. Fig. 31 shows how turnips are stripped off the ground in the various proportions enumerated above. The half can be pulled in various ways, but not all

Fig 31.



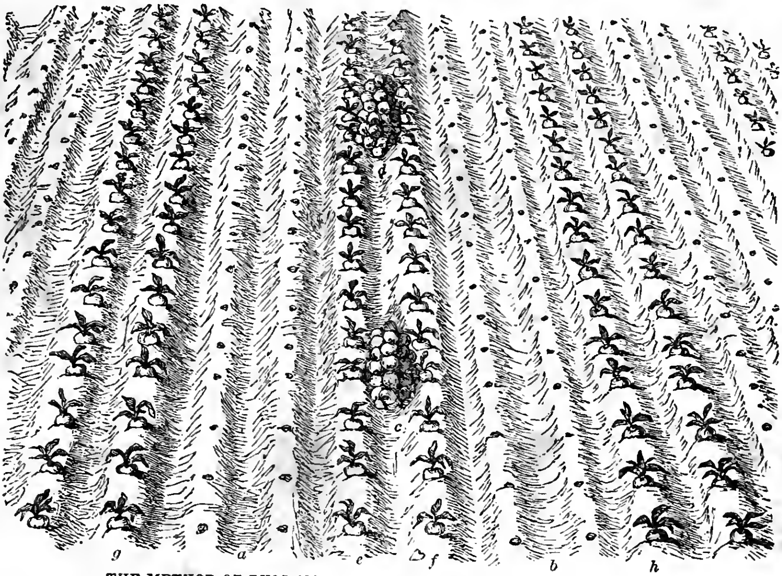
THE METHODS OF STRIPPING THE GROUND OF TURNIPS IN ANY GIVEN PROPORTIONS.

alike beneficial to the land: for example, it can be done by leaving 2 drills *a* and taking away 2 drills *b*; or by taking away 3 drills *e* and leaving 3 drills *f*; or by taking away 6 drills *i* and leaving 6 drills *h*; or by taking away 1 drill *l* and leaving 1 drill *k*. Though the same result is attained in all these different ways, in as far as the turnips are concerned, there are cogent reasons against them all except the one which leaves 2 drills *a* and takes away 2 drills *b*; because, when one drill only is left, as at *l*, the sheep have not room to stand while eating, nor lie down with ease between *k* and *m*, and because sufficient room is not left for a horse and cart to pass along *l*, without injuring the turnips on either side with the horses' feet or the cart wheels; whereas, when 2 or more drills are pulled, as at *e*, and only 2 left, as at *a*, the sheep have room to stand and eat on either side of the turnips, and the cart passes easily along *b* or *e* without injuring the turnips, as the horse walks up the centre unoccupied hollow of the drills, and the wheels occupy an unoccupied hollow on each side. Again, when 3 drills are left, as at *f*, the sheep injure the turnips of the two outside rows to reach the middle one; and they will commit much more injury to turnips left in 6 drills, as at *h*. This latter mode, when practised on light soils, is observed to affect the succeeding grain crop, which is never so good on the ground occupied by the turnips. When other proportions are determined on, one-third may be easily left, by pulling 2 drills, as at *b*, and leaving 1, as at *c*; and one-fourth may be left, by pulling 3 drills, as at *e*, and leaving 1, as at *c*; and three-fifths may be left, by pulling 2 as at *g*, and leaving 3, as at *f*. Whatever proportion may be removed, the rule of having 2 empty drills for the horses and carts to pass along when taking away the pulled turnips, without injury to the turnips, should never be violated.

813. The perfect convenience of the plan of leaving 2 and taking 2 drills, when the half of the crop is to be eaten on, will be best shown in fig. 32, where the drills are represented on a larger scale than in this figure. One field-worker clears 2

drills at *a*, and another simultaneously other 2 at *b*; and in doing so, the turnips are placed in heaps at regular distances, as at *c* and *d*, amongst the standing turnips of the 2 drills *e* and *f*, on the right hand of one worker, and on the left of the other;

Fig. 32.



THE METHOD OF PULLING TURNIPS IN PREPARATION FOR STORING.

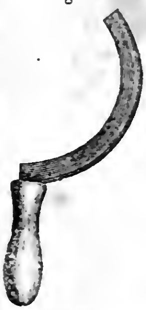
and thus every alternate 2 drills left unpulled become the receptacle of the turnips pulled by every 2 workers. The cart then passes along *a* or *b*, without touching the turnips in *e* and *g*, or in *f* and *h*, and clears away the heaps in the line of *c d*. In the figure the turnips are represented much thinner on the ground than they usually grow, in order to make the particulars more conspicuous; but the size of the bulb in proportion to the width of the drills is preserved both in the drills and the heaps. The seats of the pulled turnips are shown upon the bared drills.

814. The most common state in which turnips are placed in the temporary heaps, *c* and *d*, is with their tops on, and the tails or roots cut away. The cleanest state for the turnips themselves, and the most nutritious for cattle, is to take away both the *tops* and *tails*. Many farmers have the idea, that turnip-tops make good feeding for young beasts or calves at the beginning of the season,—not from the knowledge that the tops contain a larger proportion of bone-producing matter than the bulbs, as chemical analysis informs us, but from a desire to keep the turnips for the larger beasts, and to rear the young ones in any way; but the notion is a mistaken one, as might easily be proved by giving one lot of calves turnip-tops and another bulbs without tops, when the latter will present a superiority in a short time, both in bone and flesh. No doubt the large quantity of watery juice the tops contain at this season makes the young cattle devour them with eagerness on coming off a bare pasture, and indeed any cattle will eat the tops before the turnips, when both are presented together; but observation and experience confirm me in the opinion that the time of cattle in consuming turnip-tops is worse than thrown away; inasmuch as tops, in their cleanest state, are apt to produce looseness in the bowels, partly, perhaps, from the sudden change of food from grass to a very succulent vegetable, and partly from the dirty, wetted, or frosty state in which tops are usually given to beasts. This looseness never fails to bring down the condition of cattle in so considerable a degree, that part of the winter passes away before they entirely recover form the shock their system has received. Like my neighbours, I was impressed with the economic idea of using turnip-tops, but their weakening effects upon young cattle caused me to desist from their use;

and fortunate was the result, as ever after their abandonment the calves throve apace. A few tops may be given to young cattle with impunity along with straw, but that few will starve, not feed or rear, young cattle. The tops are not thrown away, when spread upon the ground, as they serve to manure it. I have no hesitation in recommending the tops and tails to be left in the field. Sheep are not so easily injured by them as cattle, on account, perhaps, of their costive habit; and perhaps in spring, when turnips are naturally less juicy, tops might be of service as a gentle aperient, but at that season, when they might be most useful, they are the most scanty and fibrous.

815. The tops and tails of turnips are easily removed by means of very simple instruments. Figs. 33 and 34 represent these instruments in their simplest form, fig. 33 being an old scythe reaping hook, with the point broken off. This makes a light instrument, and answers the purpose pretty well; but fig. 34 is better. It is made of the point of a worn out patent scythe, the very point being broken off, and the iron back to which the blade is riveted driven into a helve protected by a ferule. This is rather heavier than the other, and on that account removes the top more easily.

Fig. 33.



INSTRUMENT FOR TOPPING AND TAILING TURNIPS.

Fig. 34.

ANOTHER INSTRUMENT FOR THE SAME PURPOSE.

816. A superior instrument to either has lately been contrived by Mr James Kinninmonth, at Inverteil in Fife, and its form is seen in fig. 35, under the name of the "Turnip trimming-knife." The necessity for another instrument of the kind arises from the fact, that when the top of a turnip has dwindled into a comparatively small size, it affords but an inadequate hold for pulling the turnip from the ground; and when the attempt is felt by the worker likely to fail, she naturally strikes the point of the instrument into the bulb to assist her, and the consequence is, that a deep gash is made in the turnip, which, being stored for months, generally suffers in its useful qualities, by producing premature decay in the wounded part. In fig. 35, *a* is the handle, *b* the cutting edge, steeled and properly tempered, and *c* an appendage welded to the extremity of the back, in the form of a narrow edge or hoe. If the turnip requires any effort to draw it, the front of the hoe *c* is inserted gently *under* the bulb, and the operation of lifting it is effected with the greatest ease and certainty. The price of this knife, when made on purpose, is 1s. 6d., but, were it brought out as a regular article of manufacture, its price might be considerably less.*

Fig. 35.

TURNIP TRIMMING-KNIFE.

817. The mode of using these instruments in the removal of the tops and tails of turnips is this: The field-worker moves along between the two drills of turnips to be drawn, at *a*, fig. 32, and pulling a turnip with the left hand by the top from either drill, holds the bulb in a horizontal direction, as in fig. 36, over and between

Fig. 36.

MODE OF TOPPING AND TAILING TURNIPS.

* *Transactions of the Highland and Agricultural Society* for July 1844, p. 286.

John Sheriff A.R.S.A. Thos Landseer

DRAUGHT STALLION,

THE PROPERTY OF MR JAMES STEEDMAN, BOGHALL.

the drills *e* and *f*, fig. 32, and with the hook or knife described, first takes off the root at *b* with a small stroke, and then cuts off the top at *a*, between the turnip and the hand, with a sharper one, on which the turnip falls down into the heap *c* or *d*, whichever is forming at the time. Thus, pulling one or two turnips from one drill, and then as many from the other, the two drills may be cleared. Another field-worker acts as a companion to this one, by going up *b*, pulling the turnips from the drills on either side of her, and dropping them, topped and tailed, into the same heaps as her companion. The tops are scattered upon the cleared ground. A left and a right-handed field-worker get on best together at this work.

816. Due care is requisite, on removing the tops and tails, that none of the bulb be cut by the instrument, as the juice of the turnip will exude through the incision. When turnips are to be consumed immediately, an incision does no harm; but the slicing off a portion, and hacking the skin of the bulb, indicates carelessness, and, if persevered in, will confirm into a habit.

817. When two-thirds of the turnips are drawn at *b*, and one-third left, *c*, the field-worker goes up *b*, fig. 31, and, pulling the 2 drills there, drops the prepared turnips between *c* and *d*. When three-fourths are pulled, as at *e*, and one-fourth left, as at *c*, the turnips may still be dropped in the same place between *c* and *d*, the field-worker pulling all the 3 drills herself, and the horse walking along *e* when taking them away. When 3 drills are pulled, as at *e*, and 3 left, as at *f*, the same field-worker pulls all the 3 drills, and drops the turnips along the outside row next herself of those that are left in *f*. When three-fifths are left, as at *f*, and two-fifths pulled, as at *g*, the field-worker pulls the 2 drills at *g*, and drops the turnips between the two rows next her of *f*. When six drills are pulled, as at *i*, 3 women work abreast, each pulling 2 drills, and all three drop the turnips into the same heap, in front of the woman in the middle. This plan has the sole advantage of collecting a large quantity of turnips in one place, and causing little carting upon the land. When the field is intended to be entirely cleared of turnips, the clearance is begun at the side nearest the gate, and carried regularly on from top to bottom of the field—the nearest part of the crop being cleared when the weather is least favourable, and the farthest when most so. The workers are all abreast.

818. When a field is begun to be stripped for sheep, that part should be first chosen which will afford them shelter whenever the weather becomes coarse. A plantation, a good hedge, a bank sloping to the south, or one in a direction opposite to that from which high winds prevail in the locality, or a marked inequality in the form of the ground, will all afford shelter to sheep in case of necessity. On the sheep clearing the turnips from this part first, it will always be ready for a place of refuge against a storm, when required.

819. On removing prepared turnips from the ground, the carts should be filled by the field-workers, as many being employed as will keep them a-going—that is, to have one cart filled by the time another approaches the place of work in the field. If there are more field-workers than will be required to do this, the remainder should be employed in topping and tailing. The topped and tailed turnips should be thrown into the cart by the hand, and not with forks or graips; the cart should be placed alongside the drill near two or more heaps; and the carter should manage the horses and assist in the filling, until the turnips rise as high in the cart as to require a little adjustment from him in heaping, to prevent their falling off in the journey.

820. As it is scarcely probable that there will be as many field-workers as to top and tail the turnips, and assist in filling the cart at the same time, so as to keep even two carts at work, it will be necessary for them to begin the pulling so much sooner,—whether one yoking, or a whole day, or two days,—but so much sooner, according to the quantity to be carried away, as to keep the carts a-going when they begin to drive away the turnips; for it implies bad management at all times to let horses wait longer in the field than the time occupied in filling a cart. And yet how common it is to see horses waiting until the turnips are pulled, and tailed, and thrown into the cart, by, perhaps, only two

women, the carter building them up not as fast as he can get them, but as slow as he can induce the women to give them. The driving away should not commence at all until a sufficient quantity of turnips is prepared to employ at least two carts, one yoking; nor more turnips than will employ that number of carts for that time, should be allowed to lie upon the ground before being carried away, in case frost or rain should prevent the carts entering the field for a time.

821. Dry weather should be chosen for the pulling of turnips, not merely for the sake of keeping the turnips clean, but for that of the land, which ought not to be cut up and poached by the cart-wheels and horses' feet; because, when so cut, the sheep have a very uncomfortable lair, and the ruts form receptacles for water, not soon emptied; for let the land be ever so well drained, its nature cannot be entirely changed—clay will always have a tendency to retain water on its surface, and soil every thing that touches it, and deep loam and black mould will still be penetrated by horses' hoofs, and rise in large masses, with the wheels, immediately after rain. No turnips should therefore be led off fields during, or immediately after severe rain; nor should they be pulled at all, until the ground has again become consolidated; and as they cannot be pulled in frost, and if they are urgently required from the field in any of these states of weather, a want of foresight is evidently manifested by the farmer and his manager.

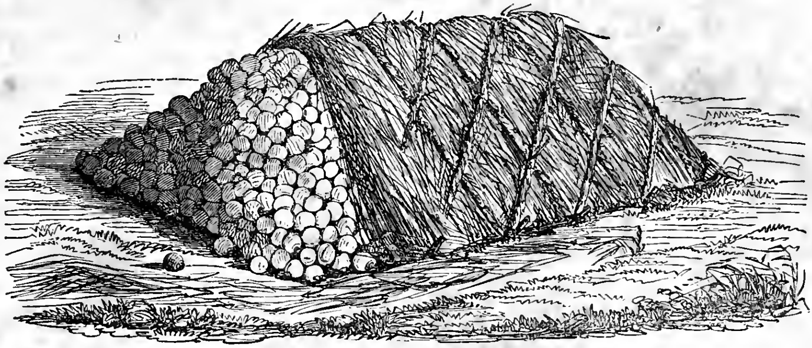
822. In commencing the pulling of turnips, one of the fields to be occupied by the sheep should first be stripped to provide a break for them whilst on pasture, to be ready to be taken possession of before the pasture becomes bare.

823. On the weather proving unfavourable at the commencement of the operation, that is, too wet or too frosty, or an important operation intervening—such as the wheat-seed, no more turnips should be pulled and carried off than will suffice for the daily consumption of the cattle in the steading; but, whenever the ground is dry at top and firm, and the air fresh, no opportunity should be neglected of storing as large a quantity as possible. This is a very important point of management, and, as I conceive, too much neglected by most farmers, who frequently provide no more than the quantity of food daily required. Some employ one or two carts an afternoon's yoking, to bring in as many turnips as will serve the cattle for two or three days at most, and these are brought in with the tops on, after much time has been spent in the field in waiting for their pulling and tailing. This is a slovenly mode of providing provender for cattle. To provide turnips in the best state, independent of the states of the weather, should be regarded a work of the first importance in winter; and it can only be done by storing a considerable quantity in good weather, to be used when bad weather comes. When a store is prepared, the mind remains easy as to the state of the weather, and having a store does not prevent you taking supplies from the field as long as the weather permits the ground to be carted upon with impunity, to be immediately consumed or to augment the store. I believe no farmer would dissent from this truth; and yet many violate it in their practice! The excuse most ready to be offered is the want of time to store turnips when the potato-land should be ploughed and sown with wheat; or when the beasts are doing well enough yet upon the pasture; or when the turnips still continue to grow. The potato-land should be sown; and, after a late harvest, it may be so after the pasture has failed; but the other excuses, founded on the growing state of the turnips and rough state of the pastures, are of no force when adduced against the risk of reducing the condition of the stock. Rather than incur such a risk, give up the rough pasture to the sheep. The ewes may require it.

824. The storing of turnips is well done in this manner. Choose a piece of lea ground, convenient of access to carts, near the steading, for the site of the store, and, if possible, in an adjoining field, on a 15-feet ridge, running N. and S. Fig. 37 gives the form of the turnip-store. The cart with the topped and tailed turnips is backed to the spot of the ridge chosen to begin the store, and there emptied of its contents. The ridge being 15 feet wide, the store should not exceed 10 feet in

width at the bottom, to allow a space of at least 2½ feet on each side towards the open furrow of the ridge, for the conveyance of water. The turnips may be piled

Fig. 37.



THE TRIANGULAR TURNIP-STORE.

up to the height of 4 feet; but will not pile to 5 feet on that width of base. The store may thus be formed of any length; but it is more desirable to make two or three stores on adjoining ridges, than a very long one on the same ridge, as its farthest end may be too far off to use a wheel-barrow to remove the stored turnips. Straw drawn out lengthwise is put from 4 to 6 inches thick above the turnips for thatch, and kept down by means of straw ropes arranged lozenge-shaped, and fastened to pegs driven in a slanting direction in the ground, along the base of the straw, as may be distinctly seen in the figure. Or a spading of earth, taken from the furrow, may be placed upon the ends of the ropes to keep them down. The straw is not intended to keep out either rain or air—for both are requisite to preserve the turnips fresh—but to protect them from frost, which causes rottenness, and from drought, which shrivels turnips. To avoid frost, the end, and not the side, of the store should be presented to the N., from whence frost may be expected most to come. If the ground is so flat, and the open furrows so nearly on a level with the ridges, as that a fall of rain might overflow the bottom of the store, a furrow-slice, in that case, should be taken out of the open furrows by the plough, a gaw-cut made with the spade, and the earth used to keep down the ropes.

825. When the turnips are to be used from the store in hard frost, the straw on the S. end is removed, as seen in fig. 37, and a cart, or the cattle-man's capacious light wheel-barrow, backed to it; and, after the requisite quantity for the day has been removed, it is replaced over the turnips.

826. Some people evince a desire to place a turnip-store in the stack-yard, on account, perhaps, of protection from frost by the stacks, but a stack-yard has not sufficient room in the beginning of winter for the turning of carts. I have seen turnips stored up between two stacks in the early part of the season, only as a temporary expedient until straw was thrashed out.

827. There are other forms of store which will preserve turnips fresh and good for a considerable time. I have seen turnips heaped about 3 feet in height, quite flat on the top, upon the ground, and covered with loose straw, and though rain passed through them readily, they kept very well.

828. A plan has been tried to pull them from the field in which they have grown, and set them upright with their tops on in another field, in a furrow made with the plough, and then to cover the bulbs with the next furrow-slice.

829. Another is, to pull the turnips, as in the former case, and carry them to a bare or lea field, and set them upright beside one another, as close as they can stand, with their tops and roots on.

830. No doubt, both these plans will keep turnips fresh enough, and an area of 1 acre will thus contain the growth of 4

or 5 acres of the field; but turnips cannot be so secure from frost in those positions as in a store; and after the trouble of lifting and carrying them has been incurred, it is much easier to take them to a store at once, where they would always be at hand, than take them first to, and bring them again from, another field; and even if they were so set in a field adjoining the steading, they would occupy a much larger space than any store.

831. Objectionable as these plans are, compared to triangular or flat-topped stores, they are better than storing turnips in houses, where they engender heat and sprout on the top, and never fail to become rotten at the bottom of the bin. Piling them against a high wall, and thatching them like a to-fall, preserves them very little better than in an outhouse.

832. Turnips put into pits dug in the ground, and covered with earth, have failed to be preserved.

833. A plan has been recommended to drive stakes $2\frac{1}{2}$ feet high into the ground, and wattle them together with brushwood, making an enclosure of three sides, in the interior of which the turnips are packed, and piled up to a point and thatched, like the store in fig. 37; and the turnips are represented as keeping fresh in such a structure until June; and one advantage attending the plan is said to be, that "where room is rather limited in the rick-yard, one pile of this description will contain 3 times as much as one of those placed on the ground of a triangular shape; and the saving of thatch is also considerable." But, as it appears to me, the providing of stakes and the trouble of wattling to form an enclosure, will far more than counterbalance any advantage of space or saving of straw for thatch, compared with the simple mode I have described in fig. 37; but no necessity exists for having a turnip-store in a rick-yard.

834. In pulling mangold-wurtzel, care should be taken to do as little injury to the roots as possible. Cleansing with the knife should on no account be permitted; and rather leave some of the leaf on than injure the crown of the root in any way. The drier the weather is the better for storing the crop, though the roots will not be injured in the store by a little earth adhering to them in wet weather. The roots are best prepared for the store by twisting off the top with the hand, as a mode of preventing every risk of injuring the root. Mangold-wurtzel not being able to withstand frost, the crop must be entirely cleared from the field before its appearance; and the best way of pulling them is in the order indicated in fig 32, at *a*, where two drills are pulled by one worker, and the adjoining two drills by another; and the trimmed roots placed in heaps in the hollow intermediate to the four drills, the leaves being also thrown into heaps between the roots. "The leaves, thus treated, when intended to be fed either by sheep folded on land, or carted off and thrown on pastures for cattle or sheep, are always clean and fit food for stock, which they are not when thrown over the land and trampled on. Besides this, the beet which has been pulled, and not carted during the day, should always be covered the last thing before leaving for the night, and the leaves, being laid conveniently in heaps, are used for that purpose. Mangold-wurtzel standing on the ground, and protected by the broad leaves, will stand a frost (if not very severe) without injury, but a very slight frost will damage those roots which are pulled; therefore it is a wise precaution to cover up the roots that are left at night." If the leaves are not desired to be used as food, they may be scattered over the ground.

835. On removing any roots, the cart goes up between two rows of pulled roots, and thereby clears a space at once of the breadth of eight drills. In this manner the work proceeds expeditiously, and with as little injury to the land by trampling as possible. To save the land still farther, the carts should always be driven up and down the drills and not across them, whether going with a load or returning empty. The pulling and driving a good crop of 20 tons of mangold-wurtzel is stated to cost from 9d. to 1s. per ton, and a bad crop will cost considerably more. "In a wet season, the removal of a crop of beet from a retentive soil is frequently injurious, by the necessary treading in carrying the crop: in extreme cases this may be entirely obviated by removing the crop by

manual labour; and though the soil be not of that retentive nature, yet those who farm wet land have occasionally recourse to the carrying the crop to heaps at the side of the field, in baskets, or wheeling in barrows; and find that the cost does not greatly exceed the carrying the crop in carts. Planks to wheel upon would facilitate the operation."

836. The *storing* of mangold-wurtzel may be effected in various ways, but in every case the roots must be secured against frost, and a thick covering of straw will effect the purpose. One plan is to build up the roots against a wall, and line the outside of the heap with hurdles and straw, and cover it with straw one foot thick as a thatch.* Another plan is to pile the roots, like a pit of potatoes, 6 feet in width at the bottom, and 4 feet high, to the point of the triangular taper, cover them with straw, and place a stratum of earth over it, taken from each side of the heap, and leaving the crest of the triangular heap uncovered with earth, to act as a ventilator from the roots, through the straw.†

837. *Carrots* are also taken up before the frost appears, and stored for winter use. They are best taken out of the ground with a three-pronged fork, when sown on the flat ground, but on drills the plough, without the coulter, answers the purpose nearly as well, and executes the work much more expeditiously, though the extremities of the largest carrots are broken off. On being taken up in either way the tops are wrenched off by the hand, and may be given to the cattle, or strewn over the ground to be ploughed in.

838. Carrots not being so easily affected by frost as mangold-wurtzel, may be stored in an outhouse mixed with dry sand, or in a triangular heap, and covered with straw only, or with straw and earth.

839. "In October, the leaves of the *parsnip*, as they *begin* to decay, should be cut off and given, when dry, to the cows: it is important to see that they be dry, as, when moist from rain or dew, they are apt to inflame the udder. The leaves come in as a convenient auxiliary to grass at this period; and, if given *moderately*, a good armful per day to each cow will impart as much richness to the milk as the parsnip itself." ‡

840. The parsnip may be taken up from the flat or the drill and stowed in precisely the same manner as carrots, not being much affected by frost, and will keep fresh in the store until April. Care, however, should be taken that none of the leaves remain attached to the roots.

841. *Cabbages* should be pulled up by the roots; for when the stem is cut over, and left in the ground, it will sprout out again, and the aftergrowth will much exhaust the soil.

842. In storing cabbages they may be sheughed into the soil, or, what is better, hung up by the stems with the head downwards, in a shed, where they will keep fresh for a long time.

ON THE VARIETIES OF TURNIPS CULTIVATED.

843. There are a great many more varieties of turnips cultivated in the country than seems necessary. Mr Lawson enumerates and describes no fewer than 46 varieties cultivated in the field; namely 11 of swedes, 17 of yellow, and 18 of white,§ the names being derived as much from the colour of the flesh as the skin. One kind from each of these classes seems requisite to be cultivated on every farm, although the yellow is omitted in some districts, and the swede in others. Where the swede is omitted, it has never been cultivated, and where the yellow is the favourite, the swede is unknown; for where it is known, its culture is never relinquished, and its extension is nearly overspreading the yellow, and even curtailing the boundary of the white. The white varieties come earliest into use, and will always be esteemed on account of their rapid growth and early maturity, though unable to

* *Journal of the Agricultural Society of England*, vol. ii. p. 300.

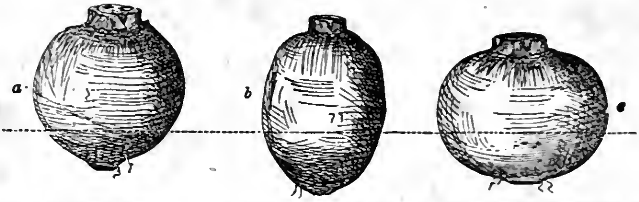
† *Ibid*, vol. viii. p. 218-221.

‡ Lawson's *Agriculturists' Manual*, p. 237, and Supplement, p. 49. § *Ibid.*

withstand severe frost. Being ready for use as soon as the pasture fails, they afford the earliest support to both cattle and sheep; and only such a quantity should be stored of them as will last to the end of the year. The yellows then follow, and last for about 2 months, to the end of February or thereabouts; and the same rule of storing them, for a specified time, is followed as with the whites. The swedes finish the course, and should last until the grass is able to support the young cattle, to the end of May or beginning of June, to which period they will continue fresh in store, if stored in the proper time and manner as recommended above; and the *most* proper time for storing them is before vegetation makes any appearance, in the end of March or beginning of April.

844. Of all the 18 varieties of white turnips, I should say that the white globe (*Brassica rapa*, *depressa*, *alba*, of De Candolle) *a*, fig. 38, is the best for early

Fig. 38.



THE WHITE GLOBE TURNIP. THE PURPLE TOP SWEDISH TURNIP. THE ABERDEENSHIRE YELLOW BULLOCK TURNIP.

maturity, sweetness, juiciness, size of root, weight of crop, and elegance of form. Its form is nearly globular, as its name indicates; skin smooth, somewhat oily, fine, and perfectly white; neck of the top and tap-root small; leaves long, (frequently 18 inches;) upright, and luxuriant. Though the root does not feel particularly heavy in the hand, it does not emit a hollow sound when struck, as the tankard turnip does; its flesh is somewhat firm, fine-grained, though distinctly exhibiting fibres radiating from the centre; the juice easily exudes, and the rind is thin. Its specific gravity was determined by Dr Skene Keith at 0·840; and its nutritive properties by Sir Humphry Davy, at 42 parts in 1000; of which were, of mucilage 7, of sugar 34, and of albumen or gluten 1.* Mr Sinclair mentions this remarkable fact in regard to the white turnip, that "the quantity of nutritive matter contained in different roots of the same variety varies according to the size and texture of their substances. Thus, a root of the white-loaf turnip, measuring 7 inches in diameter, afforded only 72½ grains; while the same quantity of a root which measured only 4 inches, afforded 80 grains;" and he makes this important conclusion, that "the middle-sized roots of the common turnip are therefore the most nutritious." †

845. I suspect that our crops of white-globe turnip ordinarily consist of middle-sized bulbs, or they contain many blanks, as the following statement will show. Taking the distance between the turnips at 9 inches — being that at which white turnips are usually thinned out — and the usual distance between the drills at 27 inches, an area of 243 square inches of ground is allowed for each turnip. Hence there should be 25,813 turnips per imperial acre; and taking 20 tons per acre as a fair crop, each turnip should only weigh 1 lb. 5 oz.! Now, a size of 6 inches in diameter overhead may be assumed; and having the specific gravity at 0·840, each turnip should weigh 6 lb., and the crop 69 tons 2 cwt., instead of 30 tons per acre. The inevitable conclusion is, either that blanks occur to the enormous extent of only 9445 turnips instead of 25,813; or the average distance between the turnips must be 20 inches instead of 9. When actual results fall so very far short of expectation, the inquiry is, Whether the great deficiency is occasioned by the death of plants after the singling process has been completed? or the average size and weight of each turnip are much less than we imagine; or the distance left by the singling is greater than we desire?—or from all these causes

* Davy's *Agricultural Chemistry*, p. 135, edition of 1839.
† Sinclair's *Hortus Gramineus Woburnensis*, p. 406-407, edition of 1824.

combined? From whichever cause, singly or combined, it is worthy of serious investigation by the farmer, whether or not the fate of the crop really depends more on these occult circumstances than on the mode of culture? Let us examine this a little:—

846. Weights and sizes of white turnips have been ascertained with sufficient accuracy. The white globes exhibited at the show of the Highland and Agricultural Society at Inverness in October 1839, gave a girth varying from 28½ to 34 inches, and a weight varying still more—from 8 lb. to 15½ lb. each root; and 3 roots of the same girth of 30½ inches, varied in weight respectively 8 lb., 9¾ lb., and 14½ lb.* After such a statement, our surprise at results may be moderated, it being evident that crops of the same bulk weigh differently; and turnips from the same field exhibit different fattening properties; and different localities produce turnips of different bulk. Whence arise so various results? The above weights are not the utmost to which this turnip attains, examples occurring from 18 lb. to 23 lb.;† and I have pulled one from amongst swedes, weighing 29 lbs., including the top.‡ And yet from 30 to 40 tons per imperial acre are regarded a good crop of this kind of turnip.

847. Of the yellow turnip, Mr Lawson has described 17 varieties, of which perhaps the greatest favourite is the green-top Aberdeen Yellow Bullock (*Brassica rapa, depressa, flavescens*, of De Candolle.) This is a good turnip, of the form of an oblate spheroid, *c*, fig. 38; the colour of the skin below the ground, as well as of the flesh, being a deep yellow orange, and that of the top bright green. The leaves are about 1 foot long, dark green, rather soft, spreading over the bulb, and collected into a small girth at the top of the turnip; the tap-root is small. Its specific gravity, as determined by Dr Keith, is 0.940; and its nutritive property, according to Sinclair, is 44 in 1000 parts, of which 4¾ are of mucilage, 37¾ of sugar, and 1½ of bitter extract or saline matters. This root feels firm and heavy in the hand, with a smooth fine skin, the flesh crisp, but not so juicy, nor the rind so thin as the globe.

848. Selected specimens exhibit a circumference of from 27 to 30 inches, with a weight varying from 6 lb. to 8½ lb., but specimens may be found weighing from 9 lb. to 11 lb. with the same diameter, showing a difference of 2 lb. in weight. Yellow turnips seldom yield so heavy a crop as either the globe or swede, 30 tons the imperial acre being a good crop; but their nutritive property is greater than white turnips. In the northern parts of the kingdom, where light soils predominate, they are grown in preference to the swede; but, from my own experience in raising the swede on the driest gravelly soil, I believe if it receives the sort of culture it requires, it would exceed the yellow in weight and nutrition in every soil.

849. Of the 18 varieties of the swedish turnip described by Mr Lawson, the Purple-top (*Brassica campestris, napo-brassica, rutabaga*, of De Candolle,) has long obtained the preference; and certainly if weight of crop, nutritious property, and durability of substance are valuable properties in a turnip, none can exceed this. It is of an oblong form, *b*, fig. 38, having the colour under ground and of the flesh a deep yellow orange, and the part above the ground a dusky purple. The leaves are about 1 foot long, standing nearly upright, of a bluish green colour, and growing out of a firm conical crown, which forms the neck of the bulb. The skin is somewhat rough, the rind thicker than either the white or yellow turnip, and the flesh very crisp. This turnip feels heavy and hard in the hand. According to Dr Keith, the specific gravity of the orange swede is 1.035, and of the white 1.022, and Sir Humphry Davy estimates its nutritive property at 64 in 1000 parts, of which 9 are starch, 51 sugar, 2 gluten, and 2 extract. Dr Keith found the Swedish turnip heaviest in April, at the shooting out of the new leaves, and after its flower stem was fairly shot in June, the specific gravity of the root decreased

* *Quarterly Journal of Agriculture*, x. p. 456. † Lawson's *Agriculturists' Manual*, p. 253-254.

‡ *The Norwich Mercury* of July 1841, makes mention of a turnip,—a white one, we presume,—exhibited at Fakenham market, and sent from Van Diemen's Land in strong brine, which weighed 84 lb., having a girth of 5 feet 2 inches. It is said to have weighed 92 lb., when pulled.

to 0.94, that of the yellow turnip. This differential fact indicates the comparative values of those turnips, and also the time for storing the swede. As Sir Humphry experimented on Swedish turnips grown in the neighbourhood of London, where they are confessedly inferior to those in the northern counties, his results as to their nutritive properties may be considered below the true mark, especially as the cases given by Professor Johnston show the proportion of nutriment as 74½ in the 1000.

850. Picked specimens have exhibited a girth of from 25 to 28 inches, varying in weight from 7 lb. to 9½ lb., but the weight varies in a different proportion to the bulk, as one of 25 inches gave 9½ lb., whilst another of 26 inches only weighed 7 lb. It is no uncommon thing to see swedes from 8 lb. to 10½ lb. A crop of 16 or 20 tons may be obtained by ordinary culture, but in the neighbourhood of large towns, such as Edinburgh, 28 or 34 tons are obtained on the imperial acre. I have heard of 50 or 60 tons boasted of, but suspect that the calculations had been made from limited and selected spots; nevertheless, a large and equal crop will sometimes be obtained, under favourable circumstances, such as I remember seeing of 50 acres within the policy of Wedderburn, Berwickshire, in 1815, when farmed by Mr Joseph Tod, Whitelaw, on walking over which I could not detect a single turnip of less apparent size than a man's head. The crop was not weighed, and was let to be consumed by cattle and sheep, the wethers to pay 6d. a-head per week, and it realised £21 per imperial acre! Taking a man's head at 7 inches in diameter, and the specific gravity of a Swedish turnip at 1.035, the weight of each turnip should be 6 lb. 11 oz., and allowing 19,360 turnips per acre, at 12 inches apart in the drill, and 27 inches between the drills, the crop should weigh 58 tons 1 cwt. Take the calculation in another form, and see the result of £21 at 6d. a-head per week, which implies the support of 32 sheep to the acre; and take Mr Curwen's estimate of a sheep eating 24 lb. a-day, for 180 days, or 26 weeks,† the crop should have weighed 61 tons 12 cwt. This must be the correct weight, so the above estimated one by sight comes very near the truth. The quantity of turnips eaten by sheep is, however, variously stated. Sir John Sinclair gives a consumption of 21 acres of 44 tons each, by 300 sheep in 180 days, or nearly 38 lb. a-day for each sheep.‡ If we take the usual allowance of 16 young sheep to an ordinary acre of 30 tons, which is 23⅓ lb. a-day to each, or ten old sheep, which is 37⅓ lb. to each, both respectively are near the results given by Mr Curwen and Sir John Sinclair, the difference between them being exactly that consumed by old and young sheep. Whether we take 24 lb or 38 lb. as the daily consumption of turnips by sheep, there is no doubt whatever of the £21 per acre having been received for their keep; but the exact consumption of food by live-stock is unknown, although a subject worthy of experimental investigation.

851. The proportion the top bears in weight to the root is little in the Swedish turnip, as evinced in the experiments of Mr Isaac Everett, South Creake, Norfolk, on a crop of 17 tons 9 cwt., grown at 18 inches apart, and 27 inches between the drills, gave 3 tons 3 cwt. of tops, on the 15th December, after which they were not worth weighing; and, what is remarkable, the tops are lighter in a crop raised on drills than on the flat surface; that is, whilst 28 tons 8 cwt. of topped and tailed turnips afforded only 5 tons 10 cwt. of tops from drilled land, a crop of 28 tons 16 cwt. from the flat surface yielded 6 tons 16 cwt. of tops.§

852. The yellow turnip will continue fresh in the store until late in spring, but the swede has a superiority in this respect to all others. The most remarkable instance I remember of the swede keeping in the store, in a fresh state, was in Berwickshire, on the farm of Whitsome Hill, when in the possession of Mr George Brown, where a field of 25 acres was pulled, rooted, and topped, and stored in the manner already described, in fine dry

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 928.
† Curwen's *Agricultural Hints*, p. 39.
‡ Sinclair's *Account of the Husbandry of Scotland*, vol. ii. Appendix, p. 47.
§ *Journal of the Agricultural Society of England*, vol. ii. p. 270.

weather in November, to have the field sown with wheat. The store was opened in February, and the cattle continued on them until the middle of June, when they were sold fat, the turnips being then only a little sprouted, and somewhat shrivelled, but exceedingly sweet to the taste. One property possessed by the Swedish turnip stamps a great value upon it for feeding stock, the larger it grows the greater quantity of nutritive matter it contains. According to Sinclair, 1728 grains of large-sized Swedes contained 110 grains of nutritive matter, whereas small-sized ones only yielded 99 grains,* affording a sufficient stimulus to the farmer to raise this valuable root to the largest size attainable.

853. This is a comparative view of the specific gravity of the turnips and roots just referred to:—

Specific gravity of orange Swedish turnip in December, ...	1·035
It is heaviest in April, about the shooting of the new leaves ; and in June, after the development of the flower stalk, it is . . .	0·940
Specific gravity of white Swedish turnip,	1·022
— — yellow bullock, .	0·940
— — white globe, .	0·840
— — carrot, . .	0·810†

854. The composition of turnips and the other roots spoken of is thus given by Professor Johnston:—

	Johnston.			Johnston.			Hermbstadt.	Crome.
	Turnips.			Mangold Wurtzel.				
	Grown on different soils near Tranent, East Lothian.			Long Red.	Short Red.	Orange Globe.	Common Carrot.	Parsnip.
Water, .	89·30	89·42	89·00	85·18	84·68	86·52	80·00	79·40
Sugar, .	5·61	6·21	6·54	9·79	11·97	10·24	7·80	5·50
Gum, .	0·11	0·11	0·16	0·67	0·50	0·13	1·75	6 10
Albumen,	0·72	0·47	0·36	0·09	0·18	0·03	1·10	2·10
Pectic and meta-pectic acids,	1·76	1·33	1·51	...	...	...	...	...
Oil, . .	0·19	0·22	0·18	...	...	...	0·35	...
Cellular fibre,	1·63	1·75	1·59	...	...	...	...	...
Saline matter,	0·54	0·49	0·59	...	...	...	...	...
Casein, (so called,) .	...	...	...	0·39	0·26	0·33	..	...
Fibre and pectic acid,	...	...	...	3·08	3·31	2·45	...	..
Starch and fibre, .	...	...	...	...	...	...	9·00	6·90
	99·86	100·	99·93	99·20	100·89	99·70	100·	100·

Professor Johnston remarks, that the above analyses of the common carrot and parsnip are very imperfect, and require to be repeated.

855. He adds—" I regret to say that our present knowledge of the valuable esculent, the *cabbage*, is almost nothing. In my laboratory the proportion of water in the leaves of several varieties of cabbage has been found to average 92 per cent, and in the stalk 84 per cent. The dry solid matter of the leaf contains from 7 to 20 per cent of inorganic or mineral matter, in which there is much sulphuric and phosphoric acids. The dry matter of the cabbage is unquestionably nutritive, though the proportion of protein, or supposed muscle-forming constituents, has not as yet been determined. The flower of the cabbage, however, (cauliflower,) in the dry state, has been found to contain as much as 64 per cent of those compounds, gluten, albumen, &c., or more than any other cultivated vegetable. The common mushroom in the dry state is the only

* Sinclair's *Hortus Gramineus Woburnensis*, p. 407.

† Keith's *Agricultural Report of Aberdeenshire*, p. 302.

vegetable, as yet known, which approaches to this proportion. Were it possible to dry cabbage, therefore, it would form a very concentrated food." *

856. A summary of the foregoing results will be useful for reference :—The three kinds of turnips described, the purple-topped swede, the Aberdeenshire yellow bullock, and the white globe, possess all the properties for feeding stock, and remain fresh during the feeding season, which is all that can be desiderated by the farmer: therefore it seems unnecessary to cultivate any other variety where these can be procured pure of their kinds. But as—

857. The *white stone* turnip comes quicker to maturity than the white globe; and in case the grass should fail in autumn more quickly than expected, it may be advisable to sow a few of the white stone variety for early use, and though not required, it will be found useful for sheep to begin the season with. And as—

858. *Laing's swede* is found to resist the influence of vegetation longer in spring than the purple-topped; a few may be sown to be used in the latest part of the feeding season, and need not be stored until the end of April.

859. A white globe turnip of 7 inches in diameter affords $72\frac{1}{2}$ grains, whereas one of 4 inches diameter affords 80 grains of nutritive matter, the smaller being the more nutritive.

860. A large swede contains 110 grains, and a small one only 99 grains of nutritive matter, the larger swede being the more nutritive.

861. The quantity of nutritive matter in the same variety of the turnip varies —in white turnips from 8 to 13 per cent, and in the yellow turnip from $11\frac{1}{2}$ to 17 per cent; so that 20 tons of one crop may be as feeding as 30 tons of another, which is an important fact, and may ccount for the discrepancies experienced y farmers in feeding stock.

862. A good crop of swede turnips weighs from 30 to 35 tons per imperial acre.

863. A good crop of yellow turnips weighs from 30 to 32 tons per imperial acre.

864. A good crop of white globe turnips weighs from 30 to 40 tons per imperial acre.

865. A bushel of turnips weighs from 42 lbs. to 45 lbs.

866. The nutritive matter contained in an imperial acre of turnips is great. In a crop of 20 tons, or 45,000 lbs., there are 900 lbs. of thick or woody fibre, 4000 lbs. of starch, sugar, gum, 670 lbs. of gluten, 130 lbs. of fat or oil, and 300 lbs. of saline matter. Turnips, it may be observed, in the table of analysis, contain a very large proportion of water, and this enhancing the cost of transport, makes it almost necessary to have them consumed on the spot where they are grown.†

867. A young Leicester sheep may be supposed to eat 23 lbs., and an older one 38 lbs. of turnips per day, during the winter half-year, or 180 days, and a young black-faced sheep 18 lbs., and an old one 28 lbs. per day, in the same time.

868. The usual allowance to eat a crop of 30 tons of turnips in the winter half-year, or 180 days, is 16 young and 8 old Leicester sheep, and 20 young and 10 old black-faced sheep per acre. In making this last estimate the state of the crop should be taken into consideration; a close crop of small yellow or white turnips takes longer time to consume than a bulkier crop of larger turnips; but a crop of large swedes, though thin on the ground, will take a longer time to consume than a closer crop of smaller roots.

869. An ox will eat about a ton of turnips every week. A two-year-old short-horn ox will consume 26 tons, and a three-year-old 30 tons of turnips in 180 days. The smaller breeds of cattle consume less.

870. Implicit reliance cannot be placed

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 911-14.

† *Ibid.* p. 928.

in any of these data, as they have not been derived from sufficiently accurate experiments, but they may enable you to make an approximation in apportioning turnips to sheep and cattle.

871. The price of turnips depends almost entirely on the demand of the locality. In the neighbourhood of towns they are always high-priced, where an ordinary crop of white will fetch £10, of yellow £12, and of swedes £16 an imperial acre. They are chiefly purchased by milkmen, or cowfeeders, as they are usually called in Scotland. In the country, about £5, 10s. for white, and £8 for Swedish turnip, to be carried off the land, are given; and for white, when consumed on the ground by sheep, £3 to £5 an acre is considered a fair price; and on the premises by cattle £5, and from £5 to £7 per acre for swedes, with straw. A fairer plan for both the raiser and consumer of turnips is to let them by week at so much a head of stock. At the usual price of 3d. per head per week for young sheep, for the ordinary period of 26 weeks, makes a cost for keep of 6s. 6d.; and if it take 16 sheep to consume an acre, the turnips will realise about £5, 5s. per acre. For old sheep, double or 6d. per head per week is given, at a cost of 13s., which, for 8 sheep, will realise the same sum per acre. For cattle 5s. per head per week is given, with straw; and if an ox take 26 weeks to eat an acre, the turnips and straw will realise £6, 10s. In years of plenty, 2d., and of scarcity 4d. per head is given for young sheep, and for older stock double those prices.

872. There are two hybrids of turnips worth mentioning, as they were produced by art—the Dale hybrid, by Mr Dale, Liberton, near Edinburgh, and the Lawtown hybrid, by Mr Wright of Lawtown, near Coupar-Angus. It is probable that most of the varieties in use are natural hybrids. Dale's hybrid is a cross betwixt the green-topped swede and the globe; but whether the white or green-topped globe I do not know. It possesses more of the appearance and properties of the yellow turnip than of either of its progenitors; and has the advantage of arriving sooner at maturity, and may therefore be sown later than the ordinary yellow turnip.

873. The Lawtown hybrid is a cross between the green-topped swede and the green-topped globe, the result of which is a heart-shaped, white-fleshed, green-topped turnip, considerably heavier and hardier than the globe, with its leaves set on like those of the swede. The obvious results of these two crosses are—a yellow turnip, Dale's, which arrives sooner at maturity than the older varieties; and a white globe, the Lawtown, which is more hardy than any other variety of white.

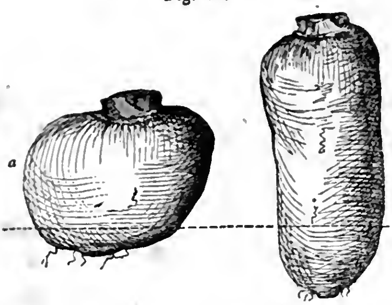
874. The crop afforded by these hybrids, in an experiment made in 1835, by Mr John Gow, Fettercairn, Kincardineshire, was, by the Dale, 28 inches in girth, 23 tons, and by the Lawton, 32 inches in girth, 27 tons the imperial acre.*

875. Although storing is the proper method of securing turnips for use during a storm of rain or snow, when the turnip-field should not be entered by a cart, yet, as a storm may overtake you, you should be provided with food for the cattle. Rain, snow, and frost, exhibit prognostics of their approach; and when any of them indicates a determined result, send all the field-workers and ploughmen to the turnip-field, and pull the turnips in the manner described above, fig. 32, removing only the tails, and throw the turnips with their tops into heaps of from 3 to 6 cart-loads each, according to the bulk of the crop, taking care to finish each heap, by placing the tops of the uppermost turnips all around the outside, to protect the bulbs from the frost, should it come suddenly unaccompanied with snow. To such heaps rain or snow will do no harm, and they serve to point out where they are, should snow cover the ground thickly. As the turnips gathered in frost or snow should be immediately consumed and not stored, they may be thrown from the heaps into the cart with a fork or graip, and the tops removed at the steading, where the process may be done in the severest weather, when women could not stand out in the field to do it.

* Lawson's *Agriculturist's Manual*, pp. 241, 245, and 257.

876. I give *a* in fig. 39 to show you

Fig. 39.



AN ILL-SHAPED TURNIP. THE TANKARD TURNIP.

what I conceive to be an ill-formed turnip, as also one, *b*, which stands so much out of the ground represented by the dotted line as to be liable to injury from frost. The turnip *a* is ill-formed, inasmuch as the upper part of it around the top is hollow, where rain, snow, or rime may lodge, and find their way into the heart, and corrupt it, as is actually found to take place. All white turnips, when allowed to remain on the ground after they have attained maturity, become soft and spongy, of inferior quality in the heart, and susceptible of rapid putrefaction, which frequently overtakes them in sudden changes from frost to thaw, and reduces them to a saponaceous pulp. This fact affords a good motive to store white turnips after they come to maturity, which state is indicated by the leaves losing their green colour and becoming flaccid. There are some sorts of white turnips always spongy in the heart, and among these I would class the tankard-shaped, represented by *b*, fig. 39; as also a flat-shaped red-topped white, and a small flat white turnip, both cultivated by small farmers, because, being small, they require little manure to bring them to maturity, and this class of tenants spread the manure on the land as thin as possible to make it go the farther. I need scarcely tell you that economy is only to be found in the cultivation of the best varieties of turnip.

877. I think it useful to give you a tabular view of the number of turnips there should be on an imperial acre, at given distances between the drills, and between the plants in the drills, and of the weight of the crop at specified weights of each turnip, that you may compare actual receipts with defined data, and endeavour to ascertain whether differences in the crop arise from deficiency of weight in the turnip itself, or in the plants being too much thinned out. The distance between the drills is the usual 27 inches, the distance between the plants is what is allowed to the different sorts of turnips. As the imperial acre contains 6,272,640 square inches, it is easy to calculate what the crop should be at wider and narrower intervals between the drills.

Usual distance between the drills.	Usual distances between the plants.	Area occupied by each plant.	Number of turnips there should be per imperial acre.	Weight of each turnip.	Weight which the crop should be per imperial acre.	
Inches	Inches.	Square Inches.		lb.	Tons.	Cwt.
27	9 between the plants of white turnips.	243	25,813	1	11	10½
				2	23	1
				3	34	11½
				4	46	2
				5	57	12½
				6	69	3
				7	80	13½
				8	92	4
27	10 between the plants of yellow turnips.	270	23,232	1	10	7
				2	20	14
				3	31	1
				4	41	8
				5	51	15
				6	62	2
				7	72	9
				8	82	16
27	11	297	21,120	1	9	8
				2	18	17½
				3	28	5
				4	37	14½
				5	47	2
				6	56	11½
				7	65	19
				8	75	8½
27	12 between the plants of swedes.	324	19,360	1	8	12¾
				2	17	
				3	25	18¼
				4	34	11
				5	43	3¾
				6	51	16½
				7	60	9¼
				8	69	2

878. On comparing a common crop of 20 tons of swedes with these data, and keeping in view the distance of 12 inches between the plants, the inevitable conclusion is, that the average weight of turnips must be less than 3 lb., or the distance between them greater than 12 inches. In

the one case your skill in raising a crop is almost rendered nugatory, and in the other your negligence in wasting space in the thinning out appears conspicuous. An amendment in both particulars is therefore requisite, and fortunately attainable; for, as a slight difference in either makes a great difference in the weight of a crop, your endeavour should be both to make the turnip heavy, and the desired distance between them invariable. For example, 5 lb. turnips, at 9 inches asunder, give a crop of 57 tons 12½ cwt.; whereas the same weight of turnip at 11 inches apart, gives only a little more than 47 tons. Now, how easy is it for careless people to thin out the plants to 11 instead of 9 inches, and yet, by so doing, no less than 10½ tons of turnips are sacrificed. Again, a difference of only 1 lb. on the turnip—from 5 lb. to 4 lb.—at 9 inches asunder, makes a difference of 11½ tons per acre. So that a difference of only 1 lb. in each turnip, and 2 inches in the distance between them, makes the united sacrifice of 21 tons per acre! Who will deny, after this, that minutiæ require the most careful attention in farming?

879. One occasionally sees in the newspapers statements of great crops of turnips; but when all particulars are not known, it is quite possible for great errors to be committed in making returns from any other mode of ascertaining the amount of a crop of turnips than by topping and tailing a whole field, and weighing every cart-load separately. For example. Suppose 1 yard is measured *from a turnip* along a drill, one yard will embrace 5 turnips of white and 4 of swedes: and, if the measurement is begun *between two turnips*, one yard will only embrace 4 turnips of white and 3 of Swedes, making, in the white a difference of 1 turnip in every 5, and in the swedes 1 in every 4; and if the weight of an acre is calculated on such data, the crop, in the case of the white, will be ⅕, and in that of the swedes ¼ beyond the truth. Again, if the yard be placed *across two drills*, their produce will be included within the yard, the distance between the drills being only 27 inches; but if the yard be placed across one drill only, then its produce alone will be included, as the yard will not reach to the drill on either side, and if the produce of the whole field is calculated on such data, the result, in the latter mode of measurement, will just give half the amount of the other. These ways of weighing a crop, when thus plainly stated, appear ridiculous; but they are the causes of error into which country people, who are not aware of the effects of the powers of numbers when squared, are very liable to fall. The part, too, of the field measured, may give a very different result from the whole, or another part, for even on turnip-soil, how different are the size and number of turnips on a rising knoll and a hollow! The difference is not so obvious on looking upon the tops alone, as after the sheep have eaten off the leaves, and exposed the bulbs. The plan, also, of filling one cart-load or so and weighing it, and filling the other cart-loads to a similar extent, without weighing them, is a fallacious one, when the fact is known, as shown above, of turnips grown on the same field differing much in weight, and therefore a few more or less in a small cart-load, will make a considerable difference in the amount over a whole field. I question much whether any person ever weighed every cart-load of turnips as they were brought from a field, or even measured many places of the same field, to ascertain the number and weight of turnips in them; and unless some plan approaching to either be adopted, the results obtained will never prove satisfactory.

880. When the trouble of weighing every cart-load is wished to be avoided, the smallest and the largest and the middle-sized turnips should be pulled, topped, and tailed, and chosen from every part of the field where a difference of size and number is found to occur—such as in hollows, on knolls, on sloping and level ground, at the top and bottom of the field—and each turnip weighed, and the tops weighed too, separately if desired, and then the average weight of the turnip may be relied on. A convenient machine for such a purpose is one of Salter's spring steel-yards, with a tin basin suspended from it by chains, in which a turnip may be placed and weighed with ease and celerity. Besides doing this, the distance from centre to centre of the tops of the turnips before they are pulled should be

measured, and noted down, and the average distance from turnip to turnip would then be ascertained. Having thus obtained correct data of the weight and number of turnips within the given limits of a field, the amount of the crop would be confidently ascertained. The average girth of turnips, though ascertained, is not an essential element in determining the weight of the crop. But the truest method is to weigh all the turnips in the field.

881. The history of the turnip, like that of other cultivated plants, is obscure. According to the name given to the swede in this country, it is a native of Sweden; the Italian name *Navoni de Laponia* intimates an origin in Lapland, and the French names *Chou de Lapone, Chou de Suède*, indicate an uncertain origin. Sir John Sinclair says, "I am informed that the swedes were first introduced into Scotland *anno* 1781-2, on the recommendation of Mr Knox, a native of East Lothian, who had settled at Gottenburg, whence he sent some of the seeds to Dr Hamilton."* There is no doubt the plant was first introduced into Scotland from Sweden, but I believe their introduction was prior to the date mentioned by Sir John Sinclair. The late Mr Airth, Mains of Dunn, Forfarshire, informed me that his father was the first farmer who cultivated swedes in Scotland, from seeds sent him by his eldest son, settled in Gottenburg, when my informant, the youngest son of a large family, was a boy of about 10 years of age. Whatever may be the date of its introduction, Mr Airth cultivated them in 1777; and the date is corroborated by the silence preserved by Mr Wight regarding its culture by Mr Airth's father when he undertook the survey of the state of husbandry in Scotland, in 1773, at the request of the Commissioners of the Annexed Estates, and he would not have failed to report so remarkable a circumstance as the culture of so useful a plant, so that it was unknown prior to 1773. Mr Airth sowed the first portion of seed he received in beds in the garden, and transplanted the plants in rows in the field, and succeeded in raising good crops for some years, before sowing the seed directly in the fields.

882. I have not been able to trace the history of the yellow turnip; but it is probable that it originated, as supposed by Professor Low, in a cross between a white and the swede;† and, as its name implies, the cross may have been effected in Aberdeenshire. Its origin must, therefore, have been subsequent to the introduction of the swede.

883. All the white varieties of field turnips obtained at first the name of the "Norfolk whites," from the circumstance of their having been first cultivated in that county, to any extent, by Lord Townshend, who, on coming home from being ambassador to the States-general, in 1730, paid great attention to their culture, and for which good service he obtained the appellation of "Turnip Townshend."

884. It is rather remarkable that no turnips should have been raised in this country in the fields until the end of the 17th century, when it was lauded as a field-root as long ago as Columella, and in his time even the Gauls fed their cattle on them in winter. The Romans were so well acquainted with turnips, that Pliny mentions having raised them 40 lb. weight.‡ Turnips were cultivated in the gardens in England in the time of Henry VIII.§

885. Dale's hybrid originated in a few ounces of a hybridal seed being sent, in 1822 or 1823, by the late Mr Sherriff of Bastleridge, Berwickshire, to Mr Robert Dale, Liberton West Mains, near Edinburgh, who, by repeated selection and impregnation, brought it to what it is, a good yellow turnip, and now pretty extensively cultivated.

886. The Lawton hybrid originated about 12 years ago by Captain Wright of Lawtown, in Forfarshire, crossing the green-topped white with the green-topped swede, to harden the white, which object proved successful; but its culture has not been pushed. By sowing the swede beside the white Lawtown, the latter has been converted into a yellow turnip, possessing the properties of the swede; and were the cross still farther prosecuted, I have no doubt that a distinct variety of the swede would be obtained.

887. A variety of swedes was brought into notice, about 8 years ago, by Mr Laing, Duddo, Northumberland, who found it amongst his ordinary swedes, and observed it by its remarkably elegant form of leaf, which is much notched near its base. It is now in use, and possesses the valuable property of resisting the influence of vegetation for at least a fortnight longer than the common varieties, as I had a favourable opportunity of observing in Berwickshire late in spring 1841, and on this account may be stored and kept in a fresh state to a very late period o. the season.

888. Like all plants, the turnip, when consumed by fire, leaves an ash containing a variety of inorganic substances. The composition of the ash of the bulb is thus afforded by Boussingault and Muspratt:—

* Sinclair's *Account of the Husbandry of Scotland*, vol. i. p. 278, note.
† Low's *Elements of Practical Agriculture*, p. 290.
‡ Dickson's *Husbandry of the Ancients*, vol. ii. p. 250-4.
§ Phillips' *History of Cultivated Vegetables*, vol. ii. p. 365.

	Boussingault.	Muspratt.
Potash	41·96	37·69
Soda	5·09	16·62
Lime	13·60	11·91
Magnesia	5·34	4·02
Oxide of iron, alumina, &c.	1·28	0·50
Phosphoric acid . .	7·58	5·80
Sulphuric acid . .	13·60	12·70
Chlorine	3·60	3·79
Silica	7·95	6·15
	100·00	99·18
Per-centage of ash in the dry state . . .	7·60	5·66

889. The proportion of ash left by the tops is much greater than that of the bulbs, the dry tops leaving from 14 to 20 per cent. Of these proportions a much larger amount consists of phosphoric acid in the tops than in the bulbs, and more than a third of the whole ash consists of earthy phosphates, as thus shown in an analysis by Johnston:—

Potash, soda, and carbonic acid .	25·95
Sulphuric acid	12·62
Chloride of sodium	14·02
Phosphates of lime and magnesia .	36·40
Carbonates of lime and magnesia .	10·01
Silica	1·00
	100·00*

890. In the beginning of 1848, it was proposed by some farmer in the county of Wigtown, to convert the Swedish turnip into a sort of meal, not so much for the use of man as food for stock. If it were possible to convert the bulb into a meal that could be preserved over years, the superfluity of one year might assist the deficiency of another; which would constitute desirable economy, as the turnip crop varies in weight to the extent of 50 per cent, according to the nature of the season.

891. The turnips would be converted into meal by being washed, and their juice then squeezed out by means of rollers; and on the squeezed fibre being dried in a kiln, would be easily ground by millstones into meal. The liquid portion could be evaporated, and its solid matter mixed with the meal.

892. A portion of turnip meal, thus prepared, was sent by Mr James Caird, Baldoon, to Professor Johnston for analysis, and was found to contain 22·82 per cent of water, and when burned, afforded 5·53 per cent of ash. When burned for nitrogen, it gave 13·68 per cent of protein compounds in the undried, or 17·72 per cent in the dried state. Its composition was this:—

	Natural state.	Dried at 212°
Protein compounds .	13·68	17·72
Gum	4·14	5·36
Sugar	48·72	59.23
Oil	1·11	1·44
Fibre and pectin .	8·10	10·49
Water	22.82	
Ash	4·27	5·53
	102·84	99·77

It contains too much water to keep a length of time, a very large proportion of sugar, and the protein compounds are equally great. It is, therefore, quite suited for feeding stock.†

893. The cabbage is considered good food for cows giving milk. The varieties of cabbage most suited for field culture are the Drum-head (*Brassica oleracea, capitata depressa,*) and the great round Scotch or white Strasburg, from which the German sour-krout is chiefly made (*Brassica oleracea, capitata spherica alba* of De Candolle.) Of these two the drum-head is the most productive, and the Scotch stands the winter best. The taste of milk is less tainted by the cabbage than turnips, and I believe more milk may be derived from it; though a decayed leaf or two in a head of cabbage will impart both to butter and milk a strong disagreeable taste. "This," says Sinclair, "I have long had an opportunity of proving." If planted in such drills as are commonly made for turnips, cabbages require good soil, and placed 18 inches asunder at least, which will give 12,907 plants to the acre, and, at 24 inches 9,680 plants; and if they at all attain to the weight that cabbages sometimes do, that is from 18 lb. to 23 lb. each, the lowest number, 18, will give a crop of 78 tons; but the usual crop is from 35 to 40 tons per acre. Their uses are to feed milk cows, to fatten oxen, and sheep are very fond of them. It is questionable how far their culture should be preferred to turnips, excepting on soil too strong for these, and as they require a large quantity of manure, they are not an economical crop in Scotland. I have no personal experience of the cabbage as a food for milk cows or feeding cattle, but know them to be much relished by ewes at the season of lambing.

894. The fresh leaves of the cabbage contain from 90 to 92 per cent of water. The dry leaf, when burned, leaves from 18 to 26 per cent of ash; so that a crop of 20 tons of cabbage, carry off from the soil more than one-half more of mineral matter than 20 tons of turnips—the quantity being 900 lb. These 900 lb. consist of—

Potash	105 lb.
Soda	184 „
Lime	189 „
Magnesia	54 „
Oxide of iron . . .	5 „
Phosphoric acid . .	112 „
Sulphuric acid . . .	192 „
Chlorine	52 „
Silica	7 „
	900 ‡

895. Since the failure of the potato, a number of varieties of cabbage have been recommended to be cultivated in the fields, among which is the turnip-stemmed cabbage or khol-rabi (*Brassica oleracea, caulo-rapa, alba* of De Candolle.) The varieties of this plant are numerous, but the best suited for field-culture are the large red and

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 384-5.

† *Transactions of the Highland and Agricultural Society* for March, 1848, p. 238.

‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 389.

green sorts. It is a native of Germany, where it is much cultivated, as also in the Low Countries and the north of France, where it is chiefly given to milk cows, for which it is well adapted, on account of its possessing little of that acridity found in the turnip to affect butter and milk. It is taken up before the frost sets in, and stored, like potatoes or turnips, for winter use. Its habits and produce are similar to the Swedish turnip, resembling it in the swollen bulb at the top of the stem when divested of leaves. Hares are so fond of it, that, on farms where they abound, its culture is found to be impracticable. Sir Thomas Tyrwhitt first introduced it into England from Germany.* It was successfully raised on the poor soil of Bagshot Heath, by Mr Hewitt Davis, in the dry summer of 1847, without purchased manure. He gave it to cows in milk, and ewes nursing early lamb, and both kinds of stock throve well upon it. Its solid matter varies from 12 to 22 per cent, and contains nearly 3 per cent of nutritive matter.

896. Although the parsnip (*Pastinacea sativa edulis* of De Candolle) is too tender a root for general cultivation in this country, it deserves notice on account of its fattening properties, as well as the good milk it yields. According to Colonel Le Couteur the weight of a good crop varies from 13 to 27 tons per acre; the latter quantity being sufficient to support 12 Jersey cows for six months, with a mixture of mangold wurtzel or turnips. The parsnip yields a heavier crop in Jersey than the Altringham carrot in the ratio of 840 : 261; but the white Belgian carrot was heavier than the parsnip in the ratio of 524 : 318. As parsnips contain 6 per cent more of mucilage than carrots, the Colonel conceives that the difference is sufficient to account for the superior fattening as well as butyraceous quality of the parsnip.† "In the fattening of cattle," says Don, "the parsnip is found equal, if not superior, to the carrot, performing the business with as much expedition, and affording meat of exquisite flavour, and a highly juicy quality. The animals eat it with much greediness. It is reckoned that 30 perches, where the crop is good, will be sufficient to fatten an ox 3 or 4 years old, when perfectly lean, in the course of 3 months. They are given in the proportion of about 30 lb. weight morning, noon, and night, the large ones being split in 3 or 4 pieces, and a little hay supplied in the intervals of those periods. And when given to milk cows with a little hay, in the winter season, the butter is found to be of as fine a colour and excellent a flavour, as when feeding in the best pastures. Indeed, the result of experiment has shown, that not only in neat cattle, but in the fattening of hogs and poultry, the animals become fat much sooner, and are more healthy, than when fed with any other root or vegetable; and that, besides, the meat is more sweet and delicious. The parsnip-leaves being more bulky than those of carrots, may be mown off before taking up the roots, and given to cows, oxen, or horses, by whom they will be greedily eaten."‡

897. The carrot is raised in the field in several parts of the country, especially since the failure of the potato; and of the cultivated varieties of the carrot, the white Belgian bids fair to supersede all others in the field. In a comparative experiment made by Mr Annesley, Fern Hill, Tockington, in 1842, between the white Belgian and Altringham carrots, he obtained from 25 tons to 29 tons 8 cwt. of the former, to from 19 tons to 21 tons 8 cwt. of the latter, with the same kinds and quantities of manure; while in the weight of the tops the difference was not nearly so great, the top of the Altringham being from 7 tons 10 cwt. to 8 tons 4 cwt. and of the Belgian from 8 tons 11 cwt. to 9 tons 14 cwt per acre. Both these crops had an excellent chance to be good, the land in 1840 having been in potatoes, and in 1841 in beans. The seed was laid in on the 9th April at the rate of 8 lb. per acre; and the white carrots were pulled on the 4th November, the red on the 21st. The soil for both was a clayey loam, one foot in depth, resting on a stiff clay.§

898. The nutritive matter contained in a crop of 25 tons, or 56,000 lb. per acre of carrots, consist of husk or woody fibre 1680 lb.; of starch, sugar, &c. 5600 lb.; of gluten, &c. 840.; of oil or fat, 200 lb.; and of saline matter, 800 lb.‖

899. Sir Charles Burrell mentions that, in consequence of giving his horses and cattle white carrots, the great saving in the use of hay is remarkable; having formerly 50 loads of hay in reserve at the end of the season, he has now 400 loads. Less hay may therefore be made in future, or more sold.¶

900. The quantity of nutritive matter afforded by a crop of mangold wurtzel of 20 tons, or 45,000 lb. per acre, consists of 900 lb. of husk or woody fibre; 4950 lb. of starch, sugar, &c.; 900 lb. of gluten, &c.; and of saline matter 450 lb. No oil or fat has yet been detected in an appreciable quantity.**

ON THE FEEDING OF SHEEP ON TURNIPS IN WINTER.

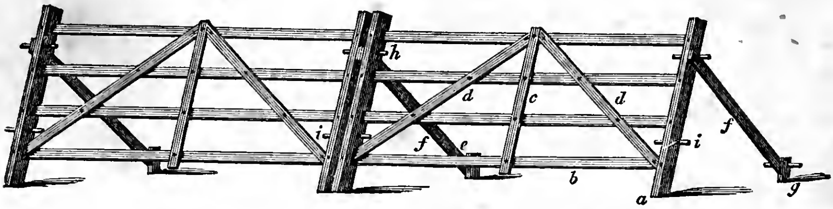
901. Room having been prepared on the turnip land for the sheep to be fattened upon turnips, by removing the half of the crop in the manner described above, fig. 31, and having selected that part of the field

* Sinclair's *Hortus Gramineus Woburnensis*, p. 411; and Lawson's *Agriculturist's Manual*, p. 187.
† *Journal of the English Agricultural Society*, vol. 1. p. 422; and vol. ii. p. 41.
‡ Don's *General Dictionary of Botany and Gardening*, vol. i. p. 229.
§ *Journal of the Agricultural Society of England*, vol. iv. p. 270.
‖ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 928.
¶ *Journal of the Agricultural Society of England*, vol. v. p. 281.
** Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 928.

to be first occupied, which will afford the sheep shelter in case of need, the first thing to be done is to carry the articles on carts to the field required to construct a temporary enclosure to confine them within a given space. It is the duty of the shepherd to erect these temporary enclosures, and he requires but little assistance from other labourers.

902. There are two ways of enclosing sheep upon turnips, by *hurdles* made of wood, and *nets* made of twine. Fig. 40 represents 2 hurdles set as they should be,

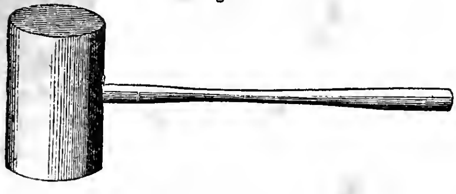
Fig. 40.



HURDLES OR FLAKES SET FOR CONFINING SHEEP ON TURNIPS.

and the mode of setting them is this: The shepherd requires the assistance of another person for this purpose. The hurdles are set down in the line of the intended fence. The first hurdle is raised by its upper rail, and the ends of its stakes are sunk a little into the ground with a spade, to give them a firm hold. The second hurdle is let into the ground in the same manner, both being held in that position by the assistant. One end of a stay *f* is then placed between the hurdles near the tops of their stakes, and the stay and hurdles are fastened together by the peg *h* passing through holes in both. Another peg *i* is passed through a lower part of the stakes. The hurdles are then inclined away from the ground fenced, until their upper rail shall stand 3 feet 9 inches above the ground. A short stake *e* is driven into the ground by the wooden mallet, fig. 41, at a point

Fig. 41.



THE SHEPHERD'S WOOD MALLET.

where the stay *f* gives the hurdles the above inclination, and a peg fastens the stake and stay together, as seen at *g*. After the first two hurdles are thus set, the operation is easier for the next, as one hurdle is raised after another, and fastened to the last, until the entire line is completed.

903. Objections may be urged against the use of hurdles, such as the inconvenience of carrying them from one part of a field to another in carts,—their liability to be broken in consequence,—the shepherd being unable to set them without assistance,—the time they require to be set,—being easily upset by a high wind blowing from behind them; and the constant repair they require in replacing pegs, stays, and short stakes. When carefully laid past at the end of the season, they will last several years.

904. Nets, made of twine of the requisite strength, form a superior enclosure for sheep; and, to constitute them into a fence, they are supported by stakes driven into the ground.

905. The *stakes* are best formed of thinnings of ash-trees which have been planted thick together, and grown tall and small, 3 inches in diameter and 4 feet 9 inches long—allowing 9 inches of a hold in the ground, 3 inches between the ground and the bottom of the net, and 3 inches from the top of the net to the top of the stake; or they may be made of larch weedings, 4 inches in diameter and 4 feet 9 inches long; but every kind of wood they are made of should be seasoned with the bark on before being cut into stakes. They are pointed at one end with the axe, and that end should be the lowest one

when growing as a tree, as the bark is then in the most natural position for repelling rain.

906. A net is set in this manner: If the ground is in its usual soft state, the stakes may simply be driven into the ground with the hardwood *mallet*, fig. 41, in the line fixed on for setting the net, at distances of 3 paces asunder. The wood of the apple-tree makes the best mallet, as not being apt to split. Should the soil be thin and the subsoil moderately hard, a hole sufficiently large for a stake may be made in the subsoil with the tramp-pick used in draining; but should it be so very hard and a larger hole required than can be easily formed by the tramp-pick, or should the ground be so dry and hard as to require the use of any instrument at all, the most efficient one for the purpose is called a *driver*, fig. 42, formed of a piece of pointed hard-wood, strongly shod with iron, with its upper end protected by a strong ferrule of iron to prevent its splitting by the strokes of the mallet. The stakes are driven that their tops may not be less than 4 feet high, along as many sides of the enclosure as are required at the place to form a complete fence.

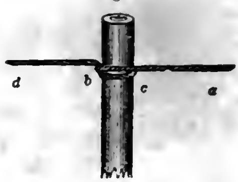
Fig. 42.

THE DRIVER.

907. The net is set in this manner: Being in a bundle, having been rolled up, when no longer required, on the arms and fastened together by the spare ends of the top and bottom ropes, these are unloosened and tied to the top and bottom of a stake driven close to the fence, and run out loose in hand towards the right as far as it will extend on the side of the stakes next the turnips. On coming to the second stake from the fence, with your face to the turnips, the bottom rope first gets a turn to the left round the stake, then the top rope a similar turn round the same stake, so as to keep the meshes of the net straight. The bottom rope is then fastened with the shepherd's knot to this stake, 3 inches from the ground, and the top rope with a similar knot near the top of the stake, drawing the net even along and upwards; and so on, one stake after another, until the whole net is *set up*, care being taken to have the top of the net parallel with the general surface of the ground throughout its entire length.

908. The shepherd's knot is made in this way: Let *a*, fig. 43, be the continuation of the rope fastened to the first stake, then press the second stake with the left hand towards *a* or the fastened end, standing at the opposite side of the stake from the net, and at the same time tighten the turn of the rope round the stake with the right hand by taking a hold of the loose end of the rope *d*, and putting it between *a* and the stake at *c*, pull it tight round the stake till it comes to *b*, where its elastic force will secure it tight when the stake is let go. The bottom rope is fastened first, to keep the net at the proper distance from the ground, and then the top rope is fastened to the same stake in the same manner at the proper height; and so on at stake after stake. A net may be set up either towards the right or the left as the starting-point may be situate, but in proceeding in either direction, the top and bottom ropes should be wound round the stakes, so as the rope should always be uppermost towards the direction in which the net is to be set up. Thus, in fig. 43, the end of the rope *d* is above *a*, and continues uppermost until it reach the next stake to the left. If both the cord and stake are dry, the knot may slip as soon as made, but if the part of the stake at *b* where the knot is fastened is wetted a little, it will make the rope keep its hold until the cord has acquired the set of the knot. It is difficult to make a new greasy rope retain its hold on a smooth stake even with the assistance of water, but a little earth rubbed on it will counteract the greasy effect.

Fig. 43.



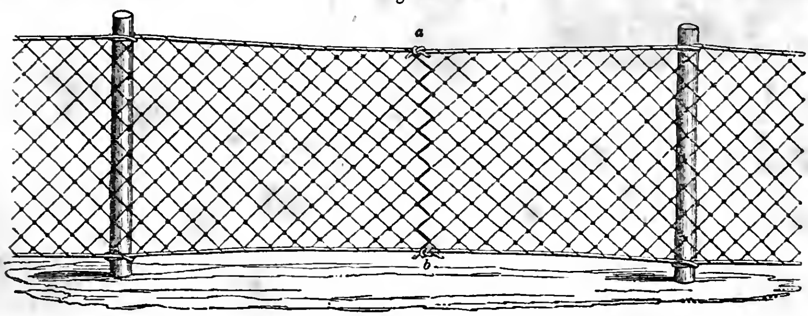
THE SHEPHERD'S KNOT, BY WHICH A NET IS FASTENED TO A STAKE.

909. Some precautions are required in setting a net besides this of the ropes. If the net is new, it may be set as tight as

you please, because all the cords will stretch considerably; but if old, the least damp or rain afterwards will tighten them so as to cause them to break. If the net is at all damp, it should be set tight, because rain cannot make it tighter, and if not then set tight, the first dry weather will loosen all the knots, and cause the cords to slip down the stakes; but although it should not be slackened to that degree, it will shake about with the wind, and bag down and touch the ground. Such an occurrence will cause the shepherd to reset the whole net, which is a just punishment to him for either not having the nets dry, or not setting them with judgment when damp. In wet weather shepherds take the opportunity of a dry moment of setting a dry net in anticipation along a new break of turnips, and they also hang up wet nets to dry on the stakes drawn along another break. Nets should never be wound up in a wet state, even for a short time, as they will soon mould and rot.

910. On connecting the setting of one net to another, its top and bottom ropes are fastened to those of the last net, and the ends of the nets themselves are brought together by lacing the meshes of both with a part of the twine left there for the purpose, as at *a*, fig. 44. Here the knots in the top and bottom ropes are seen, and the twine *a b* lacing the meshes are made

Fig. 44.



THE NET SET FOR CONFINING SHEEP ON TURNIPS.

to appear strong, to let it be perceived. One net is set after another, until the whole area is enclosed. Where there is a turn in the line of nets in going from one side of the enclosure to another, as seen on the right side of fig. 51, if a large piece of the net is still left at the turn, it should be brought down the next side; and the stake at the corner should be driven very securely down, to resist the strain upon it by the nets pulling from different directions, and such a strain will be the most powerful in damp weather. But the safer plan is to take a fresh net at the turn, and fasten it to another stake, and coil up the end of the first net along the tops of the stakes. All surplus ends of nets, when wet, should be hung upon the back of the stakes to dry. Part of the nets will cross ridges, and part run along them. Where they cross ridges but once gathered-up, or crown-and-furrow, the bottom of the nets will be nearly close to the open furrows, but where they cross a deep gaw-cut, a stake or two may be placed upon the bottom rope to keep it down, for some sheep acquire a habit of creeping under the net, where they find an opening. Where nets cross twice-gathered-up ridges a stake should be driven at the side of the open furrows, and another at the crown of the ridge, and the bottom rope tightened parallel to the surface of the ground.

911. In setting nets, each side of the enclosure should be a straight line, and the surface of the nets perpendicular; and the different sides should meet at right angles, so that every break of turnips should either be a rectangle or a square; the strain will thus be equalised over the entire cords and stakes of each side, and no undue pressure exerted on any one stake. A shepherd who pays attention to these particulars, will preserve the nets and stakes much longer in a serviceable state than one ignorant or careless of them.

912. The shepherd should always be provided with net-twine to mend any holes

that may break out in the nets; but where nets happen to be set across hare-roads, the hares will certainly keep their runs open; and it is better to allow their holes to remain open than, by filling them up, have them cut daily.

913. After the hurdles or nets have been set round the first break, the ground may be considered ready for the reception of the sheep; and the ground should be made ready before the grass fails, that the fattening sheep may not in any degree lose the condition they have acquired on the grass; for you should always bear in mind that it is much easier for you, and much better for the animals themselves, to improve the condition of lean sheep, than to regain lost condition. Much rather leave pastures a little rough than risk the loss of condition of the sheep for want of turnips. The rough pasture will be serviceable in the winter to the ewes in lamb, and to aged tups. Sheep therefore, to be fattened, should be put on turnips as early as will maintain the condition they have acquired on the grass.

914. A *break* of turnips is that part of the field occupied by the sheep.

915. As the tops of white turnips are luxuriant at the commencement of the season, the first break should be smaller than the succeeding ones, that the sheep may not have too many tops to eat at first, on a change of food from grass to turnips, and they eat them greedily on account of their freshness and juiciness; Let the sheep always fill themselves with turnips before taking them from one break to another. The second break may be a little larger than the first, and the third may be of the proper size to contain a week's food for the number of sheep. These arrangements cause the shepherd some trouble for two or three weeks in the beginning of the season; but they are trifling compared with the advantage derived by the sheep. Rather let him have the assistance of a field-worker to shift the nets than neglect them. When the tops wither in the course of the season, and a night of sharp frost will effect this, or after the sheep have become accustomed to the turnip, all danger is over. The danger to be apprehended is diarrhœa, an unnatural state for sheep, and which soon emaciates them and causes them to sink under it, and none recover from so great a relaxation of the system until after a considerable lapse of time.

916. Another precaution is, to avoid putting sheep on turnips for the first time in the early part of the day when they are hungry. Danger may be apprehended from luxuriant tops at all times, but when they are wetted by rain, snow, or half-melted rime, they are sure to do harm. The afternoon, when the sheep are full of grass, should be chosen to put them first on turnips, and although they will immediately commence eating the tops, they will not have time to hurt themselves. Should the weather prove wet at first, and the ground be cloggy or soft, rather than allow the sheep so uncomfortable a lair, it would be advisable to put them in an adjoining grass field until the ground becomes dry.

917. Sheep for turnips are selected for the purpose. Ewes being at this season with young, are never, in Scotland, put on turnips in the early part of winter, but continue to occupy the pastures, part of which should be left on purpose for them in a rough state, to support them as long as the ground is free of snow. The reason why ewes in lamb are never put on turnips is their becoming too fat, and producing small lambs, and being attacked by inflammation at the lambing time.

918. Aged tups are most frequently put on turnips, and young tups always, but never in the same part of the field as the feeding sheep, having a snug corner to themselves, or the turnips led for them to a sheltered part of a grass field.

919. Young sheep, lambs of the same year, hoggs, are always put on turnips, whether with the view of fattening them at once, or enlarging the size of their bone.

920. Every year a certain number of old ewes, unfit for farther breeding, from want of teeth, or a supply of milk, are drafted out of the flock to make room for the same number of young females, and are fattened upon turnips.

921. It sometimes happens that the castrated male lambs of last year, instead of being sold, have been grazed during the summer, and are fattened the second season on turnips.

922. All these classes of sheep, of different ages, may be mixed together and occupy the same break of turnips. It is seldom that the lambs of last year are kept on to the second year, but the draft ewes are always fed along with the young sheep, and prove useful in breaking the turnips and eating the picked shells. A mixture of old and young sheep are less useful to one another when turnips are cut by machines.

923. As sheep are best known by technical names given them according to age and sex, I shall enumerate them now, and employ them in future. A new-born sheep is called a *lamb*, and retains the name until weaned from its mother and is able to support itself. The generic name is altered according to the sex and state of the animal; when a female it is a *ewe-lamb*, when a male a *tup-lamb*, and this last is changed to *hogg-lamb* when it undergoes emasculation.

924. After a lamb has been weaned, until the first fleece is shorn from its back, it receives the name of *hogg*, which is also modified according to the sex and state of the animal, a female being a *ewe-hogg*, a male a *tup-hogg*, and a castrated male a *wether-hogg*. After the first fleece has been shorn, another change is made in the nomenclature; the ewe-hogg then becomes a *gimmer*, the tup-hogg a *shearling-tup*, and the wether-hogg a *dinmont*, and these names are retained until the fleece is shorn the second time.

925. After the second shearing another change is effected in all the names; the gimmer is then a *ewe* if she is *in lamb*, but if not, a *barren gimmer*, and if never put to the ram a *eild gimmer*. The shearling tup is then a 2-*shear tup*, and the dinmont is a *wether*, but more correctly a 2-*shear wether*.

926. A ewe three times shorn is a *twinter ewe*, (*two-winter ewe*;) a tup is a 3-*shear tup*; and a wether still a *wether*, or more correctly a 3-*shear wether*—which is an uncommon name among Leicester sheep, as the castrated sheep of that breed are rarely kept to that age.

927. A ewe four times shorn is a *three winter ewe*, or *aged ewe*; a tup, an *aged tup*, a name he retains ever after, whatever his age, but they are seldom kept beyond this age; and the wether is now a *wether* properly so called.

928. A *tup* and *ram* are synonymous terms.

929. A ewe that has borne a lamb, when it fails to be with lamb again is a *tup-eill* or *barren ewe*. After a ewe has ceased to give milk she is a *yeld-ewe*.

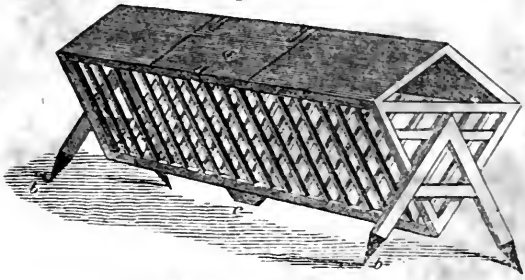
930. A ewe when removed from the breeding flock is a *draft ewe*, whatever her age may be; gimmers put aside as unfit for breeding are *draft gimmers*, and the lambs, dinmonts or wethers, drafted out of the fat or young stock are *sheddings*, *tails*, or *drafts*.

931. In England a somewhat different nomenclature prevails. Sheep bear the name of *lamb* until 8 months old, after which they are *ewe* and *wether teggs* until once clipped. Gimmers are *theaves* until they bear the first lamb, when they are *ewes of* 4-*teeth*, next year *ewes of* 6-*teeth*, and the year after *full-mouthed ewes*. Dinmonts are called *shear hoggs* until shorn of the fleece, when they are 2-*shear wethers*, and ever after are *wethers*.

932. When sheep are on turnips they are always supplied with dry fodder, hay or straw; hay is the most nutritious though expensive; but sweet fresh oat-straw answers the purpose very well. The fodder is supplied to them in racks. There are various forms of straw-racks for sheep; some are placed so high that sheep can with difficulty reach the fodder; and others are mounted high on wheels. The form in fig. 45 I have found a very convenient one, containing plenty of straw at a time, admitting the straw easily into it, being easily moved about, of easy access to the sheep, and being so near the ground as to form an excellent shelter. It is made of wood, 9 feet in length, 4½ feet

in height, and 3 feet in width, having a double sparred rack, covered with an angled roof of boards to throw off the rain. The rack is supported on 2 triangular-shaped tressels *b*, shod with iron at the points, which are pushed into the ground, and

Fig. 45.



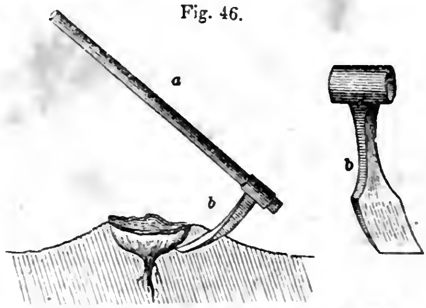
THE SHEEP STRAW OR HAY RACK.

act as stays against the wind from either side. The billet *c*, fixed on the acute edge of the rack, rests upon the ground, and supports it from bending down in the middle. The lid *a* is opened on hinges when the fodder is put into the rack. There should be at least 2 such racks in use; and when set together at an angle against the weather point, the space comprehended between them affords sufficient shelter to a considerable number of sheep, as seen at *r*, fig. 51. Such racks are easily moved about by 2 persons, and their position should be changed with a change of wind.

933. It is the shepherd's duty to fill these racks with fodder, and one or all may require replenishment daily; and this he does easily by carrying a small bundle of fodder every time he visits the sheep. When carts are removing turnips direct from the field, they carry out the bundles; it being the shepherd's duty to have the bundles ready for the carters in the straw-barn or hay-house. Though for nothing but shelter the racks should be kept full of fodder. Fodder is required more at one time than another, in keen sharp weather the sheep eat it greedily, and when turnips are frozen they will often have recourse to it, and it is useful along with succulent tops. In rainy, or soft muggy weather, sheep eat fodder with little relish; but it has been observed that they eat it steadily and late, and seek shelter near the racks, prior to a storm of wind and rain or snow; and in fine weather they select a lair in the more exposed part of the break. With a sloping rack of this form, when hay is employed as fodder, the hay should be well shaken free of seeds, as these are apt to get among the wool. With straw fodder no such annoyance is experienced.

934. Until of late years sheep were allowed to help themselves to turnips, and when the bulbs were scooped out as far as the ground would permit, their *shells*, as their bottoms fast in the ground are called, were picked out with a *turnip-picker*, the mode of using which may be seen in fig. 46. Its handle *a* is 4 feet long, and blade *b* 10 inches, including the eye for

Fig. 46.



THE BEST FORM OF TURNIP-PICKER IN USE.

the handle. By its mode of action, you will observe that the tap-root of the turnip is cut through and the shell separated from the ground at one stroke. A common form of these pickers is with the mouth cleft in two, fig. 47, between which

Fig. 47.

OBJECTIONABLE FORM OF TURNIP-PICKER.

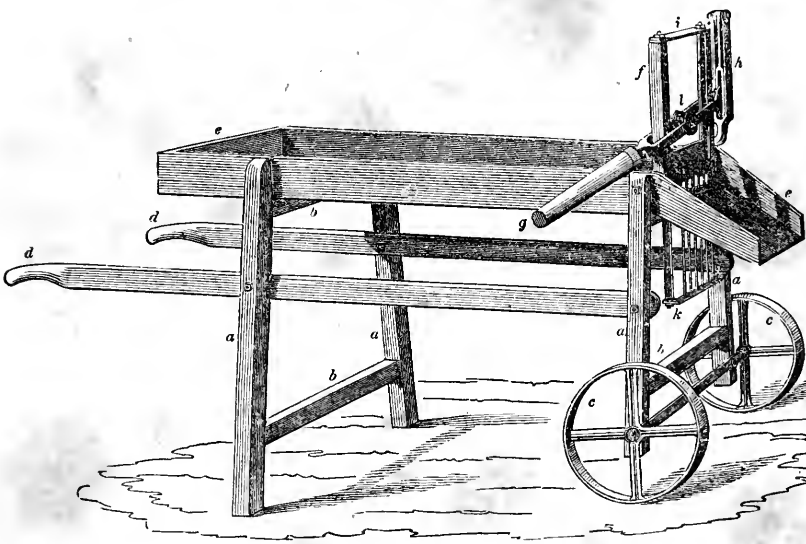
the tap-root is held, and the shell and root pulled up together. It is found, however, that the tap-root contains an acrid juice detrimental to the stomach of sheep, so that the better plan is to cut it off and leave it in the ground to rot, as is done by the best form of blade, *b*, fig. 46. Notwithstanding the very general use now of turnip-slicers, which have dispensed with the turnip-pickers, I still give the figures of these, as on many farms too few turnips are raised to require the services of the largest class of turnip-slicer.

935. Only half the ground occupied by the shells should be picked up at once—every alternate double row—to make the sheep occupy a larger space of ground while consuming them. When the ground is dry, the shells should be nearly eaten up before a new break of turnips is given; but on a few shells being left, the sheep will come over the ground again and eat them, especially in frost; and though then in a shrivelled state, shells are sweeter and softer than turnips.

936. But the mode more recently adopted of serving turnips to sheep, cut into small pieces with a turnip-slicer in troughs conveniently placed, should be in general use, while the sheep have still liberty to eat the turnips from the ground.

937. The most convenient, and a simple form of turnip-slicer, is the *lever turnip-slicer for sheep*. It is easily moved from place to place, on two small wheels, drawn along by means of two handles. It is sufficiently effective to supply sliced turnips to a small flock of sheep, and is peculiarly convenient for use where a few sheep are placed by themselves, such as tups in the corner of a grass field, or ewes in a paddock at the period of lambing. The view of the instrument is seen in perspective in fig. 48, which consists of a wooden frame supporting a trough, together with the cutting apparatus. The frame is formed of four posts, *a a a a*, spreading a little below. Each pair is connected by cross-rails, *b b*, and they are connected longitudinally by the bars, *d d*, which form also the handles of the wheel-barrow, being bolted to the posts at a suitable height for

Fig. 48.

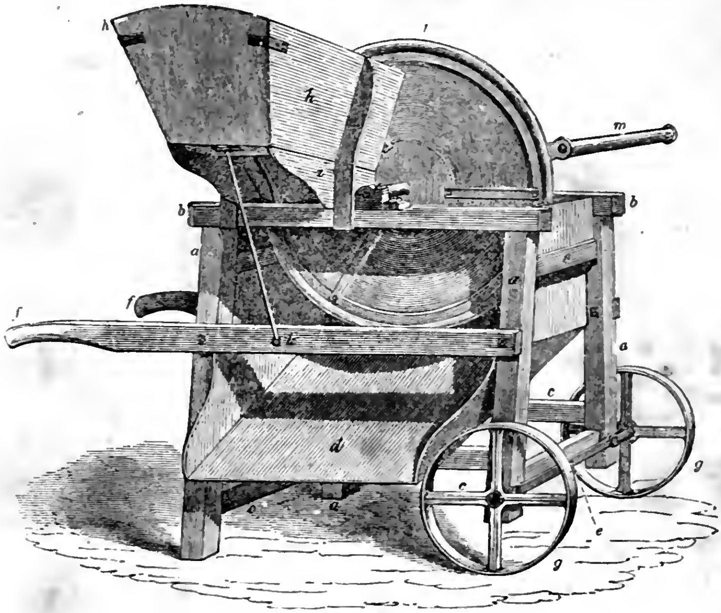


THE LEVER TURNIP-SLICER FOR SHEEP.

that purpose. A pair of wheels, *c c*, of cast-iron, fitted to an iron axle, which is bolted to the front posts, gives it the conveniency of a wheel-barrow. The trough *e*, into which the turnips are laid for cutting, has a sloping continuation in front of the cutters, for throwing off the sliced turnips. The cutting apparatus consists of a grooved frame of iron, *f*, in which the compound cutter moves up and down by means of the lever handle, *g*. A forked support, *h*, is bolted by a palm to the further side of the wooden frame, and at the extremity, *i*, of the fork a swing link is jointed. The lower end of the link is jointed to the extremity of the lever, which is likewise forked, forming its fulcrum; and the gridiron-cutter, *k l*, is also jointed by its top-bar to the lever at *l*. While the point *l*, therefore, of the cutter moves in a parallel line by its confinement in the grooves of the frame *f*, the fulcrum is allowed to vibrate on the joint *i* of the swing link—thus allowing an easy vertical motion to the cutter through the full range of its stroke. I have known one field-worker supply 220 sheep with sliced turnips by the aid of an instrument such as this. It is worked by moving the handle, *g*, with the right hand, while the left pushes forward each turnip successively to be sliced by the gridiron-cutter.

938. A more efficient machine is to be found in the *wheel turnip-slicer for sheep*, fig. 49, which is a perspective view of it. The wooden frame, spreading a little wider below, is formed with four posts, *a a a a*, one of which is only partially seen in the

Fig. 49.

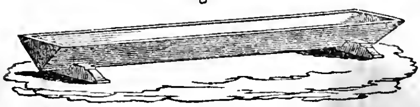


THE WHEEL-BARROW TURNIP-SLICER FOR SHEEP.

figure. The posts are connected on the sides by top-rails, *b b*, and two brace-rails, *c c*, below, one of which serves to support the spout, *d*, which discharges the sliced turnips. The sides of the frame thus formed are connected by cross-rails above and below, *e e e*, and is there furnished with the handle-bars, *f f*, bolted to the posts, and projecting a convenient length beyond them at one end. The barrow-wheels, *g g*, are fitted to an iron axle, which is bolted to the posts in front. The hopper, *h*. is fixed upon the top-rail by means of a cast-iron sole bolted upon the rail, and is further supported by a wooden bracket at each side, as seen at *i*, and by the iron stay *k*. The slicing-wheel *l*, is a disc of cast-iron, carrying three sets of cutters. The disc is mounted on an axle passing through its centre, where it is fixed, and which is supported on bearings placed on the top-rails, and, when worked, it is turned by the winch-handle *m*, fixed upon this axle. This machine is now generally made of the disc of cast-iron, carrying the cutters, mounted on a wooden frame, which is most conveniently mounted on wheels like a wheel-barrow. It was at one time made entirely of iron, but was found inconvenient to move about.

939. Fig. 50 is a simple and convenient form of trough for containing the turnips

Fig. 50.

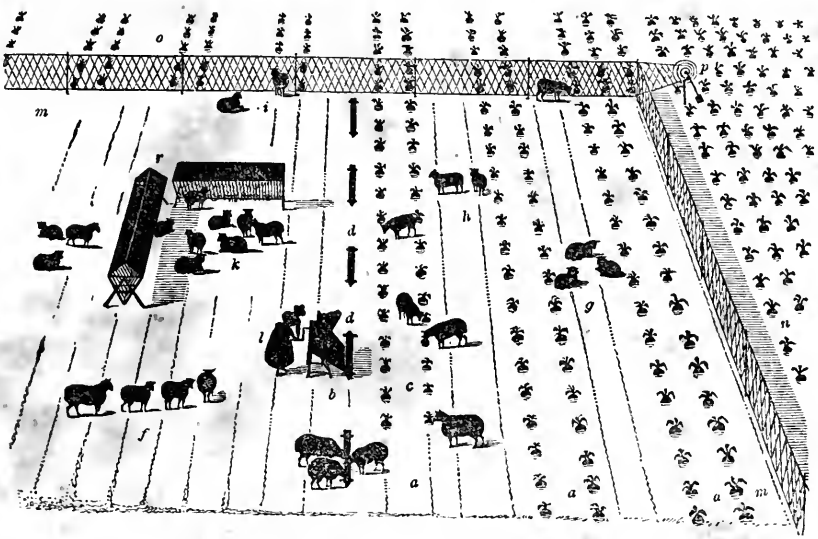


THE TURNIP-TROUGH FOR SHEEP-FEEDING.

as they fall sliced from any of the above machines. Its most convenient length is 8 feet, and it should be acute at the bottom, for the more easy seizure of the pieces of turnip by the mouths of the sheep, and it is so made by nailing two boards, of 9 inches in breadth, upon the two triangular-shaped ends, and in the niches formed in the two billets of wood to serve for feet. The troughs are set in a line along the outside of the 2 rows of turnips about to be pulled for slicing. The turnip slicer, fig. 49, is wheeled to each trough successively by one field-worker, who works the handle, and the hopper is filled by another worker who tops and tails the turnips. The sheep range themsleves on either side of each trough.

940. I have constructed fig. 51 to give you a bird's-eye view of a break of turnips in a turnip-field occupied by

Fig. 51.



THE MODE OF OCCUPYING TURNIP-LAND WITH SHEEP.

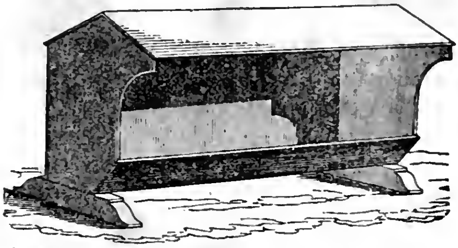
the sheep. There are the turnips *a*, half of which have been pulled. The ground is represented bared beyond the turnip-slicer *b* in its advance across one side of the break to the other. The turnip-slicer *b* is proceeding up beside the two drills *c*, and depositing the sliced turnips into one of the small troughs *d*, out of another of which some of the sheep are eating, whilst others are eating the turnips in the drills *c*. The sheep are scattered over the ground as they are usually seen, some following one another in a string *f* towards the place where their food is preparing for them, whilst others *g* are still lying resting regardless of food. Some, *h*, are standing, as if meditating what next to do, and others *i*, examining matters about the nets. Some nibble at the dry fodder in the racks *r*, whilst a group *k*, lie under their shelter. Such are the usual occupations of sheep when they have abundance of food at their command. The field-worker *l* is slicing the turnips with the machine. The nets *m* are represented enclosing two sides of the break, the other two sides being supposed to be the fences of the field. The remainder of the net along the upper part of the break is coiled round the top of a stake at *p*, and there also the mallet and driver await their use.

941. The turnips *n*, fig. 50, to the right of the nets, appear undrawn, while those, *o*, above the nets are stripped, indicating that the progress of the break at this time is upwards towards the top of the field, in a line with the drills and the ridges; and this part of the arrangement is not a matter of chance, because the breadth of each break should succeed one another across the field, that the land, when cleared of turnips, may be ploughed into ridges. A large field, that engages the sheep for a considerable part of the season, is ploughed as each stretch of breaks is cleared, to preserve the manure. In ploughing, however, with this intent, the sheep should not be deprived of any natural shelter, which should be secured to them as long as practicable, by arranging the breaks so as to make one first at the most sheltered part of the field, that the sheep might resort to the bottom of the break they are occupying, after the first breadth of breaks had been given up and ploughed from the bottom to the top of the field. Such an arrangement requires some consideration at first, as its oversight may create much inconvenience to sheep for want of shelter, or delay the ploughing. Shelter to sheep on turnips does not merely imply protection from a blast for a night or two, but also the preservation of the fleece, and the comfort to the flock through the winter.

942. I have already stated, that *tups* or *rams* are fed on turnips in a separate division from the feeding sheep. Some apportion them in a space in the same, whilst others give them a break in another field; but I prefer giving tups turnips in a small grass paddock, and slicing them with the lever turnip-slicer, fig. 48. Where tups form a large lot of 40 or 50, it may cause more trouble to fetch their turnips than to enclose them on the ground; but it should be borne in mind, in regard to tups, that whenever a tup and ewe in season become aware of the presence of each other in the same field, or in contiguous fields, neither will rest to feed. The air will carry the scent from their bodies reciprocally. Tups in a separate field cause as much trouble to the shepherd in visiting them as a larger flock; whereas, were they near home in a grass paddock, he could visit them frequently in going to and coming from his house.

943. Sheep while on turnips are fed with other substances, such as oil-cake or corn. Either of these is served in a covered trough, fig. 52, to protect it from the weather. Its construction requires no explanation.

Fig. 52.



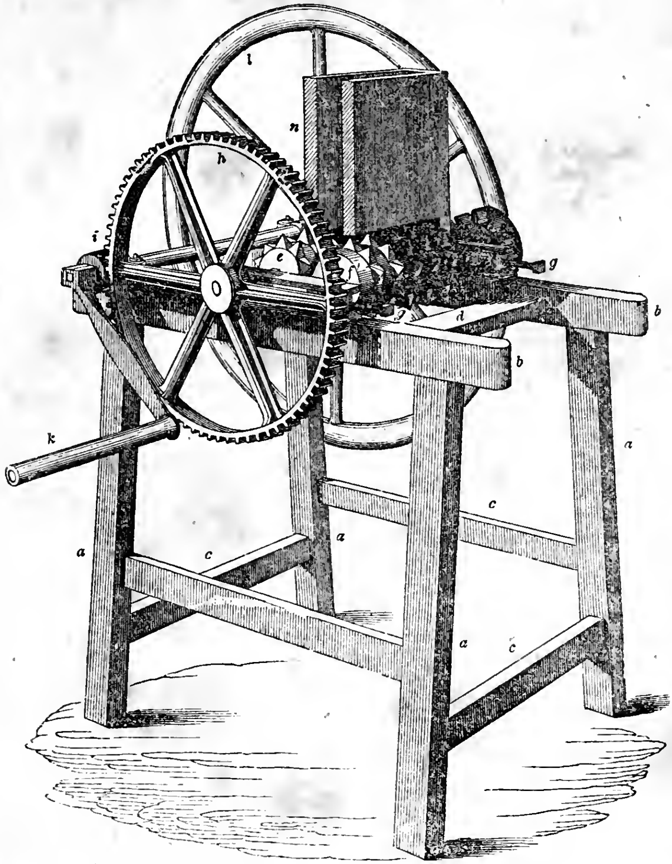
THE OIL-CAKE OR CORN BOX FOR FEEDING SHEEP.

944. I have had no experience of feeding sheep on oil-cake or corn, having farmed turnip-land, upon which sheep never failed to become abundantly fat without adventitious aid. On deaf and clay soils, however, oil-cake proves beneficial; and it may also be served in these troughs to sheep on grass in winter as their entire food. Oil-cake has the effect of keeping the dung of sheep in a moist state. It is given them in a bruised form, partly in powder, and partly in pieces, as it falls from the oil-cake breaker, a convenient machine on every farm. There is no use measuring the quantity of oil-cake to sheep when on turnips, as they will eat it when inclined, and some sheep eat it more heartily than others, but 1 lb. to each sheep a day is the usual allowance.

945. Fig 52 gives a perspective view of an *oil-cake breaker*, wherein *a a a a* are the four posts of a wooden frame on which the machinery is supported: *b b* are two top-rails. The posts are supported towards the bottom by the four stay-rails *c c c*; and the top-rails are held in position by cross-rails *d*, one only of which is seen in the figure. Of the machinery, the acting parts consist of 2 rollers, studded

all over with pyramidal knobs or teeth. These are arranged in zones upon each roller; and having a smooth space or zone between each of the knobbed zones; the

Fig. 53.



THE OIL-CAKE BREAKER.

knobs of one roller corresponding to the smooth space in the other. In this figure, *g g* are two pinching screws, which serve to regulate the distance at which the rollers are to work, and, consequently, the degree of coarseness to which the cake is to be broken. The wheel *h* is placed upon the shaft of the roller *e*, and the pinion *i*, with its shaft, and the winch-handle *k*, act upon the wheel *h*, giving a very considerable mechanical advantage to the power which is applied to the machine. The fly-wheel *l* is likewise placed upon the shaft of the pinion *i*, and is requisite in this machine to enable the power to overcome the unequal resistance of the work. A feeding-hopper *n* is placed over the line of division of the two rollers. The hopper is here represented in section, the near portion of it being supposed entirely removed, in order to exhibit more distinctly the construction of the rollers.

946. *Salt* is frequently given to sheep on turnips; but with what result, as regards their fattening, I have never learned. I have given them it, and the eagerness with which they at first followed the shepherd when he laid down a small quantity, here and there, upon flat stones, and the relish they manifested, was very remarkable; but the relish lasted a very short time, and then every day they took so little, as if they were trifling with it. Perhaps the cultivator who advocated the

use of salt to animals most perseveringly was the late Mr Curwen, of Workington Hall, Cumberland, who gave from 2 to 4 ounces per week to each sheep, when on dry pastures; and on turnips or rape, it was supplied without stint.

947. "It is, in fact, *indisputably proved*," says Mr Cuthbert W. Johnson, "that if *sheep are allowed free access to salt, they will never be subject to the disease called the rot*. Is not this a fact worthy of a farmer's earliest, most zealous attention? Some recent experiments also lead me even to hope that I shall one day or other be able to prove it to be a *cure* for this devastating disease. I have room but for one fact: Mr Rusher, of Stanley, in Gloucestershire, in the autumn of 1828, purchased, for a mere trifle, 20 sheep, *decidedly rotten*, and gave each of them, for some weeks, 1 ounce of salt every morning; two only died during the winter; the surviving 18 were *cured*, and have now, says my informant, lambs by their sides."*

948. There are certain inconveniences attending the feeding of sheep on turnips *in winter*, which you should be made aware of. A heavy rain falling some days, will render the ground soft and peachy, though thorough drained, or even naturally dry. When the cause soon disappears, the removal of the sheep for a night and day to an old grass field will give the land sufficient time to resume its firmness; and a little oil-cake will support the sheep all the time they will be there. A very heavy rain may fall in a day, and inundate the lower end of the field with water, which may take some days to subside. The best way of keeping the sheep from the wetted part is to fence it off with a net.

949. A fall of snow, driven by the wind, may cover the sheltered part of the field, and leave the turnips bare only in the most exposed. In this case, the sheep must feed in the exposed part, and the racks should be so placed there as to afford shelter. But the snow may fall heavily, and lie deep over the whole field, and cover every turnip out of reach. Two expedients only present themselves in such a case; one is to cast the snow from the drills containing the turnips, and pile it upon those which have been stripped. This cannot be done by the shepherd himself, or by female field-workers. The ploughmen must clear away the snow; in doing so in severe frost, as many turnips only should be exposed as will serve the sheep for the day. The advantage of thus clearing away the snow is, the immediate access to the turnips; but when the snow lies a considerable time, all the manure will be left by the sheep in the channels cut through the snow, and, of course, the parts upon which the snow was piled will receive none. The best plan to pursue at first, under such circumstances, is the other expedient, to give the sheep oil-cake in their troughs, in a sheltered place of the field for a time, until it is seen whether the snow is likely soon to disappear; and should it remain long, the snow may be cleared away, and its disadvantages submitted to. In the great fall of spring 1823, my turnip-field was covered with snow 4 feet deep. Having no oil-cake, and finding it impossible to remove the sheep, the snow was cut into trenches, in which the sheep soon learned to accommodate one another, and throve apace. A fresh fall of snow came a few days after from the opposite quarter, and filled up the trenches, which had to be cleared out again. The snow continued upon the ground until the end of April, and as there was then no time to manure the land which had been covered with the snow,—and, indeed, its soft state would have rendered carting upon it impracticable,—the succeeding crop of barley grew in strips corresponding to the trenches. Even a supply of oil-cake would not, in this case, have superseded the trenching of the snow, to have had the turnips eaten in time for the barley-seed.

950. Whilst the young sheep and tups are thus provided with turnips in winter, the *ewes in lamb* find food on the older grass, which, for their sakes, should not be eaten too bare in autumn. When pastures are very bare, or snow covers the ground, they should have turnips sliced in troughs, or, what is better, clover-hay in a sheltered spot. The best hay for sheep

* Johnson's *Observations on the Employment of Salt*, p. 12.

is the red clover, and next, meadow-hay; but much rather give them turnips than hay in a wet or moulded state, as either has a strong tendency to engender diseases in sheep, generally such as consumption of the lungs and rot of the liver; and as regards ewes in lamb, in particular, it is apt to produce abortion. If turnips cannot be had, and the hay bad, give them sheaves of oats, or oats in troughs, or oil-cake; but whatever extraneous food is given, do not supply it in such quantity as to fatten the ewes, but only to keep them in fair condition with hay. In the severe snow-storm of 1823, I put my ewes into an old Scots-fir plantation, into which only a small quantity of snow had penetrated, and supplied them there with hay upon the snow round the roots of the trees. A precaution is requisite in using a Scots-fir plantation in snow for sheep; its ever-green branches intercepting the snow are apt to be broken by its weight, and fall upon the sheep and kill them; and in my case, a ewe was killed on the spot by this cause the first night. Much loaded branches should therefore be cleared partly of their snow where the sheep are to lodge. In driving ewes, heavy with lamb, through deep snow to a place of shelter, plenty of time should be given them to wade through it, in case they overreach themselves, and bring on abortion.

951. In the south of Scotland, and more generally in England, rape is grown for sheep. The rape (*Brassica rapa oleifera* of De Candolle,) cultivated in this country, is distinguished from the colsat of the Continent by the smoothness of its leaves. It has been cultivated for the fattening of sheep in winter from time immemorial. The green leaves, as food for sheep, are scarcely surpassed by any other vegetable, in so far as respects its nutritious properties; but in quantity it is inferior both to turnips and cabbages. Its haulm may be used as hay with nearly as much avidity as cut straw.* The consumption of rape by sheep is conducted by breaks in exactly the same manner as that of turnips; but it is never stripped or pulled, the entire crop being consumed on the ground. In England, the rape intended for sheep is sown broadcast and very thick, in which state it grows very suitable for them. In Scotland, it is raised in drills like turnips; and although not so conveniently placed for sheep as the broadcast, the top leaves being somewhat beyond their reach from the bottom of the drill, yet the form permits the land being well cleaned in summer, which renders the rape an ameliorating crop for the land. It is acknowledged on all hands, that, for oil, the drill form of culture is far the best.

952. Every kind of sheep kept in the low country should be treated in winter in the way described above, though the remarks are meant to apply to the management of the Leicester, which is the breed cultivated where sheep form an integral part of the mixed husbandry. Where a Leicester flock is so kept, the ewes are regarded as a *standing flock*—that is, they have themselves been bred and produce lambs upon the farm until they become unprofitable, when they are fed off. But on lowland farms, in certain districts, no flock of ewes is kept for breeding, and sheep to be fattened on turnips are bought in. For this purpose some farmers purchase wethers, others old ewes, dinmonts, or lambs. When wethers are selected, the Cheviot and black-faced breeds are obtained from the mountains. Sheep are thus easily obtained for turnips at fairs in autumn; but where certain mountain stocks have acquired a good name, purchasers go to the spot, and buy them direct from the breeders.

953. Sheep on turnips have little shelter but what the fences of the field afford, or plantations. In some cases this is quite sufficient; but in others it is inadequate. Of late years, the subject of shelter has attracted much attention, and artificial means have been suggested, consisting of various devices, involving different degrees of cost, to afford shelter, not merely against sudden outbreaks of weather, but with the view of gradually improving the condition of sheep, both in carcass and wool. It is a natural expectation, that a fat carcass should produce the most wool, and constant shelter preserve its quality.

954. Ewes in lamb are very apt to catch cold, and when exposed to wet and cold weather, or kept in a wet lair, will pick lamb, that is, suffer abortion, and perhaps become rotten.

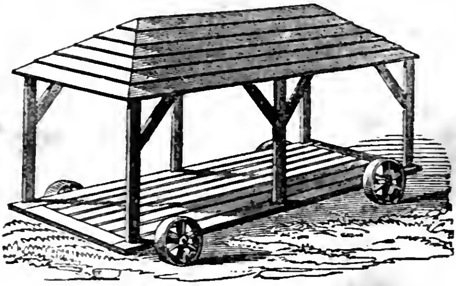
955. Mr Hunter of Tynefield, in East Lothian, tried in 1809 the littering of the break, occupied by the sheep, with straw, and supplied them with turnips upon it. He littered 300 sheep upon 25 acres of turnips, which afforded 36 tons of manure the acre, with the straw of 60 acres of wheat, or 60 tons of straw. The sheep thus treated for 5 months, fetched 2s. a-head more than

* Don's *General Dictionary of Botany and Gardening*, vol. i. p. 245.

those treated in the usual manner. This increase of price is small, and not at all commensurate to the trouble of carting, at intervals, 60 tons of straw to the field—of carting the same, as manure, from that field to another, and of carrying the turnips from the drills to the fold. When turnips are laid upon straw, sheep cannot bite them easily, from their rolling away; and this is an objection to laying whole turnips on grass, instead of cutting them with a turnip-slicer. Amongst damp litter sheep invariably contract foot rot—of which seven of Mr Hunter's flock died, the value of which should be deducted from the profits otherwise obtained.*

956. Sheep have been recommended to be fed in sheds, and these are proposed to be movable or stationary. The perspective view of a movable shed is seen in fig. 54. It is 15 feet long, 7 feet wide, with an opening of $\frac{3}{8}$ of an inch

Fig. 54.



A MOVABLE SHED FOR SHEEP ON TURNIPS.

between the floor deals. The floor rests on 2 axles of iron supported on 4 iron wheels, 1 foot diameter, which raise the shed 6 inches above the ground. The roof is made pavilion-wise, with deals overlapping each other, and elevated 5 feet above the floor. One side and both ends, when the shed is in use, could be boarded in the quarter from which the wind comes; and if the boards are fastened dead, the shed should be wheeled round to suit the wind; but if boarding be considered too expensive for fitting up such sheds, hurdles clad with thin slabs, or wattled with straw or willow, might be placed against one side and the ends, and answer the purpose. A horse is required to wheel such a shed to any distance. A shed of the above dimensions may accommodate about 20 sheep, and its cost is said to be £4. But should this construction be considered too unwieldy, the shed could be made of two pieces of half the size, which would easily be moved about by people, and, when placed together on end, would form an entire shed of the proper dimensions. The cost of two half-sheds will of course be greater than an entire one. Whether any one will ever incur the cost of sheltering sheep on turnips in such sheds is, I conceive, questionable; and some time will elapse ere the sheep become so familiarised to them as to enter them freely.†

957. Stationary sheds have been erected at the steading, the courts attached to them littered with straw, and the sheep daily supplied with sliced turnips. Many years ago the late Mr Webster of Balruddery, in Forfarshire, attempted to fatten sheep in this manner, and I had opportunities of witnessing his experiments, which were not successful, inasmuch as he employed black-faced sheep, and they became severely afflicted with the foot-rot.

958. Mr Childers, M.P. for Malton, fed 40 Leicester wether-hoggs on turnips, 20 in the field and 20 in a shed. The shed consisted of a thatched erection of rough deals, having a floor of slabs raised 18 inches above the ground, with a small court attached to it. The boarded floor was swept every day, and fresh straw put over the court after every shower of rain. The sheep were divided into as equal lots as could be drawn, the score to be fed in the shed weighing 183 stones 3 lb., and those in the field 184 stones 4 lb. Each lot got as many sliced turnips as they could eat, which amounted to 27 stones every day; 10 lb of linseed-cake, or $\frac{1}{2}$ lb. to each sheep, per day; $\frac{1}{2}$ pint of barley to each sheep; and a little hay, and a constant supply of salt. They were fed from 1st January to 1st April; and, on the fourth week, the hoggs in the shed eat 3 stones fewer turnips every day; in the ninth week, 2 stones still fewer, and of linseed-cake 3 lb. less per day. The results were these:—

Date.	20 shed hoggs.		Increase.		20 field hoggs.		Increase.	
	St.	lb.	St.	lb.	St.	lb.	St.	lb.
January 1 . .	183	3			184	4		
February 1 . .	205	0	21	11	199	8	15	4
March 1 . .	215	10	10	10	208	2	8	8
April 1 . . .	239	9	23	13	220	12	12	10
Total increase .			56	6			36	8

"Consequently," says Mr Childers, "the sheep in the shed, though they consumed nearly $\frac{1}{3}$ less food, have made $\frac{1}{3}$ greater progress."‡ Thus, in 4 months, the shed-fed hoggs gained about $\frac{1}{2}$ stone a-head more than those in the field, and were worth 3s. a-head more. This experiment of shed-feeding corroborates the ordinary experience in the progress of fattening sheep; namely, that the greatest progress is made at the beginning and end of the season. In the beginning, the fat is laid on in the inside, to fill up; and at the end, it is laid on on the outside, after the acquirement of muscle in the intermediate period.

959. Similar experiments have been made in Scotland with success. Mr Wilkin, Tinwald Downs, Dumfriesshire, fed 20 cross-bred Cheviot and Leicester hoggs in courts and sheds, on turnips, grass, and oil-cake, and their increased value over others in the field was estimated at from 22s. to 25s.

* Sinclair's *Account of the Husbandry of Scotland*, vol. ii. Appendix, p. 47.
† *Quarterly Journal of Agriculture*, vol. xi. p. 27-30.
‡ *Journal of the Agricultural Society of England*, vol. i. p. 169.

960. Mr John M'Bryde, Belkar, fed both Leicester and Cheviot wethers in *stalls* on turnips, rice, sago, sugar, and linseed-oil, and realised 7s. a-head more than from those fed in the field.* But in estimating the advantages derived from shed-feeding, the trouble occasioned in bringing the turnips from, and taking the manure to the field, should always be borne in mind. But should the plan leave no profit, yet, if it improve the quality of the wool in its most essential particulars, it is worthy of consideration in many cases.

961. A very recent instance of feeding sheep in sheds is that related by the Rev. A. Huxtable, rector of Sutton Waldron, in Dorsetshire. His sheds were 50 feet long, 15 feet wide, and thatched with straw within 3 feet of the ground, before and behind, and behind a turf wall reaches the thatch, while in front hurdles are used to keep in the sheep. Each shed contains about 50 sheep, and costs, without the straw, 41s. Within the sheds the ground was excavated 8 or 9 inches, puddled and made water-tight, and covered with 6 inches of sawdust, burnt clay, and good dry mould. This compost received and absorbed the manure that fell, which was swept into it twice every day. Over the compost was erected a perfectly level flooring of movable boards for the sheep to lie upon, at a cost of 1s. 4d. per head of sheep. The boards, after sweeping, are watered with a solution of 3 lbs. of sulphate of iron, which instantly removes the odour not only of the ammonia, but the more offensive sulphuretted hydrogen. The sheep are fed under the sheds. Mr Huxtable having observed sheep prefer the most beaten roads on the downs for their bed, he gives them the bare boards to lie upon ; and in order that the courts attached to the sheds should also be hard, he floored them with a sort of asphalt made of chalk beaten small, covered with gas tar and sand. The sheep occupy the courts while the sheds are being swept clean. The food consists of turnips, the last fortnight only of swedes, half a pint per day, (never more) of oats or peas, with straw cut into chaff, over which ground linseed has been poured mixed with boiling water. The increase of weight attained by the sheep was not accurately ascertained, but the results of the arrangement have been most successful, both in the health and well-doing of the sheep, there never having been seen one instance of lameness, even in the slightest degree, in a confinement of 5 months. The general issue may be allowed to be satisfactory, as in 12 weeks they realised a profit of 13s. a-head.†

962. In situations where the ground is rather high and smooth, and the climate indifferent, sheds, with yards attached to them, are recommended for the accommodation of Leicester and half-bred hoggs in winter on turnips. "From the experience I have had," says Mr Purves, "I do not see that sheep are better off in sheds than in the open air where the climate is fine, the situation dry and well sheltered, except in a snow-storm or in very wet weather ; but, taking average situations into account, more especially in such districts as Caithness, where the climate is variable and the soil damp, and where there is no natural or artificial shelter, there is no doubt of the advantage of the plan ; and its general introduction and uniform success in that county are its best recommendation. This system, also, in a great measure dispenses with the necessity of keeping a large number of cattle to trample down the straw in arable farms, [this remark applies only to farms where cattle are bought every year, not bred ;] and as sheep are decidedly a more profitable stock than cattle, and managed at less expense, their number can be, in this way, considerably increased, especially if bone manure or guano be used and thorough-draining persevered in. The expense of keeping in this way is much the same as in the fields. There is, however, less loss of turnips, and the manure is better preserved ; and its value will more than compensate for the carting of it to the land. When oil-cake or oats are given, the difference of expense will be amply repaid in the superior quality of the wool and mutton, and in getting the sheep early to market, and in saving the grain for other stock.

963. "A shed of 100 feet in length and 14 feet in width,—having a back wall of 6 feet high of dry stone harled with lime, and pillars in front of stone and lime, with small trees laid across the shed for joists, covered with branches and thatched with straw, together with a court fronting S. of 100 feet square, fenced on the E. and W. sides with a dry stone-wall 6 feet high, and in front with a 4 feet wall, and all coped with turf—will contain 300 hoggs. A turnip-house of 40 feet in length, and 14 feet in width, should be constructed at one end of the shed, stretching along one of the side-walls of the court; and an apartment for the shepherd should be made at the end of the house, 12 feet long by 14 feet wide." ‡

964. But the modes of feeding sheep in sheds have been modified to confining them always within the shed ; which particular mode of feeding has obtained the appellation of box-feeding. If shelter is the one thing desirable, sheep will certainly experience it to the greatest degree in box-feeding. No farther description of this mode seems necessary, as it must be well understood from the foregoing descriptions of shed-feeding.

965. Boxing-feeding has been refined into stall-feeding, in which the sheep are not only confined within a shed, but are each tied with a leather strap by the neck, to a stake in a stall under the shed. It is related that "the intelligent and able steward of a gentleman had two lots of sheep feeding in a shed, the one lot tied up each to its own stall, the other remaining

* *Quarterly Journal of Agriculture*, vol. xi. p. 128.
† *Journal of the Agricultural Society of England*, vol. vi. p. 242.
‡ *Transactions of the Highland and Agricultural Society* for January 1845, p. 399.

loose in another part of the same shed. Though treated, in other respects, similarly, the progress of those tied up was much more rapid and profitable than that of those which were loose. The effect was very evident—the cause not so. However, one evening going round the cattle-sheds, at a late hour, he observed, upon opening the door of the sheep-house, that the loose sheep were on their feet, alert and restless, and as he entered they were constantly on the move; their food was unfinished. Those, on the contrary, that were tied up were reposing with full stomachs and empty troughs. Each having eaten, uninterrupted, all it could get, was making itself ready for the next supply. Nothing was wasted. The difference in their progress was thus accounted for."

966. The shed is 16 feet wide, affording room for a double row of stalls, and a passage between them. The floor of the stalls upon which the sheep stand consists of boards three-fourths of an inch apart, supported over tanks into which the dung and urine of the sheep drop. Each stall is fitted up with a trough and stake, and the sheep are fastened to the stake by means of a leather strap round the neck, with a chain 7 to 9 inches, enough to allow the sheep to lie down with its head clear of the trough. Within, 6 inches of their height the sides of the shed are formed of a bank of earth, which admits air and light above it, but the opening can be filled up with straw when desired.*

967. The reflection arising on hearing of sheep being confined within and fattened in sheds is, that it may perhaps be a profitable enough amusement for those who have but a very few sheep to feed,—but where is accommodation to be found for the hundreds of thousands of sheep fed on turnips every winter? I have known a farmer feed as many as 5000 sheep in a winter,—and where is he to procure the materials to erect sheds for that number without immense trouble and expense? I wish not to be misunderstood. I neither corroborate nor deny the statements that have been made in regard to the profits derived from this mode of feeding sheep; but I consider all the plans I have seen recommended as impracticable on a large scale, and therefore inapplicable to the country in general. Another reflection such methods call forth is, the counteraction given to the natural habits of the sheep. I advocate shelter for sheep as earnestly as any man can do, but would allow them as much liberty as not to interfere with their entire personal movements. This I plead for all other animals as well as sheep.

968. But shed-feeding is not invariably attended with success. Mr T. E. Pawlett, Burton, Bedfordshire, put up 8 lambs in a yard of hurdles and straw, and 8 in the open field; and the former gained in weight, in 9 weeks and 3 days, from 7th December to 11th February, 19½ lb. and the latter 20½ lb. each. In another experiment, the year following, 8 lambs in the yard gained each 32 lb. in 12 weeks, and 8 in the open field 28 lb. each, giving the advantage of 4 lb. to those in the yard.

969. "This difference," observes Mr Pawlett, "is very trifling, and not in the least sufficient to compensate any one for the extra trouble and expense which must necessarily be incurred by making yards, building sheds, taking the straw to a part of the farm where, perhaps, the manure is not wanted, and by the heavy cartage of the turnips, which, even for a short distance, is costly. And if the sheep fed in yards, during the winter, are not made fat enough for the butcher in the spring, and have to be turned again to pasture, they will suffer much more from the cold winds, having been confined and kept warm in the winter, than those sheep wintered in the usual manner in the fields. It is my opinion, also," adds Mr Pawlett, "but I confess I have no means of ascertaining the fact by way of experiment, that the wool may be injured by yard-feeding; for the lambs kept in that way have a more unfavourable and unhealthy appearance than those fed in the common manner. After these trials, and finding no adequate advantage in the practice, I have given up the system of feeding sheep in yards."

970. "The advocates of yard-feeding sheep allege that they eat less food, if kept in that way, than others do which are fed in the open field. During the trial of these experiments, no difference was observed as to the quantity of food consumed by each lot,—they ate as much alike as possible, the food being carried to them in scuttles. If one lot of sheep eat less than another, it is a proof with me that they thrive in a less degree—of course I allude to sheep of the same size and breed—as I find by weighing my sheep monthly, which are kept in small lots, that those which eat less food, (and this is often the case, without any apparent cause, as they are kept in the same way,) generally gain less in weight than the other lots which feed well."

971. Although Mr Pusey recommended shed-feeding, "I am bound to state," he observes, "that, in an experiment like Mr Pawlett's, I kept 10 Down lambs in a shed and 10 out of doors, weighing each lot regularly; but that I found the gain of weight rather on the side of the lambs fed out of doors."†

972. One or two curious and interesting facts were elicited by some experiments made by Mr Pawlett, in feeding sheep on different kinds of turnips. A lot of lambs were put on white turnips, in October, and another lot on swedes, and in the course of the month the lot on white turnips had gained each 10¾ lb., while that on swedes only gained 4¾ lb each, showing a gain of 6 lb. in the month. Other experiments for the same purpose produced similar results. "Since these

* *Gardeners' Chronicle and Agricultural Gazette*, for March 4, 1848.
† *Journal of the Agricultural Society of England*, vol. vi. p. 371-2.

experiments," observes Mr Pawlett, "I have invariably used white turnips for lambs in the autumn, and find they are excellent food if not sown too early in the season, and are not too old at the time; and preferable to swedes during the months of September and October, equal to them in November, or until the latter part of that month, and very inferior to them in December, or when the weather becomes cold and frosty. Lambs are not naturally fond of white turnips, and will take to swedes much sooner." A turnip-cutter will bring them to like any turnip sooner than any other expedient.

973. Cabbages are much relished by lambs early in the season; but they do not thrive well on carrots in any season.

974. A curious and unexpected result was brought to light by Mr Pawlett, and thus, in his own words,—"Being aware that it was the custom of some sheep-breeders to wash the food,—such as turnips, carrots, and other roots,—for their sheep, I was induced also to try the system; and as I usually act cautiously in adopting any new scheme, generally bringing it down to the true standard of experience, I selected for the trial two lots of lambs,—one lot was fed, in the usual manner, on carrots and swedes *unwashed*; the other lot was fed exactly on the same kinds of food, but the carrots and swedes were *washed* very clean every day; they were weighed before trial, on the 2d December, and again on the 30th December, 1835. The lambs fed with the unwashed food gained each 7½ lb., and those on the washed gained 4¾ lb. each; which shows that those lambs which were fed in the usual way, without having their food washed, gained the most weight in a month by 2¾ lb. each lamb. There appears to me no advantage in this method of management—indeed animals are fond of licking the earth, particularly if fresh turned up; and a little of it taken into the stomach with the food must be conducive to their health, or nature would not lead them to take it."*

975. I cannot conclude the subject of feeding sheep in confinement without bearing in mind that constant confinement is ungenial to the nature of sheep,—that sheep so confined cannot again have liberty in the open field without loss of condition in flesh and deterioration of the wool,—that, were the plan universally adopted, there would not be found room around steadings for many flocks, consisting of thousands, which are fed on turnips in winter,—that the trouble attendant on the plan would be very great in bringing food to, and taking away the manure from, the sheds—that the additional trouble thus imposed would greatly reduce the amount of profit,—and that, were sheep fed with a variety of food on the land, and greater means used to promote their comfort thereon, larger profits might be received by feeding sheep than have yet been realised; and I shall now adduce some instances to that effect.

976. To test the value of linseed cake as a fattening food for sheep, Mr James Bruce, Waughton, East Lothian, took two lots of sheep of 60 each from two flocks. A part of two fields of Swedish turnips, which presented a uniformity of soil and crop, was carefully divided into equal portions, each of which was occupied by 20 sheep.

977. One lot of 60 consisted of half bred dinmonts of good quality, 20 of which *a* were put on turnips alone, 20 *b* on home cake, and 20 *c* on foreign cake. On the 1st January 1844, *a* weighed 2803 lbs., *b* 2768 lbs., and *c* 2739 lbs. On the 7th February, *a* having consumed its portion of turnips, was reweighed, and found to be 2880 lbs.; and on the 1st of March, having also consumed theirs, *b* weighed 3054 lbs., and *c* 2966 lbs. The quantity of cake consumed by each division was 1182 lbs., being nearly 16 oz. each day per sheep.

978. The other lot of 60 consisted of cheviot dinmonts of inferior quality, 20 of which *d* were put on turnips alone, 20 *e* on home cake, and 20 *f* on foreign cake. On the 9th January, the weight of *d* was 2031 lbs., of *e* 2082 lbs., and of *f* 2001 lbs. On the 15th of February, *d* having finished their turnips were reweighed and gave 2097 lbs.; and on the 2d of March, having also finished theirs, *e* weighed 2315 lb., and *f* 2274 lbs.; *e* and *f* on the cake consuming the same quantity of turnips. The management of this lot was exactly similar to that of the other, described above; but the sheep would take no more than 13 oz. each of cake each day.

979. The results of both these experiments are given in the following table:—

Lots of Sheep.		Live weight at first.	Live weight at last.	Incr.	Incr. from cake.	Cake eaten.	Of cake to produce 1 lb. mutton.	
		lb.	lb.	lb.	lb.	lb.	lb.	oz.
60	20 *a*	2803	2880	77	~	~	~	~
	20 *b*	2768	3054	286	209	1182	5	3
	20 *c*	2739	2966	227	150	1182	7	14
60	20 *d*	2031	2097	66	~	~	~	~
	20 *e*	2082	2315	233	167	880	5	4
	20 *f*	2001	2274	273	207	880	4	4

980. The remarks which the perusal of this table suggest are—that as regards the increase of live weight, the offal of the sheep remaining comparatively the same, whatever weight is gained is of intrinsic value; that the improvement on the turnips alone is below the average—and this might have been anticipated upon all the sheep, since they were much confined to a particular spot, but as all the lots experienced the same inconvenience, no one lot was peculiarly circumstanced; that the improvement experienced by *b* and *e* on the home cake, in the one field, was reversed by *c* and *f* on the foreign in the other field,—a circumstance quite unaccountable. The average quantity of cake to produce 1 lb. of mutton was 5 lb. 10 oz.

* *Journal of the Agricultural Society of England*, vol. vi. p. 368-370.

981. In another experiment Mr Bruce put 15 sheep *a* upon linseed, 20 *b* upon linseed cake, 20 *c* upon a mixture of beans and linseed for three weeks, and afterwards upon poppy cake, 20 *d* upon beans, and 20 *e* upon a mixture of beans and linseed. The results will be understood by the contents of this table :—

Lots of sheep of 20 each.	Weighed at first.	Weighed at last.	Incr.	Eaten by each sheep per week.	Incr. of each sheep per week.	Quantity of ingredients to produce 1 lb. mutton.	Total consumption.
	lb.	lb.	lb.	lb. oz.	lb. oz.	lb. oz.	lb.
a	1839	2008	169	3 8½ Linseed 4¾ Beans	1 4	2 14½ Linseed	477 Linseed 36 Beans
b	2401	2603	202	7 1¼ Linseed cake	1 2	6 5 Linseed cake	1275 Linseed cake
c	2382	2479	97	5 15½ Beans & linseed	1 9¾	4 11 Beans & linseed	310 Beans 48 Linseed
–	2479	2657	178	9 13¼ Poppy cake	1 7¾	6 10 Poppy cake	1180 Poppy cake
d	2404	2557	153	7 1¼ Beans	0 13½	8 5¼ Beans	1275 Beans
e	2417	2736	319	6 4 Beans & linseed	1 12¼	3 8¼ Beans & linseed	702 Beans 422 Linseed

An explanation is requisite for the presence of beans with the linseed given to the sheep in *a* ; the linseed, lying in a ground state, had acquired a musty smell, and the beans were added to induce the sheep to eat it.

982. In order to ascertain which of those substances would economise the consumption of turnips the most, Mr Bruce put all the above lots of sheep on a full allowance of white turnips, without tops and roots, in a grass field, together with abundance of the materials just enumerated, in the order given above, and another lot *e* of 20 sheep were supported solely on turnips. The remains of all the turnips left were collected and weighed, and deducted from the gross weight to show the actual consumption. The results, which are interesting, will be seen in the following table :—

Lots of sheep of 20 each.	Turnips consumed	Other ingredients consumed.	Consumption by Sheep each day.		Saving of Turnips.	Per-centage of saving.
			Turnips.	Other ingredients.		
	lb.	lb.	lb.	lb. oz.	lb.	lb.
a	1782	52 Linseed 3 Beans	14¾	0 7 Linseed 0 ½ Beans	859	32½
b	1781	200 Linseed cake	11¼	1 4 Linseed cake	1741	49¼
c	2402	280 Poppy cake	15	1 12 Poppy cake	1120	31¾
d	2312	200 Beans	14½	1 4 Beans	1210	34¼
e	2699	100 Beans 60 Linseed	16¾	0 10 Beans 0 6 Linseed	823	23¼
f	3522	... ...	22	... ...	...	...

983. The remarks suggested by the results of this table are—that the saving of turnips effected by the linseed cake is very great, and secures a larger proportion than the cake used in the former experiment realised ; but much of such reresults as these must depend on the size and condition of the sheep, as the lower the condition the greater quantity of food will be consumed. It may be safely held, says Mr Bruce, that an allowance of 1 lb. of good linseed cake to a sheep of 9 stones' weight imperial, every day, will effect a saving in the consumption of turnips of 33 per cent, and at the same time so improve the health of the sheep as to diminish the chances of death by upwards of 50 per cent.

984. Whether or not the use of these extraneous ingredients increases the tallow in sheep is a reasonable inquiry, and Mr Bruce made experiments to ascertain this point also, by taking 5 average ewes from each division of the experiment (981,) first weighing them, and in two days afterwards killing them after being driven 23 miles. The results are detailed in the following table :—

Lots of Sheep of 5 each.	Fed upon.	Live weight. Dec. 23.	Weight of carcass. Dec. 25.	Weight of tallow.	Weight of skin.
		lb.	lb.	lb.	lb.
a	Linseed and beans	666	344	55	52
b	Linseed cake .	647	335	57	57
c	Beans and linseed and poppy cake	654	338	57	57
d	Beans	641	327	49	52
e	Beans and linseed	688	347	61	50

985. The conclusion which Mr Bruce draws from these experiments is, that " they clearly establish the fact, that mutton can be produced at a lower rate per lb. upon a liberal use of such ingredients along with turnips than upon turnips alone, taking of course the increased value of the

manure into account; and that of the articles used linseed is the most valuable, and beans the least so, but that a mixture of the two forms a useful and nutritious article of food."

986. I would wish to point out, in the results of the last table, the curious relationship there seems to exist between the weight of the tallow and the skin of the sheep. One can scarcely imagine such a relation to exist, as the weight of the skin of a lean and of a fat sheep cannot be very different, and a skin must weigh more when the wool is fully grown upon it than when new clipt. The skins above referred to would be pretty full of wool in December, when the ewes were slaughtered. Still the coincidence of the figures, indicating the weight of the tallow and skin respectively is certainly remarkable.*

987. Experiments were made in 1844-5 on the Earl of Radnor's farm at Coleshill, on the comparative fattening properties of different breeds of sheep under the same treatment. The sheep consisted of Leicesters, South-downs, half-breds, —a cross between the Cotswold and South-down —and Cotswolds. The sheep, being then lambs, were divided into lots of 3 each of each breed, and were grazed 4 months, from 29th August 1844 to 4th January 1845, when they were put on hay and swedes for 3 months, from 4th January to the 31st of March following. While on grass, the different breeds gained in weight as follows:—

	lb.		lb.	
The Leicesters being	46	each, gained	10½	each.
South-downs	47	...	11	
Half-breds	44½	...	12	
Cotswolds	56½	...	10½	

988. While on swedes and hay they gained as follows:—

	Gained each.	Consumed each. Hay	Swedes.
Leicesters	15 lb.	255 lb.	4027 lb.
South-downs	14	252	4110
Half-breds	17½	261	4255
Cotswolds	17	276	4862

Calculating the hay at 70s. per ton, the swedes at 10s. per ton, and the mutton at 7d. per lb. the results of the experiment are first in favour of the Leicesters, then of the half-breds, then of the South-downs, and lastly of the Cotswolds. The experimenter, Mr E. W. Moore, observes, "I have lately seen the account of an experiment between half-bred sheep and the Leicesters, which confirms the opinion I entertain, that up to a certain point there is no breed of sheep that will make mutton so rapidly as the Leicesters in proportion to the food consumed."†

989. There are two varieties of the South-down breed of sheep, one a large plain sheep, the other a small compact neat sheep. The defenders of the large plain Hampshire South-downs say that this breed comes to greater weight, and makes a greater money return than the other; whilst the breeders of the Sussex South-downs reply, that more of their smaller sheep can be kept on the same farm. There being this difference of opinion, it is of consequence to know which pays best in the same circumstances. This point has been proved, in as far as a single trial can go, by an experiment made by Mr George Shackel, Reading, Berkshire, on the large and small varieties, both bred in Hampshire, and they were lambs. He says,—"I give an account of the cost of each lot, as well as the proceeds of the sale when they were fat. The two lots were fed in the same time, on the same food, and penned on the same ground, but were kept separate from the commencement of the experiment. I allowed each lot when on turnips, these not being sliced only the swedes, the same sized piece per day; and and when on swedes, from Christmas 33 bushels sliced per day, and 18 bushels of excellent clover chaff to each lot; and on the 20th February 1847, we gave them 1 lb. each sheep of oil-cake a-day, on the average, until they were sold out."

Cost of 100 very large lambs per head in Oct. 1846		41s.	
Cost of 100 very much smaller, weighing about 1½ st. less, but in better condition . .		35s.	
Difference in price per head . .		6s.	
Received per head for the 100 lambs, from March to May 1847, which cost 41s. each . . .	£3	1	3
Received per head for the 100 lambs, from March to May 1847, which cost 35s. each . . .	2	9	0
In favour of the large lambs per head	0	12	3

It ought to be mentioned that the markets were in favour of the large lambs about 2s. per head, so that the actual difference is 10s. 3d.; and if we deduct the original difference of price of 6s. in favour of the small breed, there are still 4s. 3d. per head in favour of the large breed. It would be highly interesting to ascertain the difference between 100 of the best Sussex and 100 of the best Hampshire South-downs, kept on the same land, on the same food, and tested out of doors.‡

990. The efficacy of Warnes' compound for feeding sheep, I will defer taking notice of until we come to consider the nature of its composition, and the mode of making it in the feeding of cattle.

991. Sheep are not fed on turnips on every kind of farm. Carse-farms are unsuited to this kind of stock, and where turnips are raised on them, cattle would be more conveniently fed. There being, however, abundance of straw on clay-farms, sheep might be fattened for sale in small courts and sheds at the steading on oil-cake, and hay and other succedanea for turnips, more easily than on other farms.

* *Transactions of the Highland and Agricultural Society* for July 1846, p. 376-81.
† *Journal of the Agricultural Society of England*, vol. vii. p. 296. ‡ *Ibid.* vol. viii. p. 487.

992. On farms in the neighbourhood of *large* towns, whence a supply of manure is obtained at all times, turnips are not eaten off with sheep; but near small towns, they are so fattened to manure the land. They are bought in for the purpose, and consist of Cheviot or Black-faced wethers, Leicester hoggs, or draft ewes—the latter of which, if young, feed more quickly than wethers of the same age.

993. On dairy farms there is as little use for sheep as near towns, except a few wethers to eat off part of the turnips raised with bone-dust or guano, in place of, or in conjunction with, farm-yard dung.

994. On pastoral farms, sheep are not fattened on turnips; but their treatment in winter possesses exciting interest. There are *two sorts of pastoral* farms for sheep, and I shall make a few remarks on their constitution, and of their fitness for rearing sheep.

995. The first thing that strikes any one on examining a pastoral country is the *entire want of shelter*. After being accustomed to see the enclosed and protected fields of arable land, the winding valleys and round-backed hills of a pastoral country appear naked and bleak. One is not surprised to find bare mountain-tops, and exposed slopes, in an alpine country, because it is scarcely practicable for man to enclose and shelter elevated and peaked mountains; but amongst green hills and narrow glens, where no natural obstacles to the formation of shelter seem to exist, but whose beautiful outlines rather indicate them as sites for plantations that would delight the eye of the beholder, one would expect to see at least ordinary means used for procuring shelter and comfort; and, should these even be deemed too great for the sake of the farm itself, the farm-house might surely receive protection from trees.

996. The chief difficulty of forming shelter by planting on a large scale is the dreaded expense of enclosing it—for it is wisely concluded there is no use of planting trees unless they can be protected from injury, and few animals injure young trees so severely as sheep, by nibbling with their teeth as well as rubbing against them with their fleece, and yet in a mountainous country there is no want of rock for building rough but substantial stone fences; labour is but required to remove and put them together, and it is surprising what a quantity of stones a couple of men will quarry from a hill face, and a couple of single-horse carts will convey, in the course of a summer. The carriage could always be made downhill, fresh rock being accessible at a higher elevation as the building proceeds upwards. Or, failing rock, turf, even peaty turf, makes a very good turf wall.

997. Suppose a hill-farm containing 4 square miles, or 2560 acres, were enclosed with a ring-fence of plantation of at least 60 yards in width, the ground occupied by it would amount to 174 acres. A 6-feet stone wall round the inside of the planting will extend to 13,600 yards, which at 1s. 6d. per running yard, will cost £1020. But the sheltered 2386 acres will be worth more to the tenant, and of course to the landlord, than the entire 2560 acres unsheltered would ever be; and the fence will enhance the growth of the trees by 10 years at least, whilst the proprietor will have the value of the wood for the cost of fencing. Besides, planting one farm with a ring-fence shelters one side of 4 adjoining farms of the same size. Were neighbouring proprietors to undertake simultaneously the sheltering of their farms by large plantations, on a systematic plan, not only would warmth be imparted over a wide extent of country, but the planting and fencing would be accomplished along the march-fences at less cost to each proprietor.

998. Low pastoral farms are usually stocked with *Cheviot*, and high ones with the more hardy *Black-faced* breed; and although the general treatment of both is nearly alike, yet the respective farms are laid out in a somewhat different manner.

999. A low sheep-farm contains from 500 to 2000 sheep—one that maintains from 500 to 1000 is perhaps the highest rented, being within the capital of many farmers; and one that maintains from 1000 to 2000, if it have arable land attached to it, is perhaps the most pleasant to possess, as it affords employment to the farmer, while he could easily manage the concerns of 6000 sheep without arable land, with good shepherds under him. A shepherd to every 600 sheep is considered a fair allowance, where the ground is not very difficult to traverse, and it may be held as a fair stent to put 1000 sheep on every 1200 acres imperial.*

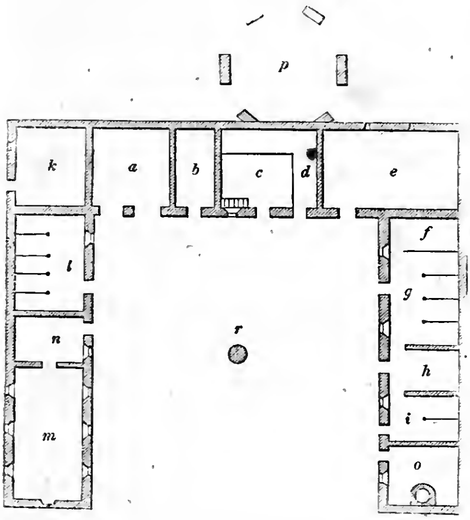
1000. Every sheep-farm should have as much arable land to cultivate as to supply turnips and hay to the stock, and provisions to the people who inhabit it. It is true, the necessaries and luxuries of life may be purchased; but every dweller in the country would prefer to raise the necessaries of life to purchasing them in any town or village. It is not easy to determine the proportion which the arable land should bear to the pastoral, to supply all the necessaries; but perhaps 2 acres arable to every 20 breeding ewes may suffice. Taking this ratio as a basis of calculation, a pastoral farm maintaining 1000 ewes should have 100 acres arable, which would require 2 pair of horses to labour in a 4-course shift; the *pasture* supplying the place of two-years-old lea. The rotation would be divided into 25 acres of green crops, 25 acres of corn after them, 25 acres of sown grasses, and 25 acres of oats after the grasses. Manure will be required for 25 acres of green crop, which would partly be supplied by the 50 acres of straw, by bone-dust or guano, and by sheep on the turnips. To make the straw into manure there are 4 horses, the cows of the farmer, the shep-

* Little's *Practical Observations on Mountain Sheep*, p. 10.

herd, and ploughmen; with a young heifer or two, the offspring of the cows. The arable land should be enclosed within a ring-fence of thorn, if the situation will admit of its growth, or of stone.

1001. A steading suitable for the arable portion of such a sheep-farm should have all the accommodation afforded in the plan, fig. 55, where the north range of building, standing E. and W.,

Fig. 55.



STEADING FOR THE ARABLE PART OF A SHEEP-FARM.

is 18 feet in width, comprehending a cart-shed, *a*, 18 feet square, gig-house, *b*, 10 feet by 18 feet, corn-barn, *c*, 32 feet by 18 feet with chaff-house, *d*, straw-barn, *e*, 40 feet by 18 feet on the ground, with granary above the implement-house, cart-shed, and gig-house, and upper-barn over the corn-barn, with a door, for taking in the grain in sheaf, by the side of the horse course, *p*, which is 26 feet in diameter. The E. wing is 18 feet in width, and contains the cart stable, 32 feet by 18 feet, fitted up with a loose box, *f*, and 4 stalls, *g*, 6 feet wide, a hay-house, *h*, 10 feet by 18 feet, riding-stable, *i*, 12 feet by 18 feet, and boiler-house, *o*, 15 feet by 18 feet, with a boiler and furnace in the gable. The W. wing is also 18 feet in width, and contains an implement-house, *k*, 18 feet square, a cow-byre, *l*, 25 feet by 18 feet, having 5 stalls of 5 feet each; an out-house, *n*, 12 feet by 18 feet, for weighing the wool in and doing any thing to the sheep, and a wool-room, *m*, 34 feet by 18 feet. The apartments may be made larger or smaller to suit the extent of the farm: *r* is the pump-well; *s* granary stair: the partition walls are 1 foot thick.

1002. The pasture division of the farm should be subdivided into different lots. Hoggs are best adapted for soft rough grass, springing from a damp deep soil, and ewes for the short and bare, upon a dry soil and subsoil. Hoggs attain large bone on soft rough pasture, where ewes would rot, and these thrive better on dry soil where hoggs would be stinted. That farm is best which contains both kinds of pasture, and maintains both breeding and rearing stock.

1003. In subdividing a farm into lots, each should contain within itself the same quality of pasture, whether rough or short; for if fine and coarse grass be within the same lot, the stock will remain almost constantly upon the fine. To the extent of one-fifth of coarse to fine may be permitted within the same lot. Should a large space of upper and inferior soil lie contiguous to what is much better, it should be divided by a fence; and, if requisite, a different breed of sheep reared upon it. By such arrangements, not only a greater number of sheep might be maintained upon a farm, but the larger number would always be in better condition.*

1004. The drainage of pastoral farms should never be neglected. The best mode of doing it will be fully explained to you when we come to treat of the subject of draining in general. Meanwhile you should know, in reference to pastoral farms, that one means of keeping part of the surface dry is to scour the channel of every rivulet, however tiny, that runs through the farm, every year—especially in those parts where accumulated gravel causes the water to overflow its banks in rainy weather, or at the breaking up of a storm. The overflowed water, acting as a sort of irrigation, sets up a fresh vegetation, which is eagerly devoured by sheep in spring, to the risk of their health; and the sand carried by it is left on the grass on the subsidence of the water, much to the injury of the teeth and stomachs of the sheep. The confinement of water within its channels also prevents it wetting the land.

1005. In recommending a connexion of arable with a pasture-farm, my object is simply to secure an abundant supply of food for sheep in winter. Were our winters as mild as to allow the sheep to range over the hills in plenty and safety, there would be little use for arable land, for the provisions of its inhabitants could easily be obtained from a market. But when storms at times almost overwhelm a whole flock, and protracted snow and frost debar the use of the ground for weeks together, it is absolutely necessary to provide food for stock upon the farm. I am aware of the folly of trusting to corn in a high district to pay rent with,—the stock must provide for that; but, nevertheless, the *more food and shelter are provided in winter for stock*, the less loss will be incurred during the most inclement season. Let one instance, out of many, suffice to show the comparative immunity from loss in providing food and shelter for

* *A Lammermuir Farmer's Treatise on Sheep in High Districts*, p. 51. The Lammermuir Farmer was the late Mr John Fairbairn, Hallyburton, Berwickshire.

sheep in winter. In the wet and cold winters of 1816 and 1818, the more than usual loss of sheep and lambs on the farm of Crosscleuch, Selkirkshire, was as follows:—

In 1816.						
200 lambs at 8s. each .	£80	0	0			
40 old sheep, at 20s. each	40	0	9			
				£120	0	0
In 1818.						
200 lambs, at 8s. each .	£80	0	0			
30 old sheep, at 20s. each	30	0	0			
				110	0	0
Value of total *extra* loss, .				£230	0	0

whereas on the farm of Bowerhope, belonging to the same farmer, and on which one-third more sheep are kept, the *extra* loss in those years was as follows:—

In 1816.						
70 lambs, at 8s. each .	£28	0	0			
10 old sheep, at 20s. each	10	0	0			
				£38	0	0
In 1818.						
50 lambs, at 8s. each .	£20	0	0			
8 old sheep, at 20s. each	8	0	0			
				28	0	0
Value of total *extra* loss				£66	0	0
Deduct loss on Crosscleuch,				230	0	0
Value saved on farm of Bowerhope				£164	0	0*

1006. Food and shelter being thus both necessary for the proper treatment of sheep in winter, the means of supplying them demand the most serious attention of the store-farmer. In winter, sheep occupy the lower part of the farm. Hoggs are netted on turnips in the early part of the season, and ewes and other sheep subsist on the grass as long as it is green. The division allotted to green crop in the arable part of the farm contains 25 acres, and allowing 3 acres for potatoes for the use of the farmer and his people, there remain 22 acres for turnips; and as land among the hills is generally dry, turnips grow well there; so that 30 double-horse cart-loads to the acre, of 15 cwt. each, may be calculated on as a return from the crop. It is thus judiciously recommended by Mr Fairbairn to strip and carry off, about the end of October or beginning of November, if the weather is fresh, before the grass fails, ⅘ of the turnips, and store them in heaps; and allow the *ewe-hoggs* to eat the remaining ⅕ on the ground, with the small turnips left when the others were pulled. In stripping the land in this proportion, 1 drill should be left and 4 carried off. This is an excellent suggestion for adoption on every hill-farm, as it secures the turnips from frost, and gives the entire command of them whenever required in a storm.

1007. It is found that *hoggs* fall off in condition on turnips in spring, in a high district, if confined upon the turnip-land — not for want of food, but of shelter and of teeth. They are always removed from the turnips in the afternoon to the pasture, where they remain all night, and are brought back to the turnips in the following morning. This treatment, it is obvious, deprives the land of much of the manure derivable from the turnips; and hence, farm-dung should be put on the land instead, where the turnips were raised with bone-dust or guano, before the grain is sown. The turnips thus consumed occupying 4⅖ acres, may last the 17 score of ewe hoggs—the number kept for refreshing the ewe-stock—about 6 or 7 weeks. After the turnips are consumed, the hoggs should be supplied from the store sliced on their pasture, with 1 double cart-load to every 8 score, which will be consumed in about 4 hours, after which they depend on the grass for the remainder of the day. Hoggs are treated in this manner until March, or longer, if the weather is bleak; when they maintain their condition, and become proof against the many diseases which poverty engenders, and their fleece weighs 1 lb. more. The cost of the 8 acres of turnips given to the hoggs, valued at £3 an acre, in a high district, is 17d. on each, which is so far reimbursed by the additional pound of wool worth 10d. or 1s. The balance of 5d. to 7d. a head, the true cost of the keep of the sheep on turnips, is a trifle compared to the advantage of wintering them in a healthy state and fair condition.

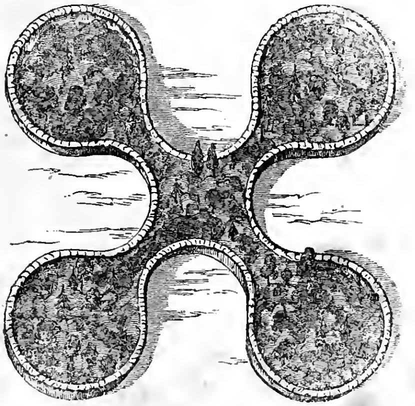
1008. As to the older sheep, they must partly depend, in storm, upon the 14 acres of turnips yet in store, and hay. The hay is obtained from the 20 acres of new grass, and allowing 5 acres for cutting-grass for suppers to horses and cows, 15 acres, at 120 hay-stones (of 22 lbs.) per acre, give 2400 hay, or 3771 imperial stones. The 1000 ewes will eat 1½ lb. each every day, besides the two cart-loads of turnips amongst them, and the hoggs ½ lb. of hay. At this rate the hay will last 31 days, a shorter time than many storms continue. The ground would yield more hay were it top-dressed with a special manure; and, besides this, the rule should be to begin with a full hand of hay at the commencement of farming, and preserve what may be left over in a favourable season, to mix with the new of the following one, with a little salt, and be thus prepared for any unusual continuance of storm.

1009. But in a storm, provender cannot be given to sheep upon snow, safely and conveniently, as ground drift may blow and cover up both; so no place is so suitable for preserving sheep and provender safe from drift as a *stell*. There are still many store-farmers sceptical of the utility of stells, if we may judge from their practice; but many repetitions of a storm are not required to convince any one, that stock are much more comfortably lodged within a high enclosure than on an open heath. A stell may be formed of plantations or high stone-wall. Either will afford shelter; but the plantation requires to be fenced by a stone-wall. Of the plantation stells, I conceive the form of fig. 56 a good

* Napier's *Treatise on Practical Store-Farming*, p. 126.

one, and may be characterised an *outside* stell. It has been erected by Dr Howison, of Cross-

Fig. 56.



THE OUTSIDE STELL SHELTERED BY PLANTATION, ON EVERY QUARTER.

burn House, Lanarkshire, and proved for 30 years. The circumscribing stone-wall is 6 feet high, the ground within it is planted with trees. Its 4 rounded projections shelter a corresponding number of recesses embraced between them; so that, let the wind blow from whatever quarter it may, two of the recesses will always be sheltered from the storm. The size of this stell is regulated by the number of the sheep kept; but this rule may be remembered in regard to its power for accommodating stock—that each recess occupies about ⅛ part of the space comprehended between the extremities of the 4 projections; so that, in a stell covering 4 acres—which is perhaps as small as it should be—each recess will contain ½ an acre. "But, indeed," as Dr Howison observes, "were it not from motives of economy, I know no other circumstance that should set bounds to the size of the stells; as a small addition of walls adds so greatly to the number of the trees, that they become the more valuable as a plantation; and the droppings of the sheep or cattle increase the value of the pasture to a considerable distance around in a tenfold degree."*

1010. In making stells of plantation, it would be desirable to plant the outside row of trees as far in as their branches shall not drop water upon the sheep in their lair, as such dropping never fails to chill them with cold, or entangle their wool with icicles. The spruce, by its pyramidal form, has no projecting branches at top, and affords excellent shelter by its evergreen leaves and closeness of sprays, descending to the very ground. The Scots fir would fill up the intervals behind between the spruce; but every soil does not suit the spruce, so it may be impossible to plant it every where. Larches grow best amongst the debris of rocks and on the sides of ravines; Scots fir on thin dry soils, however near the rock may be; and the spruce in deep moist soils.

1011. The late Lord Napier recommended the establishment of what he called a "system of stells," which would place one in the "particular haunt" of every division of the flock; and he considered that 24 stells would be required on a farm maintaining 1000 sheep—that is, 1 to little more than every 40 sheep.† However desirable it is to afford protection and shelter to stock, it is possible to incur more trouble and expense than necessary in accomplishing the object. On a farm where the practice is for the whole hirsel to graze together, it would almost be impracticable to divide them into lots of 40, one lot for each stell; and the division could not be accomplished without great waste of time, much bodily fatigue to the shepherd and his dog, and considerable heating to the sheep. I rather agree in opinion with the late Mr William Hogg, shepherd, Stobohope, that stells should be as large as to contain 200 or even 300 sheep on an emergency; and even in the bustle necessarily occasioned by the dread of a coming storm, 200 could be easily shed off from the rest, and accommodated in the sheltered recesses of a stell like fig. 56, which is accessible from all quarters; and 5 such stells would accommodate the whole hirsel of 1000 sheep.

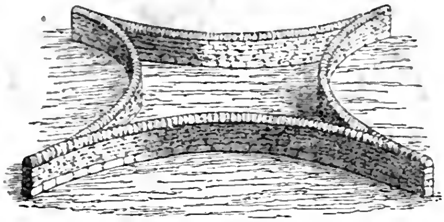
1012. Suppose, then, that 5 such stells were erected at convenient places—not near any natural means of shelter, such as a crag, ravine, or deep hollow, but on an open rising plain, over which the drift sweeps unobstructed, and on which, of course, it remains in less quantity than on any other place—with a stack of hay inside, and a store of turnips outside, food would be provided for an emergency. On a sudden blast arriving, the whole hirsel might be safely lodged for the night in the leeward outside recesses of even one or two of these stells, and, should prognostics threaten a *lying storm*, next day, all the stells could be inhabited in a short time. Lord Napier recommends a stack of hay to be placed close to the outside of every small circular stell; but it, so placed, would, I conceive, be a means of arresting the drift which would otherwise pass on.

1013. Instead of the small circular stell, Mr Fairbairn recommends a form without plantation, having 4 concave sides, and a wall running out from each projecting angle, as in fig. 57—each stell to enclose ½ an acre of ground, to be fenced with a stone-wall 6 feet high, if done by the landlord; but if by the tenant, 3 feet of the wall to be built of stone, and the other 3 feet built of turf; which last construction, if done by contract, would not cost more than 2s. per rood of 6 yards. An objection to this form of stell, without a plantation, may be seen when the wind rushes into any of the recesses: it strikes against the perpendicular face of the wall, from which, being reflected upwards, it throws

* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 334.
† Napier's *Treatise on Practical Store-Farming*, p. 122.

down the snow immediately beyond the wall, where the drift is deposited in the inside of the

Fig. 57.



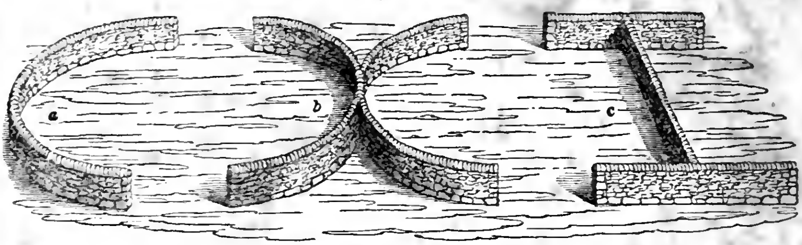
A FORM OF OUTSIDE STELL WITHOUT PLANTATION.

stell; and hence it is, I presume, that Mr Fairbairn objects to sheep being lodged in the inside of a stell.*

1014. This form, though affording more shelter, is open to the same objections as were the ancient stells, *a*, *b*, or *c*, fig. 58, the remains of many of which may be observed amongst the hills, and might yet screen sheep from a boisterous blast in summer.

1015. Much diversity of opinion exists regarding the utility of *sheep-cots* on a store-farm. These are rudely formed houses, in which sheep are put under cover in wet weather, especially at lambing time. Lord Napier recommended one to be erected beside every stell, to contain the hay in winter if necessary, and Mr Little advises them to be built to contain the whole hirsel of sheep in wet weather. It seems a chimerical project to house a large flock of sheep for days, and perhaps weeks; and, if practicable, could not be done but at great cost. I agree with those who object to sheep-cots on high

Fig. 58.



FORMS OF ANCIENT STELLS.

farms, because, when inhabited in winter, even for one night, by as many sheep as would fill them, an unnatural height of temperature is occasioned. Cots may be serviceable at night when a ewe or two becomes sick at lambing, or when a lamb has to be mothered upon a ewe that has lost her own lamb, and such cases being few at a time, the cot never becomes overheated.

1016. In an unsheltered store-farm it is found requisite to have 2 paddocks, and the number is sufficient to contain all the invalid sheep, tups, and twin lambs, until strong enough to join the hirsel.

1017. Hay should be stacked within, and the turnips stored around the outside walls, or in the plantation of stells.

1018. Tups may graze with the hirsel in the early part of the summer; but as no ordinary wall will confine them in autumn, they should be penned in one of the stells, on hay or turnips, until put to the ewes.

1019. Where a rivulet passes through an important part of a farm, it will be advisable to throw *bridges* across it at convenient places for sheep to pass easily along, to better pasture or better shelter on the opposite bank. Bridges are best constructed of stone, and though rough, if put together on correct principles, will be strongest; but if stone cannot be found fit for arches, they may do for the buttresses, and trees laid close together across the opening, held firm by transverse pieces, and then covered with tough turf, will form a safe roadway.

1020. For some time, the South-down sheep have been tried in the same pastoral districts as the Cheviot have occupied for many years, and since then have shown an equal aptitude with the Cheviot for the Scottish lowland pastoral climate; and as their mutton is the favourite in the London market, I think it not improbable they may, ere many years pass, supersede the Cheviot in many of our pastoral farms, as they have already trenched upon their ground in many localities in the low country.

1021. The highest hill farms for sheep in Scotland occupy an altitude ranging from 1500 to 3000 feet and upwards above the sea, and indeed some of them extend to the highest points of our mountain ranges.

1022. At such elevations, the pasture must necessarily be both coarse and scanty, consisting entirely of alpine plants. A considerable extent of such herbage is required to support a single sheep during a summer, and consequently the farms are of very great extent, many of them

* *A Lammermuir Farmer's Treatise on Sheep in High Districts*, p. 58.

extending miles in length, and embracing many thousands of acres.

1023. The Black-faced, or mountain or heath sheep, as it is called, because it thrives upon heath as a food, is a breed of sheep admirably well suited for occupying the highest range of farms, —having not only a bold and daring disposition, capable of enduring much fatigue in search of food, but a hardy constitution, and yielding a considerable quantum of the most delicious mutton.

1024. The circumstance of elevation and seclusion from roads imposes in the treatment of this breed a difference from that pursued in the lower country. The store-farmers of the lower country who breed Black-faced sheep sell what lambs they can spare after retaining as many as will keep their ewe-stock fresh. They thus dispose of all their wether-hoggs, the smaller ewe-hoggs, and draft-ewes. Suppose 1000 ewes wean 1000 lambs, 500 of these will be wether and 500 ewe hoggs, of which latter 17 score, or 340, will be retained, to replace one-sixth of the ewes drafted every year, and the remaining 160, together with the 500 wether-lambs, will be disposed of. The high hill store-farmer purchases those lambs, rears them until fit, as wethers, to go to the low country to be fed fat on turnips; and, acting thus, he never keeps breeding ewes.

1025. The state of the hill-pastures modify the mode of management on the hill-farms. The hill-pasture does not rise quickly in spring, nor until early summer; and when it does begin to vegetate, it grows rapidly into herbage, affording a full bite. It is found that this young and succulent herbage is not congenial to the ewe—it is apt to superinduce in her the liver-rot; but it is well adapted for forwarding the condition and increasing the size of bone of young sheep. It is, therefore, safer for the hill-farmers to purchase lambs from the south country pastoral farmers, who breed Black-faced sheep largely, as well as the Cheviot, than to keep standing flocks of ewes of their own. The winter half-year, too, on the hills, is a long period to be obliged to sustain a flock of ewes on extraneous food.

1026. It seems impracticable to have arable land on a hill-farm, at least hill-farmers are unwilling to admit that turnips are the best food for their stock in winter. Whatever may prompt them to object to arable culture on their farms, the reasons would be very strong that would prove that Black-faced sheep would not thrive on turnips in the hills, if these were raised for them on the spot. Doubtless on many farms, far removed from the great roads, it would be difficult to bring even a favoured piece of ground into culture, and especially to raise green crops upon it as they should be; but there are many glens among the hills, not far removed from tolerable roads, in which the soil might be cultivated to great advantage, and the green crop and hay from which would maintain the flock well through a stormy period extending from 6 weeks to 2 months.

1027. As a corroborative proof of the utility of cultivated land to hill-farms, is the practice of hill-farmers taking turnips or rough grazings for their stock in the lower part of the country, as nearly adjacent to their own homes as food can be procured; and of the lowland farmers, who possess hill-farms, bringing their sheep to the low country in winter, and putting them on turnips. If turnips and rough pasture will repay to be so taken, much more would they repay if raised at home; and if the stock might be thus brought through the dreary part of winter tolerably well, they would experience the conveniences of home when the snow fell deep, and covered the ground for weeks together. Stores of turnips and stacks of hay would then be as useful at home as abroad; and, when these failed, whins and bushes would afford as good food at home as at a distance. Hence the utility of raising turnips at home, and of storing a large proportion to be used in emergencies. Where a Scots-fir plantation is near a haunt of sheep these need not starve, for a daily supply of branches, fresh cut from the trees, will not only support them, but make them thrive as heartily as upon hay alone; and if a small quantity of hay is given along with the fir-leaves, they will thrive better than on hay alone.*

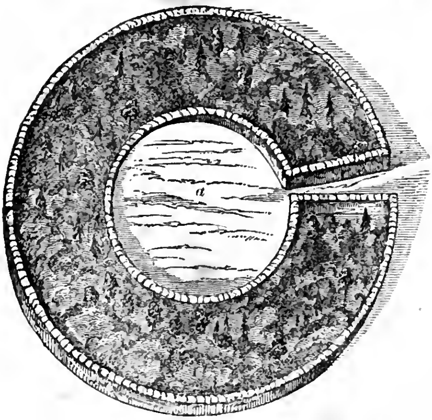
1028. The want of adequate shelter at home may induce some hill-farmers to send their stock to a lower country in winter. Their *hills* are bare of wood, the few trees being confined to the glens; and of course sheep can find no shelter in their usual grounds; and it is surprising how susceptible of cold even Black-faced sheep are when the atmosphere is becoming moist. They will cower down, creep into corners and beside the smallest bushes for shelter, or stand hanging their heads and grinding their teeth, having no appetite for food. If a piercing blast of wind follows such a cold day, the chances are that not a few of them perish in the night, and if thick snow-drift comes on, they drive before it, apparently regardless of consequences, and descend into the first hollow, where they are overwhelmed. Thus the utility of stells becomes apparent, and many hearty wishes are no doubt expressed for them by the farmer and his shepherd, when they have them not in the hour of peril.

1029. Sketching pictures of melancholy effects of storms is no substitute for the necessity, the utility, the humanity of cultivating such an extent of ground, in favoured spots, as would raise food to support, beyond a doubt or a dread, the whole flock through the protracted period of the longest storm. Such effects of storms are the strongest incentives to form extensive plantations, for shelter, on all our mountain ranges. Though some of the trees would fail to grow here and there, it does not follow that the most would not grow quite well to afford invaluable shelter in the bleakest period of the year. And such catas-

* Little's *Practical Observations on Mountain Sheep*, p. 44

trophes urge the more strongly upon hill-farmers the construction of commodious stells in the most exposed situations of the farm. Opinion is not agreed as to the best form of stell for high pastures, where wood is seldom found. At such a height the spruce will not thrive; and the larch, being a deciduous tree, affords but little shelter with its spear-pointed top. There is nothing left but the evergreen Scots fir for the purpose, and, when surrounding a circular stell, such as fig. 59, it would afford very acceptable shelter to a large number of sheep. This form of stell consists of 2 concentric circles of wall,

Fig. 59.



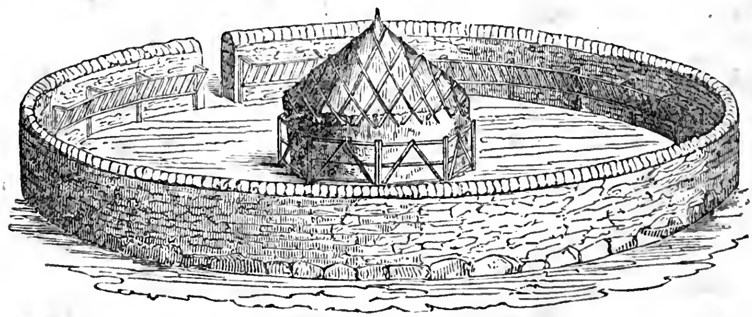
AN INSIDE STELL SHELTERED BY PLANTATION.

enclosing a plantation of Scots fir, having a circular space *a*, in the centre for sheep, as large as to contain any number. This may be denominated an *inside* stell, in contradistinction to the outside one in fig. 56, and has been proved efficient by the experience of Dr Howison. Its entrance, however, is erroneously made wider at the mouth than at the end next the interior circle, *a*, which produces the double injury of increasing the velocity of the wind towards the circle, or of squeezing the sheep the more the nearer they reach the inner end of the passage. The walls of the passage should be parallel and winding, to break the force of the wind.

1030. But where trees cannot be planted with a prospect of success, stells may be formed without them, and indeed usually are; and of all the forms that have been tried, the *circular* has obtained the preference on hill-farms; but the difficulty of determining the size as the best, is still a matter of dispute amongst hill-farmers. Lord Napier thought 7 yards diameter a good size, and the largest not to exceed 10 yards inside measure; while Mr William Hogg approves of 18 yards. I agree with Mr Hogg. In the first place, the circular form is better than a square, a parallelogram, or a cross; because the wind striking against a curved surface, on coming from any quarter, is divided into two columns, each weaker than the undivided mass; whereas, on striking against a straight surface, though its velocity is somewhat checked, it is still undivided, and its force still great, when it springs upwards, curling over the top of the wall, throwing down the snow a few yards into the interior of the figure. Any one who has noticed the position of drifts of snow on each side of a straight stone wall, will remember that the lee-ward-side of the wall is completely drifted up, while on the windward-side a hollow is left, often clear to the ground, between the snow and the wall. Every form of stell, therefore, that presents a straight face to the drift will have that fence drifted up and be no protection to the sheep. Of two curves, that which has the larger diameter will divide the drift the farther asunder. A stell of small diameter, such as 7 yards, dividing a mass of drift, divides also the current of air immediately over it so suddenly that the snow it carries is let fall into the stell. A stell of large diameter, of 18 yards, on dividing a column of air, deflects it so much on each side that it has long passed beyond the stell before it regains its former state, and before it deposits its snow; and hence the snow is found to fall in a triangular shape, with its apex away quite to leeward of the most distant part of the stell, and of course leaves the interior free of deep snow.

1031. Fig. 60 represents a stell of 18 yards diameter inside, surrounded by a wall of 6 feet high, the first 3 feet of which may be of stone, and the other 3 feet of turf, and will cost 2s. 4d. per rood of 6 yards, if erected by the tenant, but if by the landlord, and wholly of stone with a cope,

Fig. 60.



THE CIRCULAR STELL FITTED UP WITH HAY-RACKS, AND SUPPLIED WITH A HAY-STACK.

will cost 7s. per rood: this size gives 9⅓ roods, which at 7s. makes its cost £3, 5s. 4d., including the quarrying and carriage of the stones—a trifling outlay compared to the permanent advantage derived from it on a hill-farm. The opening into the stell should be from the side towards the rising ground—and its width 3 feet, and of the whole height of the wall, as seen in the figure; or it is sometimes a square of 3 or 4 feet, on a level with the ground, through which the sheep enter, while persons obtain access, in such cases, by means of stile-steps over the wall. Such a structure as this should supersede every antiquated form; and it will easily contain 10 score of sheep for weeks, and even 15 or 16 score may be put into it for a night without being too much crowded together.

1032. Stells should be fitted up with *hay-racks* all round the inside, as in fig. 60, not in the expensive form of circular wood work, but of a many-sided regular polygon. It is a bad plan to make sheep eat hay by rotation, as recommended by Lord Napier and Mr Little, but condemned by Mr Fairbairn, as the timid and weak will be kept constantly back, and suffer much privation for days at a time. Let all have room and liberty to eat at one time, and as often as they choose. The hay-stack should be built in the centre of the stell, as in fig. 60, on a basement of stone, raised 6 inches above the ground to keep the hay dry. A small stack, 5 yards in diameter at the base, 6 feet high in the stem, with a top of 6 feet in height, will contain about 450 hay-stones of hay, which will last 200 sheep 33 days, about the average duration of a long storm; but upon that base a much greater quantity of hay might be built. The interior circumference of the stell measures 160 feet round the hay-racks; and were 8 or 9 six-feet hurdles put round the stack, at once to protect the hay and serve as additional hay-racks, the hurdles would afford 47 feet more—which together give 1 foot of standing room at the racks to each of 200 sheep at one time.

1033. Stells form an excellent and indispensable shelter for sheep in a snow-storm, when deprived of their pasture; but it has occurred to me that, in want of stone-stells, very good stells or chambers might be made of snow of any form or size desired. Even around the space occupied by sheep, after a heavy fall of snow, a stell might be constructed of the snow itself, taken from its interior, and piled into walls as wide and high as required. Such a construction would remain as long as the storm endured. A new storm could be made available for repairs, and, even after the ground was again clear, the snow walls would remain as screens for some time after. A small open drain or two, in case of a thaw, would convey away the water as the snow melted.

1034. As long as the ground continues green, natural shelter is as requisite as stells,—these consist of rocks, crags, braes, bushes, heather, and such like. To render these as available to sheep as practicable, the ground should be cleared of all obstructions around them, and bushes planted in places most suited to their growth, such as the whin (*Ulex europœa*,) in poor thin clay, and it is a favourite food of sheep in winter; the broom (*Genista scoparia*,) on rich light soil; the juniper (*Juniperus communis*,) in sandy soil; the common elder (*Sambucus nigra*,) in any soil, and it grows well in exposed windy situations; the mountain ash (*Pyrus aucuparia*,) a hardy grower in any soil; and the birch when bushy (*Betula alba*,) grows in any soil, and forms excellent clumps or hedges for shelter, as well as the hazel (*Corylus avellana*,) and the common heaths (*Erica vulgaris* and *tetralix*,) when they get leave to grow in patches to their natural height in peaty earth. I shall advert to the protection of mountain land when we come to speak of shelter.

1035. There are other modes of protecting hill sheep from the severities of the weather besides stells, and which may be regarded as more personally comfortable to them than any other; and one of these is what is termed *bratting*, which is done by covering the sheep with a cloth as an apron or brat. In tracing the origin of this practice, Mr M'Turk of Hastings Hall in Dumfriesshire, observes that, "After exhausting every practicable means of yielding protection and shelter to sheep on the hills, by the erection of stells, &c., it was still found that a more constant and effectual method was necessary, and salving was resorted to, as the cheapest and most likely way of attaining three important objects—namely, defence from the cold, security from the ravages of the scab, and the destruction of vermin. It has long been known to those interested in the management of sheep, that more protection is afforded by bratting than the use of any salve; but, until of late years, salving was considered necessary, at the same time, to destroy vermin; but this double expense was too considerable to admit of a profitable return. There was another difficulty connected with bratting, which rendered it exceedingly inconvenient and unpopular. The practice was to sew the brat to the wool upon the animal, which, in hands little accustomed to the use of the needle, was both awkwardly performed, and attended with great trouble and loss of time. Never could cloth be obtained for brats at so cheap a rate as at present, while, at the same time, substances have been discovered which effectually destroy vermin, and entirely obviate the necessity of smearing, at not more than one halfpenny per head, or one-tenth of the expense of smearing. Cloth, well suited for the purpose, may be made from the refuse wool of carpet manufactories, as thick and warm as a blanket, and at only a 6d. per yard. If sacking is employed it may be had for 4d. per yard.

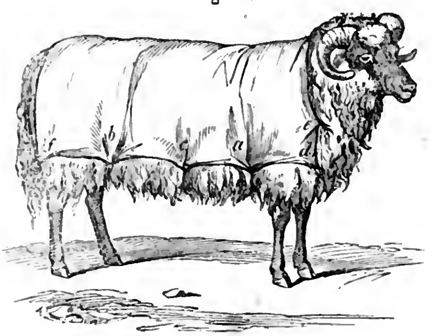
1036. "When intended for bratting hoggs, the cloth should be three-quarters wide, and two feet will be sufficient to cover one Black-faced hogg. When intended for old sheep of the best description, the brats may be made larger by applying the cloth the long way, and we have then 27 inches in width to cover the back and sides instead of 24, and it can be cut off as long as the largest sheep requires. The brat should come as far down the sides as to cover the widest part of the ribs and all the back, from the tail to the back of the neck. Instead of fitting the cloth to every sheep, the best plan is to select a sheep of the average size of the class, and measure and cut the quantity of cloth required. When the cloth has been applied to the animal, and its proper dimensions ascertained, the parts should then be marked to which the different straps and strings are to be sewed, to hold it in its proper place. A strap is fixed to one of the front corners, in a direction to pass beneath the throat, and be sewed to the other corner; and other straps are intended to pass under the belly. These straps are only sewed at first at one end, and the other end is sewed after the brat is fitted on, so as to keep it tight in its place. The straps should be of a soft material, that they may not chafe or injure the skin when the sheep is moving about. When made, the brats are dipped in coal tar, the better to resist the wet and rotting, and if taken care of will last, thus prepared, for five seasons. They ought to be made early in summer, to have time to be dried before November, when they are used. They remain on the sheep, but not longer than the beginning or middle of April, according to the state of the weather, and the condition of the flock. A person accustomed to the use of the needle, can make a brat in five minutes, and fit it on in less than other five.

1037. "A woollen brat with strings will not cost more than 5d., a flaxen one about 3½.; but the former will last much longer, and answer better. To enable the shepherd to identify the brats, when not in use, they should be branded with the farm mark in white paint. The sheep are bathed for the destruction of vermin, and the wool should regain its wonted appearance before the brat is fitted on. The prices are,—for

Small woollen brats .	5d.	to last for	5 years.
Larger	6	—	—
Flaxen	3½	—	2
Bathing to destroy vermin	½	—	1

038. Fig. 61 represents a bratted sheep, the

Fig. 61.



A BRATTED SHEEP.

tie *a* passes below the belly, immediately behind the shoulder; *b* immediately in front of the hind legs; *c* under the middle of the belly; whilst *d* and *e* pass unnoticed under the wool across the breast, and those from the hind corners at *f* may pass behind the hind legs, and be sewed below to the ties of *b*.

1039. It occurs to me to suggest that this thick woollen cloth might be rendered waterproof, and the strings to fasten on the brats might be of vulcanised India rubber, which while yielding to the motions of the animal, will cause the brat always to adhere firmly to its body.

1040. "We have found from our own experience," says Mr M'Turk, "and we have not heard the fact doubted by any one conversant with the management of sheep, that no salve hitherto tried has afforded a degree of protection equal to bratting, when thus secured to the animal. We are therefore entitled to conclude that, under this treatment, the flock will be in higher condition, and if so, the clip of wool will be greater, and the loss by death considerably lessened, and affording the means of bringing some of the more reduced of the old ewes through the winter, which could not have otherwise survived in a high and exposed district. When the brat is taken off in April, the wool will be found to have retained the *yolk*, and will appear quite yellow. When examined, it will be found to be sappy and sound, and free from the defect that wool-staplers call *husky* and *pinny*, that is, dry and brittle, which occasions much loss in the manufacture. When washed, its natural whiteness is unimpaired, we would even say increased, from the soap employed in the bathing, and the yolk which is retained."*

1041. Since *hay* is the principal food given to mountain sheep in snow or in black frost, it is matter of importance to procure this valuable provender in the best state, and of the best description. It has long been known that irrigation promotes, in an extraordinary degree, the growth of the natural grasses; and perhaps there are few localities which possess greater facilities for irrigation, though on a limited scale, than the highland glens of Scotland. Rivulets meander down those glens through haughs of richest alluvium, which bear the finest description of natural pasture plants. Were those rivulets subdivided into irrigating rills, the herbage of the haughs might be multiplied many fold. Such being the condition of those glens, I cannot too earnestly draw the attention of hill-farmers to the utility of converting them into irrigated meadows; and though each meadow may be of very limited extent, the grass will be most valuable when converted into hay. One obstruction only exists to their formation, the fencing required around them, to keep the stock off while the grass is growing for hay. But the exertion of fencing should be made for the sake of the crop protected by it. Besides places for regular irrigation, there are rough patches of pasture, probably stimulated by latent water performing

* *Transactions of the Highland and Agricultural Society* for July 1843, p. 45.

a sort of under-irrigation to the roots of the plants, which should be mown for hay; and to save farther trouble, *this* hay should be ricked on the spot, fenced with small hurdles, around which the sheep would assemble at stated hours, feed through the hurdles in frosty weather from the rick, and wander again over the green sward for the remainder of the day; and when the snow came, the stells would be their place of refuge and support. As the hay in the stack is eaten, the hurdles are drawn closer around the stack, to allow the sheep again to reach it.

1042. Hurdles are constructed in different forms. Fig. 40 is the strongest and most durable, but also the most expensive hurdle in the first cost. Each hurdle, with its fixtures, consists of 14 pieces—viz. 2 side-posts *a*, 4 rails *b*, and 3 braces *c d d*, which go to form the single hurdle; and 1 stay *f*, 1 stake *g*, and 3 pegs at *g*, *h*, and *i*, which are required for the fixing up of each hurdle. The scantling of the parts are the side-posts 4½ feet long, 4 inches by 2 inches. The rails 9 feet long, 3½ inches broad by 1 inch thick. The braces, 2 diagonals 5 feet 2 inches long, 2¼ inches broad by ¾ inch thick, and 1 upright 4 feet long, and of like breadth and thickness. The stay is 4½ feet long, 4 inches broad, and 2 inches thick, and bored at both ends for the pegs; the stake 1½ foot long, pointed and bored. The pegs 1 foot long, 1¼ inch diameter. The cost is 2s. 6d. each with the fixtures.

1043. The preparation of the parts consists in mortising the side-posts, the mortises being usually left round in the ends, and they are bored at equal distances from the joining and stay pegs. The ends of the rails are roughly rounded on the edges, which completes the preparation of the parts; and when the flake is completed, its dimensions are 9 feet in length, and 3 feet 4 inches in breadth over the rails; the bottom rail being 9 inches from the foot of the post, and the upper rail 5 inches from the head.

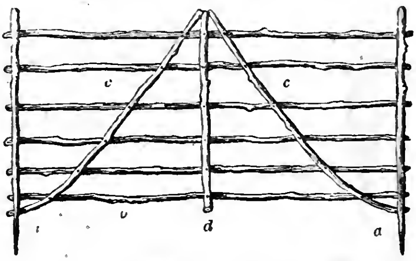
1044. Another form of flake, more extensively employed, has 5 rails, which are 1¾ inch square. The ends of the rails are turned round by machinery, and the side-posts bored for their reception, as well as the pegs also by machinery. The bottom rail is 9 inches from the foot of the posts; the spaces *between* the first and second, and the second and third rails, are each 7 inches, and the two upper spaces are respectively 8 and 9 inches, leaving 5 inches of the post above the upper rail.

1045. These are extensively manufactured in Perthshire, where young larches are abundant. Their price, when sold in retail by fifties or hundreds, is 1s. 9d. to 2s. each, including all the parts, sold in pieces; the expense of putting the parts together is usually 2d. each hurdle, including nails. In Kirkcudbright, flakes of 5 spars, and 6 feet long, sell for 1s. 2d. each.

1046. Where the common crack-willow (*Salix fragilis*) will grow, every farmer may have poles enough every year for making 2 or 3 dozen hurdles to keep up his stock. To establish a plantation, large cuttings 9 or 10 feet long should be pushed, not driven, into moist soil, and on being fenced from cattle, will soon shoot both in the roots and head, the latter being fit to be cut every seventh year. Where soil for a willow-plantation does not naturally exist, the farmer can buy his hurdles ready made at 16s. the dozen; when made at home they cost 4d. each, and when the shepherd makes them they cost only his time. Hurdle-makers go the round of the country in England, and make at 4d. and mend at 2d. each, finding their own tools.

1047. A very common form of hurdle used in England is shown in fig. 62. It is formed of any sort of willow or hard wood, such as oak-copse,

Fig. 62.



THE ENGLISH HURDLE.

ash-saplings, or underwood, such as hazel. It consists of 2 heads *a a*, 6 slots *b*, 2 stay-slots *c c*, and an upright slot *d*. The slots are mortised into the heads and nailed with flattened fine-drawn nails, at 6d. per lb., which admit of being very firmly riveted, upon which the strength of the hurdle mainly depends: 100 poles at 18s. make 36 hurdles, which, including nails and workmanship, cost £1, 11s. 6d, or 10s. 6d. per dozen. Although the horizontal slots are cut 9 feet long, the hurdle, when finished, is only somewhat more than 8 feet, the slot ends going through the heads 1 or 2 inches: 2 hurdles to 1 rod of 16 feet, or 8 to 1 chain of 22 yards, are the usual allowance.

1048. A larger kind of hurdle, called *park hurdles*, worth 2s. each, is made for subdividing meadows or pastures, and are a sufficient fence for cattle. The small hurdles are used for sheep, the larger to fence cattle, whereas the Scotch flakes answer both purposes at once, and are therefore more economical.

1049. The hurdles being carted to the field, according to the English mode, they are laid down flat, end to end, with their heads next to, but clear of, the line in which they are to be set. A right-handed man generally works with the row of hurdles on his left. Having made a hole in the hedge, or close to the dyke, for the foot of the first hurdle, with the *fold-pitcher*, fig. 63, which is an iron dibber, 4 feet long, having a well-pointed flattened bit, in shape similar to the feet of the hurdles, he marks on the ground the place where the other foot is to be in-

Fig. 63.

THE FOLD-PITCHER IN HURDLE-SETTING.

inserted, and there with his dibber he makes the second hole, which, like all the others, is made 9 inches deep. With the left hand the hurdle is put into its place, and held upright while lightly pressed down by the left foot on the lowest slot. This being done, the third hole is made opposite to, and about six inches from, the last. The dibber is then put out of hand by being stuck in the ground near where the next hole is to be made; the second hurdle is next placed in position, one foot on the open hole, and the other foot marks the place for the next hole, and so on throughout the whole row. When the place of the second foot of a hurdle is marked on the ground, the hurdle itself is moved out of the way by the left hand, while the hole is made by both hands. When the whole row is set, it is usual to go back over it, giving each head a slight tap with the dibber, to regulate their height, and give them a firmer hold of the ground.

1050. To secure the hurdles steady against the rubbing of the sheep, couplings, or, as they are commonly called, *copses*, are put over the heads of each pair where they meet, which is a sufficient security. These couplings are made of the twigs of willow, holly, beech, or any other tough shoots of trees, wound in a wreath of about 5 inches diameter.

1051. The number of hurdles required for feeding sheep on turnips is one row the whole length of the ridges of an enclosed field, and as many more as will reach twice across 2 eight-step lands or ridges, or 4 four-step lands, that is, 48 feet, or 3 or 4 ridges of 15 feet. This number, whatever it may be, is sufficient for a whole quadrangular field, whatever number of acres it may contain. The daily portions are given more or less in length, according to the number of the flock. Two of these portions are first set, the sheep being let in on the first or corner piece. Next day they are turned into the second piece, and the cross-hurdles that enclosed them in the first are carried forwards, and set to form the third piece. These removes are continued daily till the bottom of the field is reached: both the cross-rows are then to spare, and are carried and set to begin a new long-row, close to the offside of a furrow, and the daily folding carried back over 2 or 4 lands as at first. It is always the top of a field, if there be any difference of the level, where the folding is begun, that the flock may have the driest lair to retire to in wet weather.

1052. "When there is a mixed flock, that is, couples, fattening and store sheep, two folds or pens are always being fed off at the same time, which only require an extra cross-row of hurdles. The couples have the fresh pens, while the lambs are allowed to roam over the unfolded turnips, by placing the feet of the hurdles, here and there, far enough apart, or by lamb-hurdles made with open pannels for the purpose. The fattening sheep follow the couples, and have the bulbs picked up for them by a boy. The stores follow behind and eat up the shells."* It is never the practice in Scotland to put ewes with their lambs upon turnips, as new grass is considered much better for them, and the only ewe that suckles a lamb on the early part of the turnips in winter is the Dorsetshire. The *store*-sheep in Scotland—that is, the ewe-hoggs—are always fed as fully as the wether-hoggs that are fattened. In England the entire turnip-stock, ewes, lambs, and wethers, are fattened for the butcher, and sold, if possible, before the turnips are all eaten. They have hay, oil-cake, or corn, either in the field or in the sheep-house, in wet or stormy nights.

1053. An acre of good turnips maintains 5 score of sheep for 1 month.

1054. *Nets*, by which sheep are confined on turnips in winter, are made of good hempen twine, and the finer the quality of the hemp, and superior the workmanship bestowed on it, the longer will nets last. Being necessarily much exposed to the weather, they soon decay, and if carelessly treated will scarcely last more than one long season. Nothing destroys them so rapidly as laying them by in a damp state; and if rolled up wet even for a few days, they become mildewed, after which nothing can prevent their rotting. They should never be laid by damp or dirty, but washed and thoroughly dried in the open air before being rolled up and stowed away. It is alleged by shepherds that nets decay faster in drought, and exposure to dews and light, in summer than in winter. Several expedients have been tried to preserve nets from decay, among others, tanning, in imitation of fishermen; but however well that process may suit nets used at sea, it makes them too hard for the shepherd's use in tying the knots around the stakes. Perhaps a steeping in Kyan's or Burnett's solution might render them durable, and preserve their pliability at the same time.

1055. *Sheep-nets* are wrought by hand only. They are simply made of *dead netting*, which consists of plain work in regular rows. A shepherd ought to know how to make nets as well as mend them, and cannot mend them well unless he understand how to make them. Net making is a very suitable occupation for women.

1056. All the instruments required in this sort of net-making are a *needle* and *spool*. "Needles are of two kinds, those made alike at each end with open forks, and those made with an eye and tongue at one end and a fork at the other. In both needles the twine is wound on them nearly in the same manner—namely, by passing it alternately between the fork at each end, in

* *Quarterly Journal of Agriculture*, vol. iii. p. 647-53.

the first case, or between the fork at the lower end and round the tongue at the upper end, in the second case; so that the turns of the string may lie parallel to the length of the needle, and be kept on by the tongue and fork. The tongue and eye needle is preferable both for making and mending nets, inasmuch as it is not so liable to be hitched into the adjoining meshes in working; but some netters prefer the other kind, as being capable of holding more twine in proportion to their size." An 8-inch needle does for making nets, but a 4-inch one is more convenient for mending them.

1057. *Spools*, being made as broad as the length of the side of the mesh, are of different breadths. They "consist of a flat piece of wood of any given width, of *stout* wood, so as not to warp, with a portion cut away at one end, to admit the finger and thumb of the left hand to grasp it conveniently. The twine in netting embraces the spool across the width; and each time that a loop is pulled *taught*, half a mesh is completed. Large meshes may be made on small spools, by giving the twine two or more turns round them, as occasion may require."

1058. "In charging your needle, take the twine from the *inside* of the ball. This prevents tangling, which is at once recommendation enough. When you charge the needle with *double* twine, draw from two separate balls."*

1059. In joining the ends of *twine* together, in mending, the *bend* or *weaver's* knot is used, and in joining top and bottom ropes together in setting nets, the *reef*-knot is best, as the tighter it is drawn the firmer it holds.

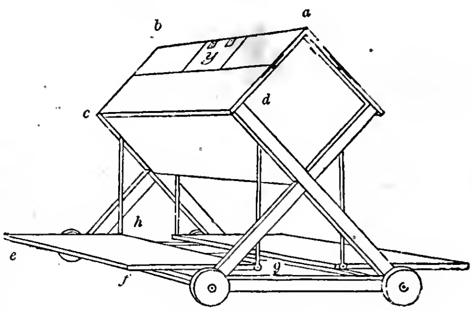
1060. Sheep-nets run about 50 yards in length when set, and weigh about 14 lb. Hogg-nets stand 3 feet in height, and dinmonts 3 feet 3 inches, and both are set 3 inches above the ground. The mesh of the hogg-net is 3½ inches in the side, and of the dinmont 4¼ inches; the former requires 9½ meshes in the height, the latter 8½. The twine for the hogg-net is rather smaller than that for the dinmont, but the *top* and *bottom rope* of both are alike strong. A hogg-net costs 12s., or under 3d. per yard; a dinmont 10s., or under 2½d. per yard, at Berwick upon-Tweed and Coldstream; but they are now sold in the prison of Edinburgh at 7s. 6d., or under 2d. per yard; while in London the charge is 4½d. per yard.

1061. It is imagined that nets will not confine Black-faced sheep on turnips, because they would be broken by being entangled in the sheep's horns; but the objection is unfounded as this anecdote will show: A very extensive feeder of Black-faced sheep, on seeing my Leicester hoggs on turnips confined by nets, expressed a willingness to try them with his own sheep, adducing the great expense of hurdles as a reason for desiring a change. After receiving a pattern net from me to stand 4 feet high, he had others made like it; and so successful was the experiment, even the first season, he ever after enclosed a large proportion of his Black-faced sheep with nets. There were a few cases of entanglement at first, but the shepherd was constantly with his large flock, and no harm happened to the sheep or nets, and it was remarked that the same sheep never became entangled more than once. They never attempted to leap over the nets, though they would not have hesitated to do so over a much higher wall.

1062. Nets are wrought by machinery. "Netting for fruit trees," observes Dr Bathurst, "is made, I believe, by machinery at the factory of Mr Benjamin Edgington. I do not know that any other nets have as yet been made for general purposes, or of any other description than plain or dead-netting. *False meshes*, or change of size of spools, have not hitherto been, as far as I know, effected by machinery."† I have made inquiry of the net-workers in the neighbourhood of Edinburgh, and find that the use of machinery is entirely confined to the making of fishing nets.

1063. A mode of preserving corn dry for sheep on turnips has been tried with success in Fife. It consists of a box like a hay-rack, fig. 64, in which the corn is at all times kept closely shut

Fig. 64.



THE CORN-BOX FOR SHEEP ON TURNIPS.

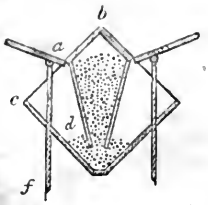
up, except when the sheep wish to eat it, when they get at it by a simple contrivance. Into the box *a b* the corn is poured through the small hinged lid *y*. The cover *c d*, concealing the corn, is also hinged, and when elevated the sheep have access to the corn. Its elevation is effected by the pressure of the sheep's fore-feet upon the platform *e f*, which, moving as a lever, acts upon the lower ends of the upright rods *g* and *h*, raises them up, and elevates the cover *c d*, under which their heads then find admittance into the box. A similar apparatus gives them access to the other side of the box. The whole machine can be moved about to convenient places by means of the 4 wheels.

1064. The construction of the interior of the box being somewhat peculiar, another, fig. 65, is

* Bathurst's *Notes on Nets*, p. 15, 17, and 138.

† *Ibid.* p. 144.

Fig. 65.



THE VERTICAL SECTION OF THE INTERIOR OF THE CORN-BOX.

given of a vertical section of it, where *b* is the hinged lid by which the corn is put into the box, whence it is at once received into the hopper *d*, the bottom of which, being open, and brought near that of the box, a small space only is left for the corn to pass into the box, the hopper forming the corn-store; *a* is the cover of the box raised on its hinges by the rod *f*, acted upon by the platform *e f*, fig. 64, and when in this position, the sheep put their heads below *a* at *c*, fig. 65, and eat the corn at *d*. Machines of similar construction have been devised to serve poultry with corn at will.* It is a safer receptacle for corn in the field than the open oil-cake trough, fig. 52, but the animals require to become familiarised with its use.

1065. Sheep may be fed on horse-chestnuts. In Switzerland, the chestnuts are bruised in a machine for the purpose, and 2 lbs. of them are given to each sheep, morning and evening, by little at a time, as they are of a heating nature. They impart a rich flavour to the mutton.

1066. It is necessary that I point out the diseases to which the animals, whose care falls under our notice, are liable, in the various seasons; but I shall not enter into the particulars of their treatment, leaving you to consult the works of accomplished veterinarians. The first disease which presents itself on sheep, in the low country in winter, is *purging*, occasioned by eating too heartily of the tops, when first confined on turnips. At first, the complaint is not alarming, and the physicking may do good ultimately; but should it increase, or continue beyond the existence of the exciting cause, it may pass into diarrhœa, causing prostration of strength, and at last terminate in dysentery. When the purging is moderate, the pain is inconsiderable: but when aggravated, the mucous membrane, which is the *seat* of the disease, acquires a tendency to inflammation, and griping and colicky pains are the consequence. The disease should not be thought lightly of, but speedily checked. When the green food, as in this case, is obviously at fault, the sheep should be removed to dry pasture until the symptoms disappear. One year, I remember, the white turnip tops grew so luxuriantly, that when Leicester hoggs were put on in October, they were very soon seized with purging, and the symptoms were much aggravated by alternate occurrences of rain and raw frost. The sheep were removed to a rough moory pasture, which had been reserved for the ewes; and, while there, I caused the field-workers to switch off the turnip-tops with sickles, and thus got rid of the cause of complaint. In a short time the hoggs were restored to the turnips, and throve apace; though the wool behind was much injured by the fæcal discharge. And this is one of the losses incurred by such a complaint; and at a season, too, when it would be improper to clip the soiled wool away, to the risk of making the sheep too bare below to lie with comfort upon the cold ground.

1067. Sheep are sometimes infested with a species of *louse*, which belongs to the same generic group as that of the horse, and is named the *Trichodectes sphærocephalus*, the *Pediculus ovis* of the older zoological writers. It is characterised by Mr Denny as having the head nearly orbicular, rough, and fringed with stiff hairs, and the third joint of the antennæ longest and clavate. Being one of the gnawing lice, it destroys the wool by cutting it near the root.

1068. This animal is perhaps induced to make its appearance by an increase of condition after a considerable period of poverty. It is seldom seen on Leicester sheep, because, perhaps, they are seldom in the state to induce it; but hill-sheep are not unfrequently infested by it, and when so, it is amazing what numbers of the vermin may be seen upon a single sheep, its powers of reproduction seeming prodigious. It lodges chiefly upon and below the neck, where it is most effectually destroyed by mercurial ointment, which should not, however, be applied, *in quantity*, in very cold or in very wet weather; and in these circumstances, tobacco-juice and spirit of tar may be safely used. Professor Dick says, that, in slight visitations of the louse, a single dressing of olive oil will cause its disappearance.

1069. The Ettrick Shepherd mentions a curious danger to which sheep affected with lice are liable, "the animal is in danger of being *bridled*. This is occasioned by the animal's bending its neck extremely to claw its throat with its teeth; on which occasions the teeth often fasten in the wool, so that it cannot disengage them, and it soon loses the power of its neck. I have known several die in this way."†

1070. A quart bottle of decoction of tobacco-leaf, containing a wine glass of spirit of tar, is a useful lotion, for many purposes, for a shepherd to have constantly in his possession; and it is easily poured out by a quill passed through the cork.

1071. Another disease to which sheep are subject on passing from a state of poverty to improved condition, is the *scab*, and hoggs are most susceptible of it. This disease indicates its existence by causing sheep to appear uneasy, and wander about without any apparent object; to draw out locks of wool with its mouth from the affected parts, as the disease increases; and, lastly, to rub its sides and buttocks against every

* *Prize Essay of the Highland and Agricultural Society*, vol. vii. p. 405.
† Hogg *On Sheep*, p. 100.

prominent object it can find, such as a stone, a tree, a gate-post, the nets, and such like. Mr Youatt says that it arises from an insect, a species of *acarus* ;* and mercurial ointment is a sure remedy ; a weak compound of 1 part of the ointment with 5 of lard for the first stage, and another, a stronger, of 1 part of ointment and 3 of lard, for an aggravated case. The ichorous matter from the pustules adheres to and dries upon the wool, and gets the name of *scurf*, which should first be washed off with soap and water before applying the ointment. The scab is a very infectious disease, the whole flock soon becoming contaminated ; but the infection seems to spread, not so much by direct contact, as by touching the objects the animals infected have rubbed against. Its direct effects are deterioration of condition, arising from a restlessness preventing the animal feeding, and loss of wool—large portions not only falling off, but the remainder of the broken fleece becoming almost valueless ; and its indirect effects are propagation of the disease constitutionally, and hence the loss to the owner in having a scabbed flock, for no one will purchase from one to breed from that is known to be, or to have been, affected by scab.

1072. The very existence of this disease is disgraceful to a shepherd—not being able to detect its existence at the earliest stage, and allowing it to make head amongst the flock. When it breaks out in a standing flock, it must have been latent in the sheep, or in the ground, when the shepherd took charge of the flock, and some shepherds have only the skill to suppress, not eradicate it ; but it is his duty to examine every sheep of his new charge, and every newly purchased one, before being allowed to mix with the hirsel, and also to make inquiry regarding the previous state of the ground.

1073. On soft ground sheep are affected with *foot-rot*, when on turnips. The first symptom is a slight lameness in one of the fore-feet, then in both, and at length the sheep is obliged to kneel down, and even creep upon its knees, to get to its food. The hoof, in every case, first becomes softened, when it grows mis-shaped, occasioning an undue pressure on a particular part ; this sets up inflammation, and causes a slight separation of the hoof from the coronet ; then ulcers are formed below where the hoof is worn away, and at length arrives a discharge of fetid matter. If neglected, the hoof will slough off, and the whole foot rot off—which would be a distressing termination with even only one sheep ; but the alarming thing is, that the whole flock may be similarly affected, and this circumstance has led to the belief that the disease is contagious.

1074. Much difference of opinion, however, exists among store-farmers and shepherds on this point, though the opinion of contagion preponderates. For my part, I never believed it to be so, and there never would have been such a belief at all, had the disease been confined to a few sheep at a time ; but though numbers are affected at one time, the fact can be explained from the circumstance of all the sheep being similarly situate ; and as it is the condition of the locality which is the cause of the disease, the wonder is that any escape the affection at all, rather than that so many are affected.

1075. The first treatment for cure is to wash the foot clean with soap and water, then pare away all superfluous hoof, dressing the diseased surface with some caustic, the butter of antimony being the best—the affected part being bound round with a rag, to prevent dirt getting into it again—and removing the sheep to harder ground, upon bare pasture, and there supplying them with sliced turnips. This cure indicates that the disease may have been prevented by carefully examining every hoof before putting the sheep upon the bare ground, and paring away all extraneous horn ; and should the turnips be upon soft moist ground, let them be entirely sliced, and let the sheep be confined upon a small break at a time, which will soon be trodden firm, and walking superseded. I may mention that sheep accustomed to hard ground, when brought upon soft, are most liable to foot-rot, and hence the necessity of frequent inspection of the hoof when sheep are on soft ground ; and if the farm has a large proportion of soft land, the shepherd should inspect a few sheep daily.

1076. Erysipelatous complaints occur in winter amongst sheep. "*Wildfire*, it is said," observes Professor Dick, "generally shows itself at the beginning of winter, and first attacks the breast and belly. The skin inflames and rises into blisters, containing a reddish fluid, which escapes and forms a dark scab. The animal sometimes fevers. Venesection (blood-letting) should be used, the skin should be washed with a solution of sugar of lead, or with lime-water, and physic given, such as salts and sulphur ; afterwards a few doses of nitre."†

1077. There is no circumstance upon which an argument could be more strongly founded in favour of arable land being attached to every hill-farm, for raising food for stormy weather, than the fatality of *braxy*. It affects young sheep of the Black-faced breed, which subsist upon the most elevated pasture. Indigestion is the primary cause, exciting constipation, which sets up acute inflammation of the bowels, and causes death. The indigestion is occasioned by a sudden change from succulent to dry food ; and the sudden change is impelled by the sudden appearance of snow concealing the green herbage the sheep were eating, obliging them to subsist upon the tops of old heather, and the dried twigs and leaves of the bushes that overtop the snow. By this account of the origin of the disease, it is obvious that were stells provided for shelter, and turnips for food, the braxy would never affect young hill-sheep.

1078. The Ettrick Shepherd thus describes its

* Youatt *On Sheep*, p. 53-8.

† Dick's *Manual of Veterinary Science*, p. 110.

symptoms:—"The loss of cud is the first token. As the distemper advances, the agony which the animal is suffering becomes more and more visible. When it stands, it brings all its four feet into the compass of a foot; and sometimes it continues to rise and lie down alternately every two or three minutes. The eyes are heavy and dull, and deeply expressive of its distress. The ears hang down, and, when more narrowly inspected, the mouth and tongue are dry and parched, and the white of the eye inflamed. . . . The belly is prodigiously swelled, even so much that it sometimes bursts. All the different apartments of the stomach are inflamed in some degree."* Violent inflammation succeeds, with a tendency to mortification and sinking, so that, after speedy death, the stench of the viscera, and even of the carcass, is intolerable. Its effects are so sudden, that a hogg apparently well in the evening will be found dead in the morning.

1079. Cure thus seems almost unavailable, and yet it may be effected, provided the symptoms are observed in time; when, if blood is drawn freely from any part of the body, as from nicks made across the under side of the tail, from the vein under the eye, and that behind the fore-arm, and a dose of salts administered in warm water, the animal will most probably recover.†

1080. But the grand object is *prevention* of the disease, by a timely supply of succulent food; and if turnips cannot be obtained, it may be worth the store-master's consideration whether oil-cake should not be provided, and given along with hay, during a storm. The laxative property of oil-cake is well established, and its carriage to the remotest hill-farm comparatively easy. Mr Fairbairn recommends the use of salt to young sheep, when shifted suddenly from fresh to dry food; and as a condiment it would prove beneficial, especially in the case of ruminants, as cattle and sheep, the structure of whose digestive organs renders them peculiarly susceptible of indigestion; and on this account it would be a valuable assistant to the more nutritious oil-cake. Instead of entirely acquiescing in the Ettrick Shepherd's recommendation "to pasture the young and old of the flocks all together,"—as has been done in Peeblesshire, to the eradication, it is said, of the braxy,—as being in many cases impracticable and attended with no profit, Mr Fairbairn suggests, "Let the pasture for a hirsel be as nearly as possible of one soil. To overlook this is a mighty error, and the surest means of making the flock unequal. The heath should also be regularly burned, and the sheep never allowed to pasture *long upon soft grass*," but put them on turnips, as "an infallible antidote against the progress of the malady," which he has "invariably found to give a settling stroke to the disease."‡

1081. The Ettrick Shepherd mentions the existence of 4 kinds of braxy, namely, the *bowel sickness*, the *sickness in the flesh and blood*, the *dry braxy*, and the *water braxy*, all originating in the cause above described, and of a class of diseases allied in their nature to hoven in cattle, and flatulent colic or batts in horses.

ON THE ACCOMMODATION AFFORDED TO CATTLE IN WINTER BY THE STEADING.

1082. On looking at the plan of the steading, Plate II., you will find that the cattle should occupy the following parts,—the courts, the hammels, and the byres.

1083. The courts are occupied by the young beasts, such as the calves of the year, and the year-olds.

1084. The hammels by the two-year-olds, or such as are fattening for the butcher.

1085. The byres are destined for the milk cows, the breeders of the calves; and in parts of the country, byres are also employed in the fattening of the cattle for the butcher: but where they are used, of course hammels are dispensed with. We shall, by-and-by, see whether byres or hammels are best suited for the fattening of cattle.

1086. Before any of these apartments can be occupied by their respective tenants, they should be liberally littered with straw. The first littering of the courts and hammels should be abundant, as a thin layer of straw makes an uncomfortable bed, whereas a thick one is not only comfortable in itself, but acts as a drain to the moisture in the heap of manure above it. More comfort to cattle is involved in this ordinary matter than most farmers seem to be aware of, but it is obvious that the first layer of litter, if thin, soon gets trampled down, and in rainy weather the soil below it as soon becomes poached—that is, saturated with wet and pierced into holes with the cattle's feet; so that any *small* quantity of litter afterwards laid upon this, will but absorb the moisture below it, and afford no *dry* lair to the cattle. A thick layer does not become poached even in wet weather, the feet cannot pierce through it, and, acting as a drain, the moisture is let pass and

* Hogg's *Shepherd's Guide*, p. 32.

† *The Mountain Shepherd's Manual*, p. 13.

‡ *A Lammermuir Farmer's Treatise on Sheep in High Districts*, p. 194.

kept below, and the bedding above remains comparatively dry.

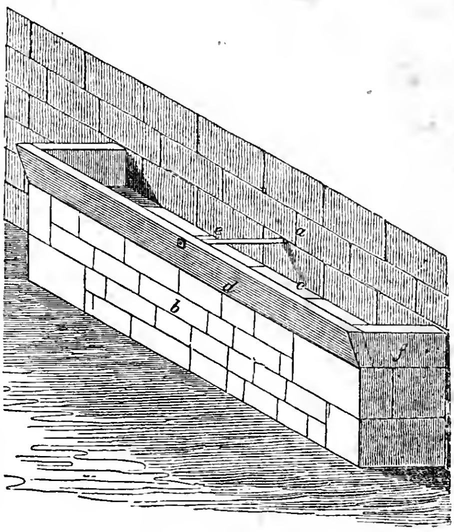
1087. Sometimes a deficiency of straw is experienced in the early part of winter, from various causes, amongst which may be mentioned a dislike in farmers to thrash a stack or two of the new crop in early winter, even when no old straw or old stack of corn is left from the former crop—and a ready excuse is found in the want of water or wind to move the thrashing machine; but however recently formed the stacks may be, and inconvenient to thrash their produce at the time, it should be done by some means rather than stint the cattle of bedding; for should bad weather immediately arrive, an event not unlikely to happen, the cattle may become so chilled in their ill-littered quarters, that a great part of the winter may elapse before they recover from its effects; and hence arise disease and serious reduction of profit.

1088. With even plenty of old stacks, a want of water to drive the thrashing-machine may really be experienced, and this is no uncommon occurrence in the beginning of winter on farms which depend upon surface-water only for their supply; and a windmill is in no better condition from want of wind. In case such contingencies *may* happen, it is the duty of the farmer to provide a sufficient quantity of litter in good time,—and there are various ways of doing this. Those who still use the flail may employ it at any season; and those having horse thrashing-mills are equally independent. Bog-land supplies coarse herbage, which should be made into hay in summer; but precaution is requisite in using turf as a bottoming for the litter of courts, as turf will become like a sponge full of water after the first fall of rain, and scarcely any quantity of straw will prevent the cattle rendering the bedding above it a poached mass. I once tried turf, after considering it well dried, but was glad to drive it out of the courts again. Ferns cut and won, as also dried grass and leaves from woods, form an excellent foundation for litter. By one or all of these means, a comfortable bed may be provided for the cattle at the commencement of the season, under the most unfavourable circumstances as regards the command of straw.

1089. The plan of the steading, Plate II., shows two courts for young cattle, one on each side of the straw-barn. It will be observed that the left-hand court is entirely closed in by itself, while the right-hand one has a causeyed road round two sides of it, which is the cart road to the corn-barn, and to one of the doors of the straw-barn. The cattle have liberty to walk on this road when they choose, but it should nevertheless be swept clean every day by the cattle-man. The left-hand court is occupied by the calves, and the other by the year-olds. They are both fitted up alike with turnip troughs along the walls, with a straw-rack which stands independently in the middle of the court, and with straw-racks along the walls of the sheds, which, in these cases, are placed under the granaries in the highest part or north range of the building.

1090. The *troughs for turnips* are placed against the walls, as in fig. 66, where *a* is

Fig. 66.

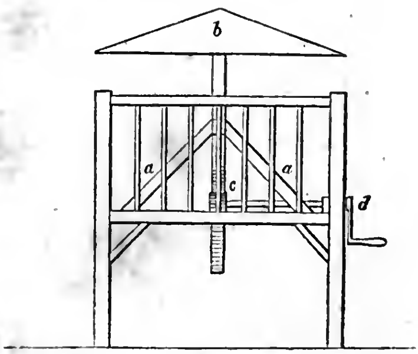


TURNIP TROUGH FOR COURTS.

the wall against which the trough is built, and *b* a building of stone and lime 2 feet thick, to support the bottom of the trough, of which the lime need not be used for more than 9 inches in the front and sides of the wall, and the remaining 15 inches may be filled up with any hard material; *c* is the flagging placed on the top of this wall, to form the bottom of the trough. Some board the bottom with wood; and, where wood is plentiful, it is cheap, and answers the purpose, and is pleasanter for the cattle in wet and frosty weather; but where flags can be easily procured, they are more durable: *d* is a plank 3 inches thick and 9 inches in depth to keep in the turnips. Oak planking from wrecks, and old spruce trees, however knotty, I have found a cheap and durable front for turnip troughs. The planks are spliced together at their ends, and held on edge by rods of iron *e* batted with lead into the wall, and with nut and screw in front. The height in front should not exceed 2 feet 9 inches for calves, and 3 feet for the other beasts, and it will become less as the straw daily accumulates. The trough, here shown short, may extend to any length along the side of a court.

1091. The *straw-racks for courts* are made of various forms. On farms of light soils, where straw is usually scarce, a rack of the form of fig. 67, will be found serviceable in preserving the straw from rain,

Fig. 67.

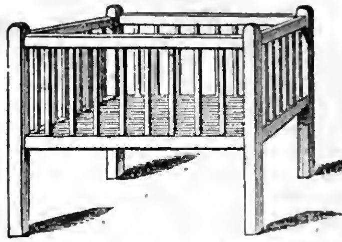


COVERED STRAW-RACK FOR COURTS.

where *a a* is the sparred bottom inclined upwards to keep the straw always forward to the front of the rack in reach of the cattle. The shank supporting the movable cover, *b*, which protects the straw from rain, passes through the apex of the bottom. The shank with its cover is moved up and down, when a supply of straw is given, by the action of a rack and pinion, *c*, worked by the handle *d*. The rack is made of wood, 5 feet square, and 5 feet in height to the top of the corner posts; and sparred all round the sides as well as the bottom, to keep in the straw.

1092. A more common kind of rack is in fig. 68, of a square form, sparred round the sides and bottom to keep in the straw. The cattle draw the straw through the spars

Fig. 68.

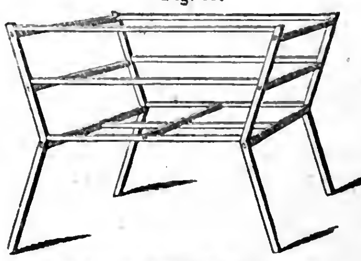


WOODEN STRAW-RACK FOR COURTS.

as long as its top is too high for them to reach over it, but after the dung accumulates, and the rack thereby becomes low, the cattle get at the straw over the top. It is made of wood, 5 feet square and 4 feet in height. This, and the rack above, may be pulled up higher when the dung accumulates much.

1093. Fig. 69 is a rack of malleable iron to supply the straw always over its top,

Fig. 69.



IRON STRAW-RACK FOR COURTS.

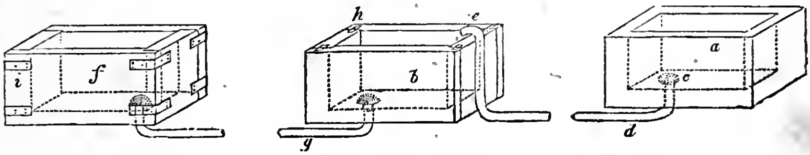
and is rodded in the sides to keep in the straw. It remains constantly on the ground, and is not drawn up as the dung accumulates, as in the case of the racks described. It is $5\frac{1}{2}$ feet in length, $4\frac{1}{2}$ in breadth, and $4\frac{1}{2}$ in height; the upper rails and legs are of 1 inch square iron, and the other rails $\frac{3}{4}$ inch. This is, of course, the most durable straw-rack.

1094. Few things indicate greater care for cattle than the providing of *stored turnips* for their use; such being not only convenient, but the best mode of keeping them clean and fresh. The sites of the turnip stores may be seen both in the isometrical view, Plate I. and in the plan, Plate II. They should be made of stone and lime 8 feet by 5 inside, and 6 feet in height, with an opening in front, 2 feet and upwards from the ground, for putting in and taking out the turnips; or they may be of wood, where it is cheap. They may either be covered or straw used to protect the turnips from frost. They should be placed near the cattle, and be easy of access to carts from the roads.

1095. The supply of *water* to all the courts is of paramount consideration. The troughs may be supplied with water either directly from pump-wells, or by pipes from a fountain at a little distance, the former being the most common plan. As a pump cannot conveniently be placed at each trough, I have found a plan of supplying any number of troughs from one pump, to answer well, provided the surface of the ground will allow the troughs being placed *nearly* on the same level. One plan is to connect the bottoms of any two or more troughs on the same level, with lead pipes placed under ground; and on the first trough being supplied direct from the pump, the water will flow to the same level throughout all the other troughs. This particular arrangement is subject to this objection, that when any one of the troughs is emptying by drinking, the water is drawn off from the rest of the troughs, to maintain its level throughout the whole.

1096. Were the trough which receives the water placed a few inches *below* the top of the one supplying it, and a lead pipe to come from the bottom of the supply trough over the top of the edge of the receiving one, the water might entirely be emptied, by drinking, without affecting the quantity in any of the others. Let *a*, fig. 70, be the supply trough immediately beside the pump; let *b* be the trough in

Fig. 70.



WATER-TROUGHS.

any other court to be supplied with water from *a*, and let it be 3 inches below the level of *a*. Let a lead pipe, *d*, be fastened to the bottom of *a*, the orifice looking upwards, and protected by the hemispherical drainer, *c*. Let the lead pipe, *d*, be passed under ground to the trough *b*, and emerge from the ground by the side of and over the top of *b* at *e*. When *a* is filling with water from the pump, the moment the water rises in *a* to the level of the end of the end of the pipe at *e*, it will commence to flow into *b*, and will continue to do so until *b* is filled, if the pumping be continued. The water in *a*, *below* the level of the end of the pipe at *e*, may be used in *a* without affecting *b*, and the water in *b* may be entirely used without affecting *a*.

1097. Water-troughs may be made of various materials; *a* is hewn out of a solid block of free-stone, which makes the closest, most durable, and best trough.

1098. If of flag stones, as *b*, the sides are sunk into the edges of the bottom in grooves luted with white lead, and held together with iron clamps, *h*, at the corners. This makes a good trough, but is apt to leak at the joints.

1099. Trough *f* is made of wood dovetailed at the corners, which are held together by clamps of iron, *i*. When made of good timber, and painted, they last many years.

1100. Water-troughs are sometimes supplied from a large cistern, somewhat elevated above their level, and filled from a well with a common or force-pump. In this case a cock, or ball-and-cock, are required at each trough: if a cock, the supply must depend on the cock being turned in due time; and if a ball-and-cock, the supply depends on the cistern always having water in it: but this method is expensive, and liable to go out of order.

1101. In an abundant supply of water from natural springs, accessible without the means of a pump, lead-pipes may be made to emit a constant stream of water into each trough, and the surplus conveyed away in drains to the horse-pond, or to any other useful purpose.

1102. Still another mode may be adopted where the supply of water is plentiful, and it flows constantly into a supply-cistern. Let the supply-cistern be 2 feet in length, 1 foot wide, and 18 inches in depth, provided with a ball-and-cock, and let a pipe proceed from its bottom to a trough of dimensions fit for the use of cattle, into which let the pipe enter by the end or side a little way, say 3 inches, below the mouth of the trough. Let a pipe proceed from this trough, as from the lower bend of the pipe *e*, at the bottom of the trough *b*, fig. 70, into the end of another trough, and so on, from trough to trough, into the ends of as many succeeding troughs, on the same level, as are required, and the water will rise in each as high as the mouth of the pipe, and which, when withdrawn by drinking from any one trough, the ball-and-cock will replenish it direct from the supply-cistern; but the objection to the ball-and-cock applies as strongly in this as in the other case, although economy of pipe attends this method.

1103. The sheds attached to large cattle courts are usually provided with more than one opening or door, with the view of allowing a timid animal to escape by one door while chased by another. But, in my opinion, the comfort of the cattle is more secured with only one entrance, inasmuch as every draught of air is prevented; and although the object of two entrances is laudable in affording a means of escape to a beast that may be ill-used by the rest, the advantage to one is dearly bought at the sacrifice of comfort to the others; and, after all, it is doubtful whether the contingency thus dreaded can be avoided in any way, unless from the probability of general agreement after a common use of the same apartment for some time. Cattle bought promiscuously from different quarters, and put together, are much less likely to agree in the same court than those brought up together from calfhood. However brought together, there should not exceed 20 beasts kept together in a court.

1104. Hammels are fitted up with turnip troughs in the same manner as the courts, though the straw-racks are always fastened in the corners or against the walls in the sheds, and never placed in the small courts.

1105. Hammels consist of a shed, and an open court, communicating by a large opening. The shed part need not be so wide as the rest of the apartments in the farmstead, in as far as the comfort of the animals is concerned; and in making it narrower, considerable saving is effected in the cost of the roofing.

1106. There is no definite rule for the *size* of hammels; but as their advantage consists in assorting the cattle according to their age, temper, size, and condition, and in giving them liberty in the fresh air, they should not only be much smaller than courts, but only contain 2 large oxen, or 3 small ones. Hammels, however, are often made much larger than this. When the dung is proposed to be taken away by horse and cart from the courts, these should not be less than 30 feet in length by 18 feet in breadth, and the entrance gate 9 feet in width; and this size will easily accommodate 4 oxen, which will each attain the dead-weight of 70 stones imperial. But the dung may be taken out with barrows, and a court 15 feet in length by 12 feet in width, free of the turnip trough, will accommodate 2 such oxen as these.

1107. The sheds to both these sizes of courts need not exceed 14 feet in width, and their length is equal to the width of the courts.

1108. To give permanency to hammels, the sheds should be roofed like the other buildings, though to save expense many farmers roof them with small trees placed close together upon the walls of the sheds, and build thereon straw, corn, or beans.

This is an excellent place for a stack of beans or pease; but the finished building is the best adapted for its own purpose. Temporary erections are constantly requiring repairs, and in the end cost as much as substantial work.

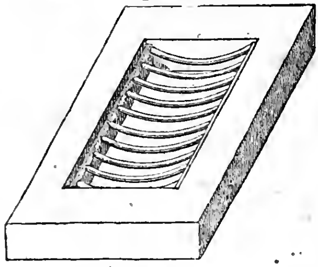
1109. The door of the shed, 5 feet in width, should be at one side and not in the middle of the hammel, to afford the more room and warmth to the interior. The corners of the scuncheon should be champered off, to save the cattle being injured against sharp angles.

1110. The divisions betwixt the respective courts should be of stone and lime walls, 1 foot in thickness, and 6 feet in height. Those within the sheds should be carried up quite close to the roof, but more frequently they are only carried up to the first balk of the couples, over which a draught of air is generated from shed to shed, much to the discomfort of the animals.

1111. I prefer hammels to large courts, even for the younger beasts, because the heifers might be separated from the steers, and each class subdivided to suit colour, strength, age, temper, or any other point in which a few agree, and differ from the rest, and it is surprising how much better the same animals look when well assorted.

1112. Neither courts nor hammels are completely furnished for the comfort of their tenants unless provided with well-built drains to convey away the surplus liquid manure, when there happens to be any excess of it. For this purpose a *drain* should enter into each of the large courts, and one across the middle of each set of hammels. The ground of every court should be so laid off as to make the lowest part of the court at the place where the drain commences or passes; and such lowest point should be furnished with a strong block of hewn freestone, into which is sunk flush an iron grating, having the qars only au inch asunder, to prevent the passage of straws into the drain. Fig. 71 gives an idea of such a grating, made of malleable iron, to bear rough usage, such as the wheel of a cart passing over it; the bars being placed across, with a curve

Fig. 71.

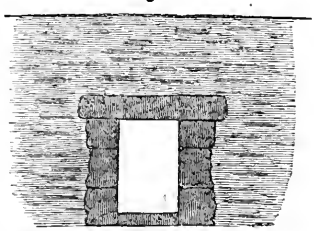


DRAIN GRATING FOR COURTS.

downwards, to keep them clear of obstructions for the water to pass through them. A writer, in speaking of such gratings, recommends "they should be strong, and have the ribs well bent *upwards*, as in that form they are not so liable to be choked up;" * a remark quite correct in regard to the form of gratings for the sewers of towns, as with the ribs bent *downwards* in such a place, the accumulated stuff brought upon them would soon prevent the water getting down into the drains; but the case is quite different in courts where the straw, covering the gratings, lies loosely over the ribs bent downwards, and acts *as a drainer;* but were it to be pressed against the ribs bent upwards, the water could not percolate through it. Any one who has seen the straw of dunghills pressed hard against a raised stone in the ground below it, will easily understand the effect. The positions of these gratings are indicated in the plan, Plate II.

1113. Liquid manure drains should be built with stone and lime walls, 9 inches high and 6 inches asunder, flagged smoothly in the bottom, and covered with single stones. Fig. 72 shows the form of this sort of drain, and sufficiently explains its struc-

Fig. 72.



LIQUID-MANURE DRAIN.

* *Prize Essays of the Highland and Agricultural Society,* vol. viii. p. 375.

ture. As liquid manure is sluggish in its motion, the drains require a much greater fall in their course than rain-water drains. They should also run in direct lines, and have as few turnings as possible in their passage to the *tank*, which should be situate in the lowest part of the ground, not far from the steading, and out of the way. The advantage of these drains being made straight is, that, should they choke up at any time, a large quantity of water poured into them would clear the obstruction away. The direction of these drains may be seen in the plan, Plate. II., towards the tank. It might be possible to have a tank to each set of hammels and courts, to collect the liquid manure from each separately; but such a multiplicity of tanks would be attended with much expense at first, and inconvenience at all times. Were the practice adopted of spreading the liquid manure on the field at once, as is done by the Flemish farmers, a tank in every court would be convenient.

1114. The *liquid manure tank* should be built of stone or brick and lime. Its form may be either round, rectangular, or irregular, and it may be arched, covered with wood, left open, or placed under a slated or thatched roof; the arch forming the most complete roof, the rectangular form should be chosen. I have found a tank of an area of only 100 square feet, and a depth of 4 feet below the bottom of the drains, contain a large proportion of the whole liquid manure collected during the winter, from courts and hammels well littered with straw, in a steading, for 300 acres, well provided with rain-water spouts. The position of the tank may be seen in the plan, Plate II. It is rectangular, and might be roofed with an arch.

1115. A *cast-iron pump* should be affixed to one end of the tank, the spout of which should be as elevated as to allow the liquid to run into the bung-hole of a large barrel placed on the framing of a cart, or over a series of compost dunghills. I have lately seen an iron pump which raised water by means of a series of screw-fans, made of metal, such as are used in the screw-propellers of ships, and which, being simple in construction, and not liable to be put out of working order, would answer well for pumping so thick and viscid liquid as liquid manure.

1116. It is clear that if all the rain that falls upon the roof of the steading gets leave to make its way into the courts and hammels occupied by the cattle, that it will pass through the manure as rapidly, and in as large a quantity, as the rain happens to fall copiously or otherwise; and that, in its way through the manure to the drains which convey it to the liquid-manure tank, it will dissolve a large proportion of the soluble part of the manure, and in so far deteriorate the quality of the dunghill. The liquid manure thus conveyed to the tank will, therefore, largely consist of rain water; and when it is carried from the tank to the fields, or spread over the compost heaps, there will be carried or spread as much of rain-water. Now, of what utility is it to the field or the compost heap in incurring the expense and trouble of moving about so much rain-water? Would it not be a more sensible proceeding to prevent the rain-water entering the courts, and only bestow the trouble of carrying or spreading the pure liquid-manure which shall flow from the dunghills, when the straw is unable to absorb and retain any more of it? No doubt it would; and yet I believe the largest proportion of the liquid manure one hears being collected in the tanks, consists only of rain-water, excepting in the case of dairy farms, where the cows are supplied largely with succulent food in the byres, and with very little litter.

1117. For the purpose of getting rid of the rain water, the eaves of the roofs of the houses which surround the courts should be provided with *rain-water spouts*, not only to take it from the roofs, but to pour it into drains to be carried to a ditch at a distance from the farmstead.

1118. As to the rain from the other parts of the roofs, *drains* should be formed along the bottom of every wall not immediately surrounding the courts. The drains should be dug 6 inches below the foundation-stones of the walls, conduited with a main pipe-tile, and the drain filled to the surface of the ground with broken stones. The broken stones will receive the rain dropping from the roofs, and the pipe-tile conduit will carry it away; and should the stones ever become hardened on the surface, or grown over with grass, the grass might be easily removed, and the stones loosened by the action of the hand-pick.

1119. Rain water-spouts are made of wood, cast-iron, lead, or zinc, the last being quite durable, very light, and cheapest in the end, and are fastened to the wall by iron holdfasts. The direction of the rain-water drains may be traced along the dotted lines, accompanied by arrows, in the plan Plate II.

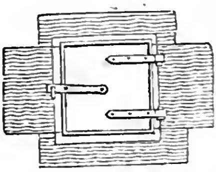
1120. The cow-house or byre is occupied by the cows, and in some districts by the fattening oxen also, and is fitted up in a peculiar manner. The cows stand in stalls: the stalls, to be easy for the cows to lie down and rise up, in my opinion, for a large kind of cattle should never be less than 5 feet in width. Four feet is a more common width, but is too narrow for a large cow, and even 7 feet is considered in the dairy districts a fair-sized double stall for two cows. My opinion is, that every cow should have a stall for her own use, lying, standing, or eating her food, of sufficient length and breadth that she may lie at ease betwixt the manger and the gutter. The width of the byre should be 18 feet; the manger 2 feet in width, the length of a large cow about 8 feet, the gutter 1 foot broad, leaves 7 feet behind the gutter for a passage for containing the different vessels used in milking the cows and feeding the calves. The ceiling should be quite open to the slates, and a ventilator for every four or five cows in the roof, for regulating the temperature and supplying the byre with fresh air. A door, divided into upper and lower halves, should open outwards to the court on a giblet-check, for the easy passage of the cows to and from the court, and each half fastened on the inside with a hand-bar. Two windows with glass panes, with the lower parts furnished with shutters to open, will give sufficient light, as also air, with the half-door. The walls should be plastered for comfort and cleanliness.

1121. The *stalls* are most comfortably made of wood, though some recommend stone, which always feels hard and cold. Their height should be 3 feet, and length no farther than to reach the flank of the cow, or about 6 feet from the wall. When of wood, a strong hard-wood hind-post is sunk into the ground, and built in masonry. Between this post and the manger should be laid a curb-stone, grooved on the upper edge to let in the ends of the travis boards. The deals are held in their places at the upper ends by means of a hard-wood rail, grooved on the under side, into which the edge of the deals are let; and the rail is fixed to the back of the hind-post at one end, and let into the wall at the other, and there fastened with iron holdfasts. Stone travises are no doubt more durable, and in the end perhaps more economical, where flag-stones are plentiful; but I would in all cases prefer wood, as feeling warmer, being more dry in damp weather, and less liable to injure the cows coming against them, and within doors will last a long time. The plan of the byres may be seen in Plate II.

1122. The *mangers* of byres are usually placed on a level with the floor, with a curb-stone in front to keep in the food, and paved in the bottom. Such a position I conceive highly objectionable, as, on breaking the turnips, the head of the animal is so depressed that an undue weight is thrown upon the fore-legs, and an injurious strain induced on the muscles of the lower jaw. A better manger is made of flag-stones or wood, resting on a building of stone and mortar, raised about 20 inches from the ground, and a plank set on edge in front to keep in the food. This front should be secured in its position with iron rods batted into the wall at one end, and the other end passed through the plank to a shoulder, which is pressed hard by means of a nut and screw. Out of such a manger the cow will eat with ease any kind of food, whether whole or cut; and all feeding-byres for oxen should be fitted up with mangers of this construction. Mangers are generally made too narrow for cattle with horns, and the consequence is the rubbing away of the points of the horns against the wall.

1123. The *supply of green food* to cattle in byres may be effected from the outside through holes in the wall at the back of the manger. This is a convenient mode for the cattle-man, but is costly in the outfit, and allows the wind to blow forcibly upon the heads of the cows. Fig. 73 is a door shut in the opening of the wall on the outside. I prefer giving the food by the stall, when it is 5 feet wide, and no cold air can come upon the cows. But when the stalls are narrow, a passage of $2\frac{1}{2}$ feet in width, betwixt the stalls and the wall, would allow the cattle-man to supply turnips and fodder. In such a case, the space behind the cows is reduced to $4\frac{1}{2}$ feet in width.

Fig. 73.



DOOR THROUGH WHICH TO SUPPLY MANGERS WITH TURNIPS.

1124. A wide single stall is not only useful in supplying the food from within the byre, but admits of the cows being more easily and conveniently milked. A double stall is objectionable for several reasons: a cow is a capricious creature, and not always friendly to her neighbour, and one of them in a double stall must be bound to the stake on the same side as she is milked from; and, to avoid the inconvenience, the dairy-maid either puts the cow aside nearer her neighbour, in the same stall—which may prove unpleasant to both parties—or the cow in the adjoining stall nearer *her* neighbour, which may prove equally inconvenient. Neither is it a matter of indifference to the cow from which side she is milked, for many will not let down their milk if the milkmaid sits down to the unaccustomed side. The best plan in all respects is, for each cow to have a roomy stall to herself.

1125. The *floor* of byres should be paved with rectangular stones, excepting the gutter, which should be broader than an ordinary square-mouthed shovel, and flagged at the bottom, to form a trough with two curb-stones, and it is then quickly cleaned out. A similarly formed gutter, though of smaller dimensions, should run from the main one through the wall into a liquid manure drain. The causewaying of the stalls should extend only a very little farther than the hind-posts, because cattle, in lying down and rising up, first kneel upon their fore-knees, which would be injured if pressed against any hard substance like stones, and which would be the case if the causeway was not always covered with litter. I remember of a valuable short-horn cow, in Ireland, getting injured in the knees from this cause: they swelled so much, and continued so long in a tender state, that she would not lie down at all; and all the while her owner was not aware of the cause until I suggested it; and on removal of the pavement, and substitution of beaten mould, and proper treatment of the parts affected, she recovered and continued well.

1126. A most excellent pavement has of late years been made by the Kamtulicon Company in London, of caouchouc or India rubber and sand, which possesses all the firmness of boards and the softness of India rubber, and is impervious to dampness from below, and unaffected by wet upon its surface. It forms a very suitable paving for the inner half of the stalls of byres, or the stalls of stables. It is to be regretted that so valuable an article is so dear. It was sold two years ago at 9s. per square yard of one inch in thickness, it then rose to 11s., and to 21s., owing, it is said, to the scarcity of the gum, which costs 6d. per lb. in the crude state. It is now 14s. Still, at the dearest cost, I would fit up every byre I had with it.

1127. The India rubber pavement is always laid upon hard concrete, and its durability depends upon the degree of perfection in which the basis has been formed. The concrete consists of putting together, for every bushel of good lime-shells, $2\frac{1}{2}$ bushels of *sharp* sand, and 4 bushels of gravel, and mixing them with as much water as to form a paste of the consistency of lime mortar, and which will then have a bulk of 8 bushels of concrete.

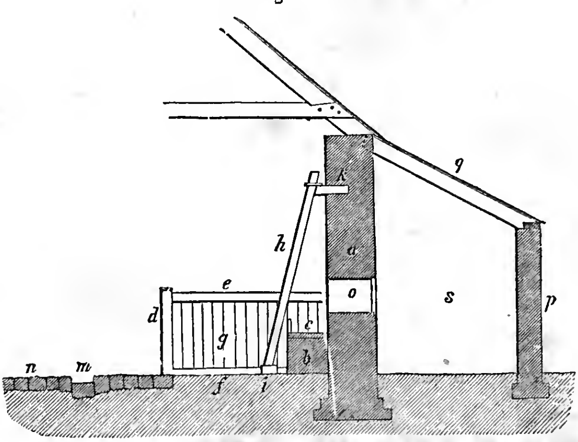
1128. A ground work to place the concrete upon is formed in this manner; Let the earth be removed to the depth of 12 inches, and its place occupied with small broken stones, well beaten down and compacted together, leaving room above them for at least 2 inches of concrete, and for the thickness of the India rubber pavement to lie above it. The concrete is spread upon the surface of the broken stones firmly, and finished with a smooth surface. Two or three days will be required to render the concrete hard enough for use, according to the state of the weather; but it must not be used until it has become very hard.

1129. The pavement is formed in slabs of about 7 feet long, and 18 inches in width, of two thicknesses, one inch and half an inch. The half-inch is too thin for the purpose of pavement for grown cattle to stand upon: perhaps three-quarters of an inch would suffice, but I would prefer the inch-thick in all cases. The pavement is easily cut into pieces of any size with a chisel and hammer. The pieces are laid flat upon the hardened concrete, and one piece is joined by the edge to another, by using a solution of the caoutchouc in naptha, which, being like a thin jelly, is easily spread with a broad knife upon the edges of the pieces of the pavement; and, on these being brought together after a while, the spirituous naptha evaporates, and leaves the gum as a firm cement in the joinings; and after the solution has become firm, the pavement is fit for use.

1130. Fig. 74, is a section of a *travis and manger of a byre*, as just described, where *a* is the wall, *b* the building which supports the manger *c*, having a front of wood, and bottomed with either flags or wood; *d* the hard-wood hind-post, sunk into the ground, and built in with stones and mortar; *e* the hard-wood top-rail, secured behind the post *d*, and let into and fixed in the wall *a* with iron holdfasts; *f* the stone curb-stone, into which the ends of the travis-boards are let; *g* the travis-boards let endways into the curb-stone below, and into the top-rail above, by a groove in each; *h* a hard-wood stake, to which the cattle are fastened by binders, the lower end of which is let into a hole in the block of stone *i*, and the upper fastened by a strap of iron to a block of wood *k*, built into the wall *a*; *m* is the gutter for the dung, having a bottom of flag-stones, and sides of curb-stones; *n* the paved floor; *o* the opening through the wall *a* by which the food is supplied into the manger *c* to the cattle, from the shed *s* behind. This shed is 8 feet wide, *p* being the pillars, 6 feet in height, which support its roof *q*, which is a continuation of the slating of the byre roof, the wall *a* of which is 9 feet high. But where these small doors are not used, the shed *s*, pillars *p*, and roof *q*, are not required, but they might form a convenient turnip-store, to which access might be obtained from the byre by a back door.

1131. Cows are bound to a stake in the stall by means of a ligature which goes round the neck behind the horns. One method of binding is with the *baikie*, which is made of a piece of hard-wood, *e* fig. 75, standing upright, and flat to the

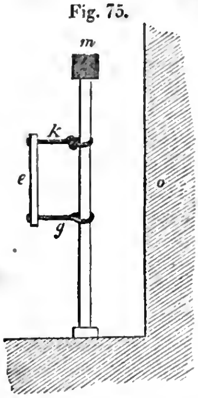
Fig. 74.



BYRE TRAVIS, MANGER, AND STAKE.

neck of the cow. A rope *g* fastens the lower end of it to the stake, upon which it slides up and down by means of a loop which the rope forms round the stake. This rope passes *under* the neck of the animal, and is never loosened. Another rope *k* is fastened at the upper end of the piece of wood *e*, and, passing *over* the neck of the animal, and round the stake, is made fast to itself by a knot and eye, and serves the purpose of fastening and loosening the animal. The neck, being embraced between the two ropes, moves up and down, carrying the baikie along with it. This method of binding, though quite easy to the animals themselves, is objectionable in preventing them turning their heads round to lick their bodies; and, the stake being in a perpendicular position, the animals can only move their heads up and down, and are obliged to hold them always over the mangers.

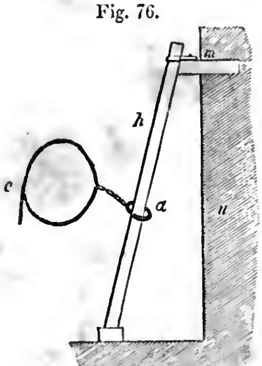
Fig. 75.



A BAIKIE.

1132. A much better mode of binding cattle is with the *seal*, which consists of an iron chain, fig. 76, where *a* is the large ring of the binder, which slides up and down the stake *h*, which is here shown in the same position as is *h* in the section of the stall in fig. 74. The iron chain, being put round the neck of the cow, is fastened together by a broad-tongued hook at *c*, which is put into any link of the chain that forms the gauge of the neck, and it cannot come out until turned on purpose edgeways to the link of which it has a hold. This sort of binder is in general use in the midland and northern counties of Scotland. It is the most durable form of binder, and gives the animal liberty, not only to lick itself, but to turn its head in any direction it pleases; and the inclination of the stakes gives the animal the farther liberty of lying down or standing back quite free of the manger.

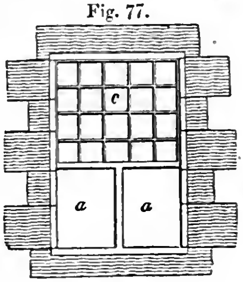
Fig. 76.



CATTLE SEAL OR BINDER.

1133. A convenient form of *window* is essential to the comfort of a byre. It consists of two shutters, *a a*, fig. 77, 2 feet in height, which open by cross-tailed hinges, and are kept shut with thumb-latches. The window-frame is made of wood, and glazed with four rows of panes, $2\frac{1}{2}$ feet in height, and 5 in number to the width—the opening of the window being $4\frac{1}{2}$ feet in height and 3 feet in width. Such a form of window admits of much light and air.

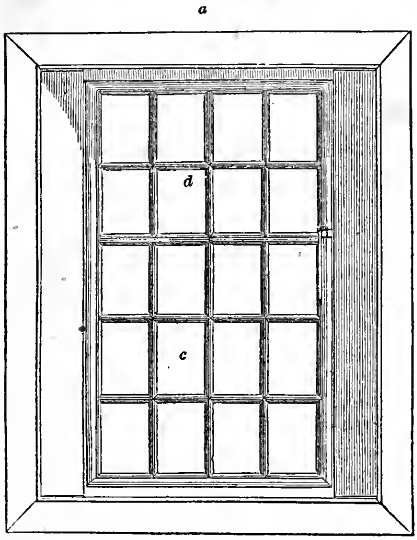
Fig. 77.



BYRE WINDOW.

1134. A good description of window for cottages and offices was made by Messrs M'Culloch and Co., Gallowgate, Glasgow, and for which they received a premium from the Highland and Agricultural Society. "This window is extremely simple in its construction, and may with safety be pronounced efficient in point of comfort and utility; while the price, it is believed, will not be higher than the cheapest description of iron windows now in use, and, for durability, will be preferable to those of any other material. The dimensions that have been recommended for the windows of ordinary cottages are, 39 inches for the height, and 24 inches for the width, within the wooden frames. The size of glass required for these frames is $7\frac{1}{4}$ by $5\frac{1}{4}$ inches. The sash is divided into 2 unequal parts, the lower part having 3 squares in height, and the upper part 2. The lower part is permanently fixed, while the upper part is constructed to turn in the vertical direction on pivots, which are situate in the line of its middle astragal; and both parts are set in a substantial wooden frame, which may either be built in while the wall is erecting, or set in afterwards in the ordinary way, with or without checked rebats, according to the taste of the proprietor. The window and its arrangements will be better understood by reference to the annexed cuts, fig. 78 showing an inside elevation, fig. 79 a vertical section, and fig. 80 a plan, in each of which a portion of the wall is

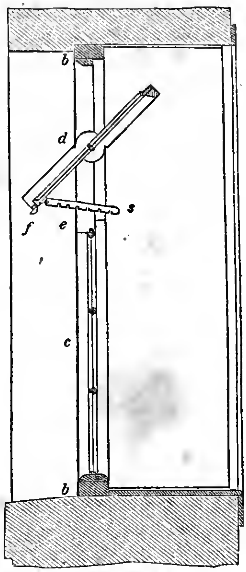
Fig. 78.



THE ELEVATION OF AN IMPROVED WINDOW FOR LIGHT AND AIR.

exhibited, and the same letters refer to the corresponding parts of each figure; *a* is a portion of the surrounding wall, *b* the wooden frame of the window, *c* the lower sash, which is dormant, and *d* the upper and movable sash. In fig. 79, the upper sash is represented as open for ventilation. When shut, the parts of the opening sash cover and overlap the fixed parts in such a manner as to exclude wind and water; but when ventilation is required, the arrangement of the parts which produce this is such as to enable the admission of air to any extent. For this purpose the notched latch *e* is jointed to a stud in the edge of the sash; a simple iron pin or stud is also fixed in the wooden frame at *s*, and, the notches of the latch being made to fall upon this stud at any required distance, the requisite degree of opening is secured; and when the sash is again closed, the latch falls down parallel with, and close to, the sash. To secure the sashes when shut, the T bolt *f*, in the middle of the meeting bars, has only to be turned a quarter round, and the movable sash is held fast in close contact with the other.

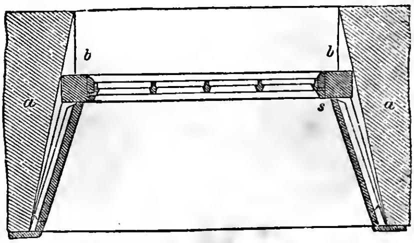
Fig. 79.



THE VERTICAL SECTION OF AN IMPROVED WINDOW FOR LIGHT AND AIR.

Fig. 78 represents the windows as finished with simple dressings, namely, plain deal shutters, facings, and sole, which, at a small expense, would give an air of neatness and comfort, and promote a corresponding taste in the other parts of a cottage. Though the dimensions of the window here stated may be conceived sufficient for lighting an apartment of ordinary size in a cottage, they can, nevertheless, be varied to suit every purpose in offices and elsewhere. This may be done either by employing two such windows, as above described, with a mullion of wood or of stone between them, or the single window may be enlarged by 1 or 2 squares in width, or in height, or in both directions."*

Fig. 80.



THE PLAN FOR AN IMPROVED WINDOW FOR LIGHT AND AIR.

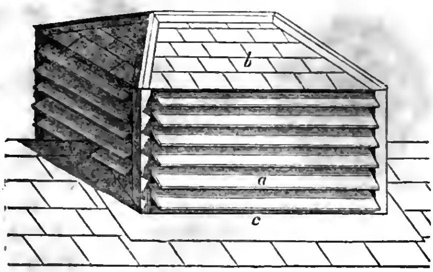
* *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 538-41.

1135. It is proper to mention that zinc, in the opinion of tradesmen, is too weak for window-sashes to admit of repair by an unpractised hand. Wood and lead are, for the same reasons, equally unsuitable. Malleable iron, even so thin as to impede the light but little, if the astragals are not provided with flanges for the glass to rest against, the repair must also be a work of some difficulty, and is also deemed unfit for the purpose. Cast-iron, therefore, appears to be the material least liable to objection; but astragals of cast-iron must be of considerable thickness, and such frames, consequently, could not be adapted to a very small size of glass, without materially obscuring the light. The iron sashes, as shown above, without the wooden frames, cost 5s., and glass for such windows may be purchased at 2¾d. per square.

1136. It greatly promotes the comfort and health of animals confined for many hours every day in one apartment to have the fresh air admitted to them without the creation of draughts, and no means of obtaining this object is so much in our power, as placing *ventilators* in the roof of the part of the steading so occupied by the animals.

1137. Fig 81 is a *ventilator*, in which the Venetian blinds *a* are fixed, and answer

Fig. 81.



A VENTILATOR.

the double purpose of permitting the escape of heated air and effluvia, and of preventing the entrance of rain or snow. The blinds are covered and protected by the roof *b*, made of slates and lead; *c* is an apron of lead. Such a ventilator would be more ornamental to the steading than fig. 81 is, and more protective to the blinds, if its roof projected 12 inches over. One ventilator 6 feet in length, 3 feet in height in front, and 2 feet above the ridging of the roof, for every six horses or cows, might suffice to maintain a complete ventilation. But such openings in the roof will not of themselves constitute ventilation, unless an adequate supply of fresh air is admitted below; and the supply might be obtained from small openings in the walls, including the chinks of doors and windows when shut, whose gross areas should be nearly equal to those of the ventilators. The openings should be in such situations and numbers as to cause no draught of air upon the animals; and might be conveniently placed, protected by iron gratings on the outside to prevent the entrance of vermin, in the wall behind the animals, of such a form as to deflect the air upwards against a plate of iron, to spread it about as much as possible. Other forms of ventilators are in use, consisting of a piece of large lead pipe projected through the roof and bent downwards; or simply a few of the slates or tiles raised up a little, either of which is better than no ventilator at all, but neither so effectual for the purpose of ventilation as the one I have described.

1138. The construction of byres for the accommodation of *fattening oxen* and *milk cows* is quite the same, but feeding byres are usually made much too small for the number of oxen confined in them. When stalls are put up, they seldom exceed 4 feet in width; more frequently two oxen are put into a double stall of 7 feet, and not unfrequently travises are dispensed with altogether, and simply a triangular piece of boarding placed across the manger against the wall, to divide the food betwixt each pair of oxen. In double stalls, and where no stalls are used, even small oxen, as they increase in size, cannot all lie down at one time to chew their cud and rest; and as they require more room and rest the fatter they become, the larger the oxen become they are hampered the more. In such confined byres, the gutter is placed too near the heels of the oxen, and prevents them standing back when they desire. Short stalls, it is true, save the litter being dirtied, by the dung dropping from the cattle directly into the gutter, and the arrangement saves the cattle-man trouble; but the saving of the litter in such a case is at the sacrifice of comfort to the animals.

1139. Such arrangements for economy

are legitimate considerations for cowkeepers in towns, where both space and litter are valuable; but when they induce to the construction of inconvenient byres in farmsteads, they indicate parsimony in the landlord and ignorance in the architect; and every farmer who consults the well-being of his animals should never sanction such a plan. The truth is, the erection of confined structures is one of the many evils arising from being unacquainted with agriculture by those who sanction them, because they save a little outlay at first. Expenditure is a tangible object; but, in stinting the requisite accommodation in the farmstead, proprietors injure their own interests, for it has a considerable influence on the mind of the farmer when valuing the rent of the farm he wishes to occupy. Should you have occasion to fit up a byre for milk cows or feeding oxen, bear in mind that a small sum withheld at first, may cause a yearly loss of greater amount, by preventing the feeding cattle attaining the perfection which a comfortable lodging would promote, or the cows bearing the stout and healthy calves, which ample room would promote the growth of.

1140. The several apartments being thus prepared for the reception of all the sorts of cattle to be accommodated in the steading in winter, let us now dispose of all the cattle into their respective apartments; and for this purpose look at the plan of the steading, Plate II. The different classes of cattle are cows, calves of the year, one-year-olds, two-year-olds, bulls, heifers in calf, and extra cattle.

1141. *Cows* occupy the byre Q. Each should always occupy the stall she has been accustomed to, and will then go out and come into its own stall without interfering with any other. Cows thus learn to stand quietly in their stalls to the cattle-man who feeds them, and the dairy-maid who milks them. The byre is furnished with a court *l*, water-trough *w*, and liquid manure-drain *x*; the turnip store is at *f*.

1142. The *servants' cows* are accommodated in the byre Y, in the same range of building as the hammels N, fitted up in the same manner as the byre Q, and having a court *v*, water-trough *w*, and liquid-manure drain *x*. This byre has no turnip store, as the servants supply their own turnips.

1143. The *calves of the year* occupy the large court K. Where they are put all together male and female, strong and weak, but having plenty of trough room around two of the walls, they are all provided with abundance of food, without the fear of the stronger buffeting about the weaker. The shed they occupy at night is at D, with the straw-rack in it *h*, and in the centre of the court stands the straw-rack *o*, fig. 67, where straw is scarce, or figs. 68 and 69, where it is plenty. The turnip troughs are fitted up as in fig. 66, and extend along two of the walls. The water-trough is at *w*, it being essential for young stock to have water at will, and necessarily so, when they do not get as many turnips as they can eat; and when they do, young cattle are all the better from having it at command. The turnip-store for this court is at *g*; and *x* is the mouth of the liquid-manure drain, to carry off the superfluous water. The young creatures occupying this court, where is much traffic in going to and from the corn-barn C, soon become familiarised with the people of the barn, and frequently get pickings of corn.

1144. The court I is fitted up precisely with the same conveniences of feeding-troughs *z*, water-trough *w*, straw-racks *h* and *o*, and turnip-store *i*, as the other court for the 1-year-olds.

1145. The *2-year olds, fattened for the butcher*, occupy the hammels M, where are feeding-troughs *z*, liquid-manure drains *x*, fodder in racks, in three of the corners of the sheds, and turnip-stores at *e* and *f*.

1146. When oxen are fattened in byres instead of hammels, the byres are fitted up, as I have said, in the same manner as those at Q and Y. Oxen usually stand in pairs in double stalls, with a small partition across the turnip-trough at each travis. When cattle are bound to the stake for the first time, they are apt to be restless for some days, and until they become reconciled to their confinement, which they will be very soon, provided they have plenty of food given them.

1147. Occasionally the cow stock requires to be renewed, one or two at a time, by *young heifers*; and as these, when in calf, are not fattened, they are put into hammels by themselves as at N, which are fitted up in precisely the same manner as those at M, with feeding-troughs *z*, straw-racks in the corner of the sheds, liquid-manure drain *x*, and turnip-stores *p* and *q*. Each hammel will afford accommodation to those heifers in calf.

1148. The old cows, which these heifers are to supersede, are fattened in the hammels N.

1149. Bulls, young and old, occupy the hammels X, which are also fitted up with feeding-troughs *z*, water-troughs *w*, liquid-manure drains *x*, and racks in the corners of the sheds. More than one bull-calf may be reared together; but more than one bull which has served cows should never be intrusted together.

1150. It is the duty of the cattle-man to attend to all these cattle during the winter, and he assists in assorting them into their respective apartments.

1151. Having accommodated all the cattle, according to their kinds and ages, in their respective places in the steading, for the winter, let us attend to the treatment which each class should daily receive during their confinement from the cattle-man; but it may be useful, in the first instance, to enumerate the nomenclature by which cattle are recognised, and to specify the particular duties of the cattle-man.

1152. The *names* given to cattle at their various ages are these:—A new-born animal of the ox-tribe is called a *calf*, a male being a *bull-calf*, a female a *quey-calf*, *heifer-calf*, or *cow-calf*; and a castrated male calf is a *stot-calf*, or simply a *calf*. Calf is applied to all young cattle until they attain one year old, when they are *year-olds* or *yearlings*,—*year-old bull*, *year-old quey* or heifer, *year-old stot*. *Stot* in some places is a bull of any age.

1153. In another year they are 2-*year-old bull*, 2-*year-old quey* or *heifer*, 2-*year-old stot* or *steer*. In England females are *stirks* from calves to 2-year-old, and males *steers*; in Scotland both young male and female are *stirks*. The next year they are 3-*year-old bull*, in England 3-year-old female a *heifer*, in Scotland a 3-*year-old quey*, and a male is a 3-*year-old stot* or *steer*.

1154. When a quey bears a calf, it is a *cow*, both in Scotland and England. Next year the *bulls* are *aged*; the *cows* retain the name ever after, and the *stots* or *steers* are *oxen*, which they continue to be to any age. A cow or quey that has received the bull is *served* or *bulled*, and are then *in calf*, and in that state are in England *in-calvers*. A cow that suffers abortion *slips* its calf. A cow that has either *missed* being in calf, or has *slipped* calf, is *eill*; and one that has gone dry of milk is a *yeld-cow*. A cow giving milk is a *milk* or *milch-cow*. When 2 calves are born at one birth, they are *twins*; if three, *trins*. A quey calf of twins of bull and quey calves, is a *free martin*, and never produces young, but exhibits no marks of a hybrid or mule.

1155. *Cattle*, *black cattle*, *horned cattle*, and *neat cattle*, are all generic names for the ox tribe, and the term *beast* is a synonyme.

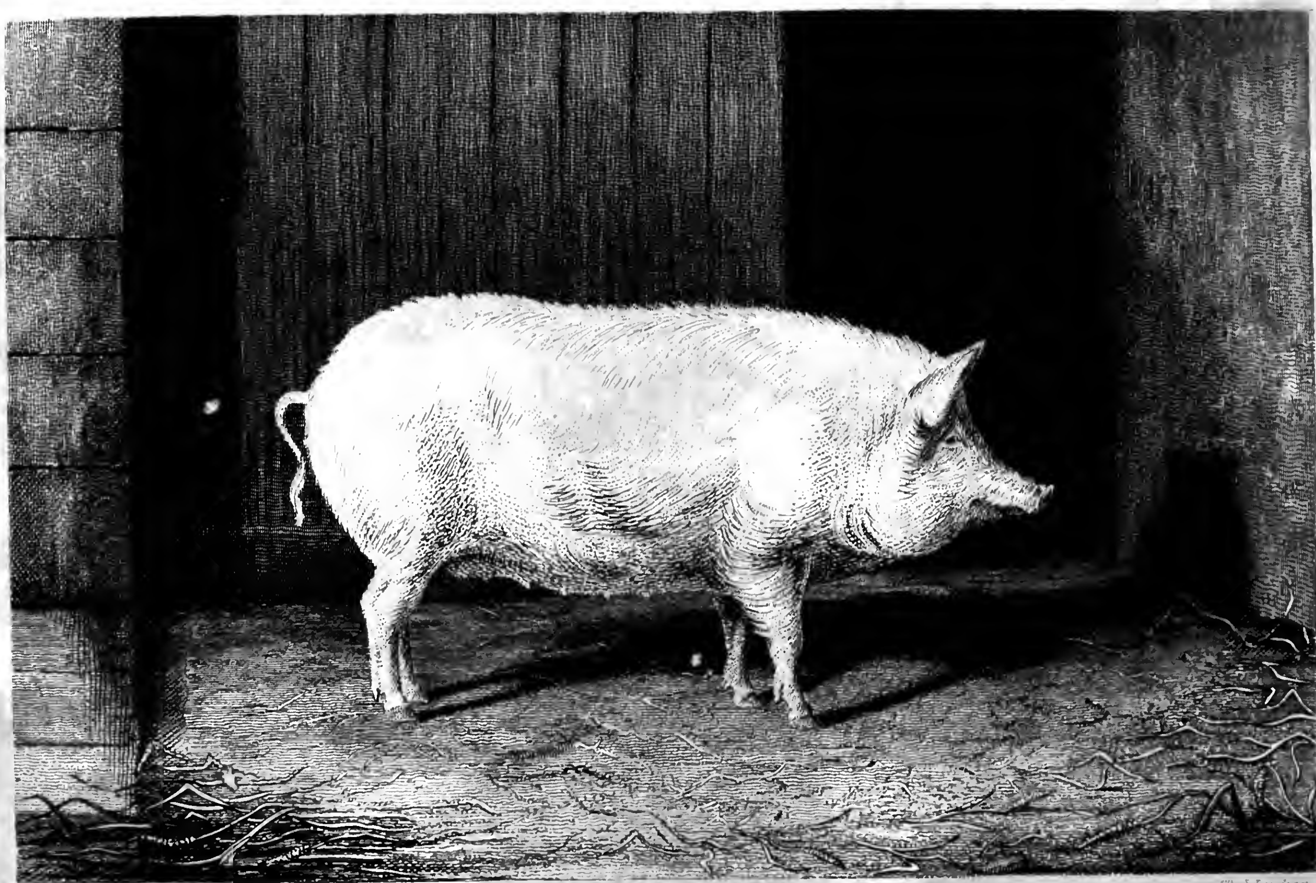
1156. An ox without horns is *dodded* or *humbled*.

1157. A castrated bull is a *segg*. A quey-calf whose ovaries have been obliterated, to prevent her breeding, is a *spayed heifer* or a *spayed quey*.

ON THE REARING AND FATTENING OF CATTLE ON TURNIPS IN WINTER.

1158. The most personally laborious part of the duty of a cattle-man in winter is *carrying straw in large bundles on his back to every part of the steading*. It may easily be imagined, from this statement, that when the straw-barn is inconveniently placed, or at a considerable distance from the byres and hammels, the labour of the cattle-man must be very much increased; indeed, it is possible, from that circumstance alone, for him to require assistance to fulfil the duties he has to perform. An inconvenience of this kind may thus be the cause of incurring the expense of another man's wages for the winter.

PLATE V.



BROOD SOW.

THE PROPERTY OF HIS GRACE THE DUKE OF BUCCLEUCH.

1159. A convenient means of carrying straw is with a soft rope about the thickness of a finger, and 3 yards in length, furnished at one end with an iron ring, through which the other end slips easily along until it is tight enough to retain the bundle, when a simple loop-knot keeps good what it has got. Provided with 3 or 4 such ropes, the cattle-man can bundle the straw at his leisure in the barn, and have the bundles ready to remove when required. The iron ring permits the rope to free itself readily from the straw when the bundle is loosened.

1160. The *dress* of a cattle-man is worth attending to, as regards its appropriateness for his business. Having so much straw to carry on his back, a bonnet or round-crowned hat is the most convenient head-dress for him; but what is of more importance when he has charge of a bull, is to have his clothes of a sober hue, free of gaudy or strongly-contrasted colours, especially *red*, as that colour is peculiarly offensive to bulls. It is with red cloth and flags that the bulls in Spain are irritated to action at their celebrated bull-fights. Instances are in my remembrance of bulls turning upon their keepers, not because they were habited in red, but from some strongly contrasted bright colours. It was stated that the keeper of the celebrated bull Sirius, belonging to the late Mr Robertson of Ladykirk, wore a red nightcap on the day the bull attacked and killed him. On walking with a lady across a field, my own bull—the one represented in the plate of the Short-horn Bull, than which a more gentle and generous creature of his kind never existed—made towards us in an excited state; and for his excitement I could ascribe no other cause than the red shawl worn by the lady; for as soon as we left the field he resumed his wonted quietness. I observed him excited, on another occasion, in his hammel, when the cattle-man—an aged man, who had taken charge of him for years—attended him one Sunday forenoon in a new red nightcap, instead of his usual black hat. Be the cause of the disquietude in the animal what it may, it is prudential in a *cattle-man* to be habited in a sober suit of clothes.

1161. *Regularity of time* in every thing done for them, is the chief secret in the successful treatment of cattle. Dumb creatures as they are, cattle soon understand any plan that affects themselves,—and the part of it to which they will reconcile themselves most quickly is regularity in the time of feeding; and any violation of regularity will soon cause them to show discontent. The regularity consists in giving the same sort of cattle the same kind of food at the same period of the day, each day in succession. The cattle-man cannot follow this regular course without the guidance of a watch; and if he has not one of his own, such is the importance of regularity in this matter, that no one should be selected a cattle-man until a watch is provided him.

1162. The cattle-man's day's work commences at break of day, and ends at nightfall, expanding the day with that of the season, until daybreak appears at 5 in the morning, and nightfall occurs at 6 in the evening; and after those hours he is not expected to work, excepting at 8 at night, when he examines, with a light, every court and byre, to see that the cattle are in health and comfort before he goes to bed. At every hour of daylight he does its stated work; and it is only in the morning and evening, as the day lengthens with the season as it advances, that any change in the time is allowable. As the same amount of work must be done every day, he has most to do in the least time—in the shortest days in winter, and as the days lengthen he has more leisure.

1163. Let us accompany the cattle-man through a whole day's work. He breakfasts before he begins his labours. At daybreak, or not earlier than 5 in the morning, should the day dawn before that hour, he goes to the byre Q, Plate II., to the cows, and removes any dung in the stalls into the gutter, with a graip, to make them clean for the dairymaid, when she comes to milk the cows. This business may occupy about 10 minutes.

1164. On farms on which calves are bred, the cows are heavy with calf in winter,—so most of them will be dry in that season, and those still yielding milk, being the latest to calve, will give but a scanty supply. It is not as *milk*-cows that cows are treated in winter, receiving but little succulent food.

1165. The graip with which he clears away the dung is seen in fig. 82, and consists simply of three long prongs of iron, and a helve of wood set in a socket of iron having a slight bend in it at the end nearest the prongs. This bend gives a leverage power to the handle, when the graip is used to lift rank wet litter; and it serves also to keep the hands so elevated as not to be dirtied by the dung or litter.

Fig. 82.

THE GRAIP.

1166. He then goes to the servants' cow-byre Y, and does the same piece of work for the cows there, and for the wives of the servants, who also milk their cows at this time. It may occupy him 5 minutes.

1167. He shuts the doors of both the byres, and leaves the half-doors into the courts open for the admission of fresh air.

1168. He goes to the fattening beasts in the hammels M, and always cleans out with a shovel the refuse of the turnips of the former meal, first from the same trough, beginning at one end of the range of troughs; and immediately that one trough is cleared out, he replenishes it with turnips from the turnip store at hand, the turnips being broken with one of the instruments in use. In this manner one hammel is supplied with turnips after another. This may occupy him 40 minutes.

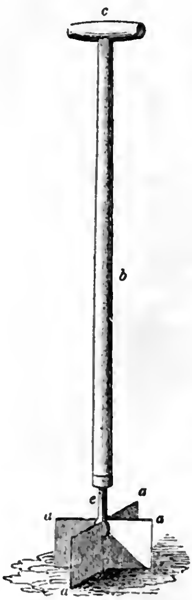
Fig. 83.

THE SQUARE-MOUTHED SHOVEL.

1169. The byre and stable shovel is seen in fig. 83. It has a broad square mouth, to stretch across the bottom, and enter the corners of the gutter of the byre or the turnip troughs of the hammels and courts. Its helve is of wood, having a slight curve in it, to save the hands being dirtied when using it in shovelling dung.

1170. There are various ways of cutting or slicing turnips for cattle. An old sharp-edged spade will cut them in pieces well enough; but the turnips are either too much bruised, or the cut pieces are apt to start away. Any of the instruments made for the purpose is better—of which are several—and a choice may be made from them according to the quantityof the turnips to be sliced. Fig. 84 is one form of hand slicer. The cutting part consists of 2 steel-edged blades, which are slit half-and-half at their middle point, so as to penetrate each other, standing at right angles, forming the *cross cutter a a a a*. They are then embraced in a four-split palm, and riveted. The palm terminates in a short shank *e*, which is again inserted into the hooped end of a wooden handle *b*, which is finished with a crosshead *c*. The price of this instrument is 8s. 6d. The mode of using it is obvious. It is held by the hand in a vertical position; and when placed upon a turnip, one thrust downward cuts it into quarters. This instrument is also varied in its construction, being sometimes made with 3, and even with 4 blades, dividing the turnip into 6 or into 8 portions.

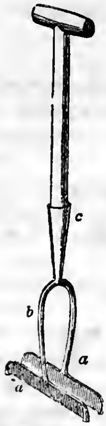
Fig. 84.



THE HAND TURNIP-CHOPPER, WITH CROSS BLADES.

1171. Another form of the same species of slice is represented by fig. 85. It has two blades *a a*; but they, instead of crossing, stand parallel to each other, and therefore divide the turnips into three portions, resembling slices, of considerable thickness, the middle one being $1\frac{1}{2}$ inch thick. In the construction of this cutter, a blunted stud is formed at the extremities of each blade, which project below the cutting edge about $\frac{1}{4}$ inch, serving as guards to save the cutting edges from receiving injury when they have passed through the turnip, by striking against any hard surface. These guards, it may be remarked, would form a useful addition to all this class of cutters. The arm *b* of the blades rises to a height of 9 inches, widening upward to $3\frac{1}{2}$ inches, to give freedom to the middle slice to fall out. The two arms coalesce above, and are then formed into the socket *c*, to receive the handle, which terminates in a crosshead.

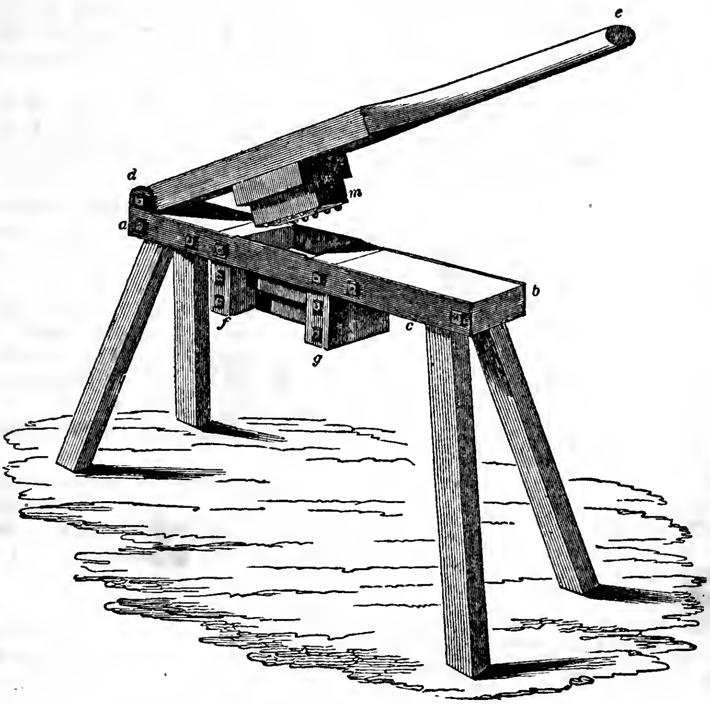
Fig. 85.



THE HAND TURNIP-CHOPPER, WITH PARALLEL BLADES.

1172. The lever turnip-slicer, fig. 86, is a more efficient instrument than either of these. It was contrived by Mr Wallace, Kirkconnell, as an improvement on a pre-existing machine of the same kind. It consists of a stock in 2 pieces, connected by an iron bar or strap *a c*, which is repeated on the opposite side, and the whole bolted together. The two pieces forming the sole are separated longitudinally from each other, so as, with the two side-straps of iron, to form a rectangular opening, bounded on the two ends by the parts of the sole, and on the two sides by the side-straps, which, to the extent of the opening, are thinned off to a sharp edge, and thus form the two exterior cutters. The sole is supported at a height of 2 feet upon 4 legs, and the lever *d e* is jointed at *d* by means of a bolt passing through it and the ears of the side-straps. The lever is 4 feet in length, its breadth

Fig. 86.



THE LEVER TURNIP-SLICER FOR CATTLE.

and thickness equal to that of the sole, but is reduced at the end *e* of a convenient size for the hand. It is furnished with a block of wood *m*, the lower face of which is studded with iron knobs, to prevent the turnip sliding from under it. The cutter blocks *f g* are made of cast-iron, and contain 8 cutters, which make the most convenient size of slice. In using this portable machine, the workman takes hold of the lever at *e* with his right hand, and, having raised it sufficiently high, throws a turnip into the cradle with the left hand. The lever is now brought down by the right hand, which, with a moderate impetus, and by means of the block *m*, sends the turnip down upon the cutters, through the openings of which it passes, while the cutters are dividing it, and the whole falls in uniform slices into a basket placed beneath. In most cases it is found more convenient to have a boy to throw in the turnips, to expedite the work. The cost of this machine is 30s.

1173. When this lever turnip-cutter is furnished with an additional set of cutting knives, six in number, fixed at right angles to those described above, the machine is rendered useful for cutting turnips for sheep ; and it will cut them in long narrow parallelopipeds, well suited in shape for being taken into the mouths of sheep. It will thus be also a cheap instrument, not exceeding 40s. in price.

1174. From the hammels the cattle-man proceeds to the large court K to the calves, cleans the turnip troughs of the refuse, supplies them with turnips from the store, breaking the turnips with one of the slicers,—the lever one doing the work most quickly. The calves not being able to eat a large quantity of turnips, he may be occupied with them for 15 minutes.

1175. The year-olds in the other large court I then demand his care. The turnip troughs are cleared of refuse, fresh turnips are supplied from the store, and sliced with the machine. These larger animals requiring more turnips, he may be occupied among them about 25 minutes.

1176. The fattening oxen in the hammels receive, of course, as many turnips as they can eat,—and so ought the young beasts in the courts; but in case of a deficiency in the crop, the calves should have a full allowance, while the older stots and queys may be put upon short allowance. Rather than this, it would be better to purchase oil-cake for the fattening oxen, and give them fewer turnips, and let the younger beasts receive a full allowance.

1177. The bulls in the hammels X next receive his care. Their turnip troughs are cleaned out, and a few fresh turnips given them, and sliced with a hand instrument. The two hammels may engage him 10 minutes.

1178. The extra beasts feeding in the hammels N should next be attended to, by cleaning out their turnip trough, and giving them a fresh supply of sliced turnips, which will be most conveniently done by a hand instrument. These may take 10 minutes to be attended to.

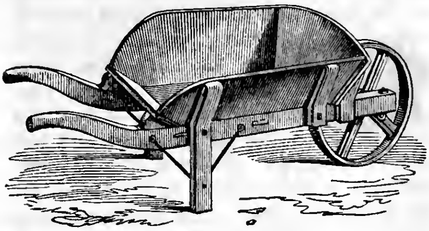
1179. The heifers in calf in the hammels N should have no turnips in the morning, only a little fresh oat-straw. It may take 10 minutes to go for this to the straw-barn, and put it into the racks.

1180. Having thus given all the cattle at liberty their morning's ration of food, the cattle-man takes a bundle of fresh oat-straw from the straw-barn, returns with it to the byre Q, and gives a little to each of the cows to engage them, while he employs himself in removing all the dung and dirtied litter from the stalls and gutter, with the graip, shovel, and wheel-barrow, fig. 87, into the court, wheeling and spreading it equally over its surface, and sweeping the gutter and causeway clean with the besom. The work altogether may engage him 30 minutes.

1181. In like manner he gives the servants' cows a little fresh oat-straw, and cleans out their byre of dung and litter. In doing this he may be engaged 25 minutes.

1182. The wheel-barrow is shown in fig. 87, and is of the common form, with close-boarded bottom, sides, and back, and of a capacity sufficient to carry a good load of litter; but not of greater breadth than will easily pass, with a load, through the door.

Fig. 87.



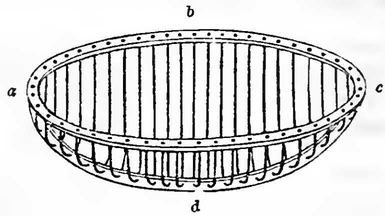
A WHEEL-BARROW.

1183. When the byres have thus been cleaned, he takes a bundle of litter from the straw-barn, and returns with it to the byre, and on clearing the troughs of the refuse fodder, and sprinkling it over the stalls for litter, they are ready for the reception of the turnips about to be given to the cows. After milking is finished by the dairymaid in the morning, the common practice is to give the cows, though heavy in calf, a feed of cold turnips into their empty stomachs, which I consider a very injudicious practice; and this is evinced by the fact of the fœtus indicating unequivocal symptoms of its existence in the womb, as it does after a drink of cold water taken in the morning. I therefore prefer giving cows some fresh straw, to prepare their stomach for the turnips. Cows in calf never get as many turnips as they can eat, the object being not to fatten, but support them in a fair condition for calving; and were they fed fat, they would run the risk of losing their life at calving by inflammation, and their calves would be small. It is not easy to specify the number or weight of turnips that should be given to cows; but I conceive that $\frac{1}{3}$ of what a feeding ox would consume will suffice. After the troughs have been supplied with the requisite quantity of turnips sliced, and the same order of distribution, from stall to stall, daily observed, the stalls are littered with the straw the cattle-man brought with him; and on shutting the principal door, and leaving the other half-door open for air, he leaves them for a time to rest and chew their cud; for nothing irritates cows more than to go about them, or about the byre, and make a noise, while they are eating their principal meal. All this work may require about 30 minutes.

1184. The turnips are supplied to the cows, either through the openings in the wall, or from the passage running along the heads of the stalls, or from the causeway by the stalls themselves, by whichever way the byre has been constructed. The most common practice of carrying the turnips is by the stalls in baskets, called *sculls*, which are hollow hemispherical-shaped baskets of willow, having an opening on each side, to take hold of the stout rim for handles. Sculls are made of the common basket-willow, or of iron wire.

1185. A wire basket is seen in fig. 88, where the rim *a b c*, forming its mouth, is

Fig. 88.



THE WIRE TURNIP-BASKET.

a flat slip of iron $\frac{3}{4}$ of an inch in breadth, and the keel or bottom *a d c* is of the same dimensions and materials. Holes are punched through them, at about 3 inches apart from each other. The small iron rods are inserted through them, receiving a bend to suit the form of the basket, and the ends of those attached to the rim *a b c* are shouldered below, and fastened with a counter-sink rivet above. The spaces left at the ends of the keel, under the rim, at *a* and *c*, form the handles. The cost is about 2s. 6d. each, and with due care—such as the replacement of a rod now and then, when broken,—will last from 5 to 10 years. Were there two keels instead of one, the basket would stand steadier upon the ground to be filled with turnips.*

1186. The servants' cows are then littered for them to lie down and rest, the turnips being given to them by the servants themselves, in such quantities, and

* *Quarterly Journal of Agriculture*, vol. xi. p. 112.

at such time, as they think proper. The littering may occupy about 10 minutes.

1187. The supply of turnips to the servants' cows depends on the terms of the agreement made with the servants. When a specified number of cart-loads are given, the servant may not choose to give them to his cow during the earlier part of the winter, if she is dry; but if in milk, the servant's family give what quantity they choose from their own store. If the farmer has agreed to treat his servants' cows in the same manner as his own, the cattle-man takes charge of them as he does those of his master.

1188. The heifers in calf now get a few turnips, and they should be sliced with one of the hand instruments. This may occupy 10 minutes.

1189. The extra beasts feeding in the hammels N should now receive some fresh oat-straw as fodder. The time engaged in this may be about 10 minutes.

1190. All the cattle having now been fed, the next step the cattle-man takes is to supply the cattle in the hammels and courts with fodder and litter. He first pulls all the old fodder out of the racks and scatters it about as litter, and then supplies them with fresh oat-straw from the straw-barn. The litter straw is then taken from the straw-barn, and used to litter the courts and hammels in such quantity as is requisite at the time, dry, fresh, or frosty weather saving the usual quantity, and rainy weather requiring more than the usual quantity, to render the courts comfortable. This distribution of the straw may occupy about 30 minutes.

1191. Whatever be the state of the weather, whether cold or warm, wet or dry, the cows should now be turned into the court to enjoy the fresh air, lick themselves and one another, drink water from the trough, and bask in the sun. They should go out every day until they calve, except, perhaps, in a particularly stormy, cold wet day. One hour at least, and longer if fine, they should remain out.

1192. In loosening cows from the stalls, a plan requires to be pursued to prevent confusion. Every cow, in the beginning of the season, should be put in the stall she has occupied since she first became an inmate of the byre; and she will always go to *it*, and no other, avoiding the least collision with the rest. In loosening them from the stalls, they should be so one by one, always beginning at the same end of the byre, and finishing at the other, and not indiscriminately. This will prevent impatience in each animal, and collision on the floor, and jamming in the doorway on going out,—accidents always injurious to animals with young.

1193. The servants' cows are let out into their court in the same manner. The two byres may in this way occupy 15 minutes.

1194. It is now time to give the fattening beasts in the hammels their mid-day ration of turnips; and in doing this it is as necessary to clear the turnip troughs of refuse as in the morning. The turnips should also be sliced. This may occupy 20 minutes.

1195. In enumerating all the portions of time mentioned in doing these various pieces of work by the cattle-man, it will be found to amount to 5 hours 5 minutes; and if he began his work at dawn, at 7 o'clock, the time now, after the fulfilment of so much of the day's labour, will be 5 minutes past 12 at noon. Farm labourers dine at 12 o'clock, so the cattle-man is thus ready for his dinner, both as regards time and the state of his work. Should the cattle-man find he has too little time to accomplish the amount of work indicated, he has the consolation of believing that, as the days lengthen after the 22d of December, he will have longer time to do the same quantity of work, and that he cannot possibly have more to do at any time.

1196. The cattle-man is entitled to rest one hour at dinner.

1197. Immediately after his dinner-hour is spent, the cattle-man goes to the straw-barn, and bundles as many *windlings* of straw, for supper, as there are cows or cattle in byres under his charge. A windling is a small bundle twisted and fastened upon itself, and is about 10 lbs. in weight. He also makes up a few large bundles of fodder. Taking one of these last to the cow-byre, he places fodder into every stall.

1198. The cows are then returned from the court into the byre ; and, to remove every temptation from even a greedy cow running up into another one's stall for the sake of snatching a little of her food, no green food should be lying in the troughs when they return to their stalls; and none should be given them immediately after returning to the byre, as the expectation of receiving it will render them impatient to leave the court, and make them restless in the stall until they receive it. This is contrary to usual practice, but it will suppress inordinate desire, prevent violation of discipline, and the necessity for correction. When subjected to regular discipline, cows soon obey it, and make no confusion, but conduct themselves peaceably. They should be bound to the stake in the same regular order they were loosened from it, from one end of the byre to the other, and the regularity provides against any cow being forgotten to be bound up.

1199. The servants' cows are returned into their byre in the same manner.

1200. He then replenishes the racks in the courts and hammels with fresh straw, strewing about the old fodder as litter; and he litters both with as much fresh straw from the barn as is requisite to render the ground comfortable to the cattle to lie down in the open air if they choose. In moonlight, many of the cattle choose to be out in the open air all night, even though rime should be deposited on their backs.

1201. He places the windlings in the byres in the proportion they are required by the cows, for their evening foddering; and he does this to avoid the danger of going into the straw-barn at night with a light.

1202. When the business with the straw in foddering and littering has been gone through, it is time to give the cows their second ration of turnips, to have them eaten up by the time the dairymaid returns to the byre, at dusk, to milk them. Some people don't give cows when dry a second ration, but I think they require it for the support of their condition. The dairymaid closes the door of their byre.

1203. The fattening oxen in the hammels then receive their evening ration of turnips, having the troughs cleaned out, and the turnips sliced as on the former occasions, and the quantity given will depend on the state of the night; for if the moon shine through the greater part of the night, a larger allowance of turnips should be given, as cattle eat busily during moonlight. This is also a practice with sheep on turnips.

1204. The calves in the larger court K, and the young cattle in the other large court, receive their second ration of turnips sliced, immediately after the fattening beasts have been served. Although both these lots receive as many turnips as they can eat, their daily allowance may be given at two instead of three times, to save a little trouble. Where the turnip troughs, however, are not sufficiently extensive to contain the requisite quantity, without piling the turnips on one another in heaps, it will be necessary to afford a supply three times instead of twice; for where turnips are so piled up in the troughs, the cattle never fail to push over, if they can, upon the dung litter, every turnip they have bitten a piece off, to get to the fresher ones below, and thus cause waste.

1205. The extra beasts fattening in the hammels N should be treated in the same manner as the young beasts.

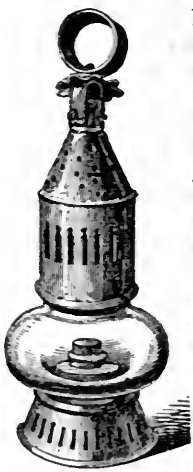
1206. The young heifers in the hammels N, and the bulls in the hammels X, next receive their turnips; and as neither of them get as many as they can eat, their proportion is divided into two small meals, sliced, one served after all the rest in the morning, and the other after the rest in the evening. Both these classes depending much upon fodder for food, it should be of the sweetest and freshest straw, and supplied at least 3 times a day, morning, noon, and evening; and having water at command, and liberty to move about, they will maintain sufficient condition. The heifers and bulls are supplied from the turnip stores *p* and *q*.

1207. He then litters the servants' cows for the night, by which time the cows in the other byre will be milked; immediately after which they are also littered for the night, and the doors closed upon them, and the labours of the day are finished.

1208. At eight o'clock in the evening the cattle-man inspects every court, byre, and hammel, and sees that all the cattle are well and comfortable. Until twilight permit him to see the cattle, he takes a lantern to assist him. In the courts and hammels the cattle have access to the fodder at all times; in the byres it is otherwise. He now gives the cows the windlings of straw he had made up in the straw-barn, and piled up in each byre at nightfall.

1209. A proper form of lantern that will distribute a sufficient intensity of light all around, and be safe to carry to any part of a steading, amongst straw or other highly inflammable material, is yet, perhaps, a desideratum. The nearest approach to safety of any form of lantern I have seen is that in fig. 89, which consists chiefly of a stout glass globe, which may be knocked against a piece of timber and yet not be fractured. It has an oil-lamp, which screws and unscrews into its place from below, within the foot upon which it stands, and a ring by which it is carried; and the hand is elevated enough to be protected from the heat which escapes along with the smoke from the ventilator. A lantern of tin, with a globe about 9 inches meter, a suitable size, costs 6s. 6d.

Fig. 89.



A SAFE LANTERN.

1210. The treatment of *oxen* fattened in a byre is somewhat different from that of cows. As it is unusual to fatten oxen in byres and hammels on the same farm, what I have said of fattening cattle in the hammel should be considered in lieu of what I shall now say of fattening them in a byre. Cattle get as many turnips as they can eat, and are not permitted to leave their stalls until sold off fat. After the stalls of the cow-byres have been cleared into the gutter, of any dung that might annoy the dairymaid, the cattle-man goes to the feeding-byre, and, first removing any fodder that may have been left from the previous night into the stalls, and any refuse of turnips from the troughs into the gutter, gives the cattle a feed of turnips at once. The quantity at this time should be more than the third of what they eat during the day; for they have wanted a long time, and they should be fed 3 times a-day—in the morning, at noon, and at sunset; and in distributing the food, the same regularity should always be observed as in the case of the cows, the same ox receiving the first supply, and the same ox the last. When thus fed in regular order, cattle do not become impatient for their turn. The best plan is to begin serving at the farthest end of the byre, as the cattle-man has then no occasion to pass and disturb those already served; and so in the case of *double-headed* byres, in which cattle stand on both sides, tail to tail, both sides should be served simultaneously, one beast alternately on each side, thus still leaving the served ones undisturbed. With the half-door left open for the admission of fresh, and the emission of heated air through the ventilators, the cattle-man leaves them to enjoy their meal in quietness. Whenever the cattle have eaten their turnips, the byre should be cleared of the dung and dirty litter with the graip, shovel, besom, and wheeled into the dunghill with the barrow. A fresh foddering and a fresh littering are given, when they are left to themselves to rest and chew the cud until the next time of feeding, which should be at mid-day, when rather less than a third of turnips will suffice. After finishing this feed, more fodder is given, and the dung drawn from the stall into the gutter. In the afternoon, before daylight goes, the dung should again be carried away to the dunghill, and then the last supply of turnips given. After these are eaten up, a fresh foddering is given, and the litter shaken up and augmented where requisite. After eating a little of this fodder, the cattle will lie down and rest until visited at night.

1211. In thus minutely detailing the duties of the cattle-man, my object has been to show you rather how the turnips and fodder should be distributed relatively than absolutely; but whatever hour and minute the cattle-man finds, from experience, he can devote to each portion of his work, you should see that he performs *the same operation at the same time every day.* By paying strict attention to time, the cattle will be ready for and expect their wonted meals at the appointed times, and will not complain until they arrive. Complaints from his stock should be distressing to every farmer's ears; for he may be assured they will not complain until they feel hunger; and if allowed to hunger, they will not only lose condition, but render themselves, by discontent, less capable of acquiring it when the food happens to be fully given. Wherever you hear lowings from cattle, you may safely conclude that matters are conducted there in an irregular manner. The cattle-man's rule is a simple one, and easily remembered:—*Give food and fodder to cattle at fixed times, and dispense them in a fixed routine.* I had a striking instance of the bad effects of irregular attention to cattle. An old staid labourer was appointed to take charge of cattle, and was quite able and willing to undertake the task. He got his own way at first, as I had observed many labouring men display great ingenuity in arranging their work. Lowings were soon heard from the stock in all quarters, both in and out of doors, which intimated the want of regularity in the cattle-man; whilst the poor creature himself was constantly in a state of bustle and uneasiness. To put an end to this disorderly state of things, I apportioned his entire day's work by his own watch; and on implicitly following the plan, he not only soon satisfied the wants of every animal committed to his charge, but had abundant leisure to lend a hand at any thing that required his temporary assistance. His old heart overflowed with gratitude when he found the way of making all his creatures happy; and his kindness to them was so undeviating, they would have done whatever he liked. A man better suited, by temper and genius, for the occupation I never saw.

1212. You may regard all these minute details, on the treatment of cattle, frivolous and unnecessary: but they are not so; and your own interest will soon tell you, that where a number of minutiæ have to be attended to, unless taken in order, they are apt to be forgotten altogether, or attended to in a hasty manner; and none of these conditions, you will also admit, are conducive to correct management. Observe the number of minute things a cattle-man has to attend to. He has various classes of cattle under his charge—cows, fattening beasts, young steers, calves, heifers, bulls, and extra beasts besides; and he has to keep them all clean in their various places of abode, and supply them with food and fodder three times in a short winter's day of 7 or 8 hours. Is it possible to attend to all these particulars, as they should be, without a matured plan of conduct? The cattle-man requires a plan for his own sake; for were he to do every thing when the idea just struck him, his mind, being guided by no rule, would be as prone to forget as to remember what he had to do. The injurious effects upon the condition of animals of irregular attendance upon them, seem to render a concocted plan necessary to be adopted. Before you can see the full force of this observation, you would require to be told that food, fodder, and litter, given to cattle in an irregular manner,—such as too much at one time and too little at another, frequently one day, and seldom another,—surfeiting them at one time, hungering them at another, and keeping them neither clean nor dirty, never fails to prevent them acquiring that fine condition which good management always secures.

1213. Let us reduce the results of bad management to figures. Suppose you have three sets of beasts, of different ages, each containing 20 beasts, that is, 60 in all, and they get as many turnips as they can eat. Suppose that each of these beasts acquires only half a pound less live weight every day than they would under the most proper management, and this would incur a loss of 30 lbs. a day of live weight, which, over 180 days of the fattening season, will make the loss amount to 5400 lbs. of live weight, or, according to the common rules of computation, 3240 lbs., or 231 stones of dead weight at 6s. the stone, £69, 6s., a sum equal to more than five times the wages received by the cattle-man. The question, then, resolves itself into this—whether it is not for your interest to save this sum annually, by making your cattle-man attend your cattle according to a regular plan, the form of which is in your own power to adopt and pursue?

1214. What I have just stated applies to the fattening of ordinary cattle, but selected cattle may be desired to be fattened to attain a particular object. You may have, for instance, a pair of very fine oxen, which you are desirous of exhibiting at a particular show. They should have a hammel comfortably fitted up for themselves, and your ingenuity will be taxed to render it as convenient and comfortable as possible, which you will the better be able to do, after determining on the sorts of food you wish to give them. You will present a choice of food, and, therefore, will provide a trough for sliced Swedish turnips—a manger for linseed-meal—another for bruised oats—a third for compound—a rack for hay—and a trough for water. There should be abundance of straw for litter and warmth, and daily dressing of the skin to keep it clean, as *fat* oxen can reach but few parts of their body with their tongue. But all these appliances will avail nothing, if a regulated attention is not bestowed by the cattle-man. The cattle have as much as they can eat, but then what they eat should be administered with judgment, if you wish to attain a particular end. It will not suffice to set an adequate portion of each sort of food daily before them, to be taken at will; one or more of the kinds will have to be given at stated times, that each may possess the freshness of novelty and variety, and thereby be eaten with relish. Every particular thus demands attention, and affords sufficient exercise to the judgment; and if this is in the case with particular animals, the necessity for attending in a similar manner on cattle in ordinary circumstances cannot but be impressed on your mind.

1215. Much has been said on the propriety of wisping and currying cows and fattening oxen in the byre, and much may be said in recommendation of the practice, were the cattle always confined to the byre; but animals which are at liberty a part of the day do not require artificial dressing, except when in high condition, inasmuch as they can dress their own, and one another's skin, much better than any cattle-man. With cattle constantly confined in the byre, it seems indispensable for their good health to brush their skin daily; and I believe no better instrument can be used for the purpose than an old curry-comb, assisted with a wisp of straw. Currying should only be performed on the cattle when not at food; and this should be strictly enjoined, for people, who have charge of animals, have a strong propensity to dress and fondle them when at food; from no desire to torment them, but chiefly because they will then be in a quiet mood. Still the process has a tendency to irritate some cattle, and please others so much as to make them desist eating, and on that account should be prevented. Many other animals are never more jealous of being approached than when eating their food,—as exemplified by the growl of a dog, and the scowl of a horse.

1216. From the commencement of the season to the end of the year, white turnips alone are used; after which, to the end of the winter season, the yellows are brought into requisition, or swedes, where the yellows are not cultivated.

1217. When turnips are brought from the field in a dirty state, which will be the case in wet weather from clayey soil, they ought to be washed in tubs of water, and, as long as the dirt is fresh, they will be the more easily cleansed. Washing is not so troublesome and expensive a business as may at first seem. A field-worker, having a large tub of water placed beside a store about to be filled with turnips, takes them up one by one with a small fork, and dashing them about in the water for an instant, pulls them off against the edge of the store or barrow; and this she does much faster than the cattle-man wheels them away and slices them for the beasts. A friend of mine used a very curious mode of washing turnips. Whenever any of the fields of his farm, along which passed the lade that conducted the water from the dam to the thrashing-mill, were in turnips, he caused the lade to be filled pretty full of water, by making a damming in it in the particular field, according to the fall of the ground. The turnips were then topped and tailed, and plunged into the lade, from a cart when the distance was considerable, and from a hand-barrow, carried by field-workers, when near. The damming in the field being cut, and the sluice at the mill a little opened, the current of water floated the turnips to the steading, where they were taken out from behind the grating of the sluice, and carried to the stores in barrows. When the turnips were very dirty, they were washed in the lade by a person pushing them about with a pole. That some provision for cleaning turnips is sometimes necessary, is certain; for I have seen very fine cattle eating turnips in such a state that the dirt actually bedaubed them to the very eyes, which the tops, being left on, had assisted much in doing. Surely no one will say that filth, in any shape, is beneficial to cattle; not that they dislike to lick earth at times, but they do so, in their own way, to rectify acidity in the stomach.

1218. When turnips have not been stored, and are brought from the field as required, they will probably be in a frozen state at times, when, even if sliced by any of the instruments in use, they will be masticated by the cattle with difficulty; and frozen turnips never fail to chill cattle, which is indicated by the staring coat. Means should therefore be used to thaw frozen turnips, and the most available is to put them for a time in tubs of cold water. This process is attended with much more expense than storing them in the proper season.

1219. It is supposed that an ox, which attains a weight of 70 stones imperial at the end of the season, consumes in fattening a double horse-load of turnips per week; and, as carts are usually loaded at field-work in winter, the weight of a load may be estimated at about 15 cwt.; so that the ox will consume about $2\frac{1}{8}$ cwt. or 16 stones 2 lbs. a day, or 5 stones 5 lbs. at each of 3 meals, and about $19\frac{1}{2}$ tons during the season of 26 weeks. The calves may consume $\frac{1}{2}$, or 8 stones, and the 2-year-olds $\frac{3}{4}$, or 12 stones a day; cows receiving one-third of the oxen, 5 stones 5 lbs. a day. Each scullful contains about $37\frac{1}{2}$ lbs. These comparative quantities are given from no authenticated data, for I believe no comparative trials, with different ages of cattle, have ever been made, but merely from what people imagine to be near the truth; and such an estimate should be made at the beginning of every season, that you may know whether there are turnips enough to serve the stock. It was correctly ascertained by Mr Stephenson, Whitelaw, East Lothian, in a careful experiment of feeding 18 oxen of 42 stones, that they consumed 10 stones 2 lbs. on an average each of turnips daily;* and Mr Boswell Irvine of Kingcausie, found that oxen of 43 stones consumed only 9 stones of turnips each daily.† This discrepancy between the two statements might be explained, perhaps, if we knew every particular of the treatment in the two cases. Taking $9\frac{1}{2}$ stones as the average quantity of turnips consumed every day by oxen of 42 stones, and taking it for granted that oxen consume food nearly in the proportion of their weight, the result will be very nearly what is stated above by guess, nearly 16 stones per day, by cattle of 70 stones.

1220. Cows are kept on every species of farm, though for very different purposes. On *carse* and *pastoral* farms they are merely useful in supplying milk to the farmer and his servants. On *dairy* farms they afford butter and cheese for sale. On some *farms near large towns*, they supply sweet and butter milk for sale. And on *farms of mixed husbandry*, they are kept for the purpose of producing calves.

1221. On carse and pastoral farms, cows receive only a few turnips in winter, when they are dry, and are kept on from year to year; but where the farmer supplies milk to his work-people, as a part of their wages, they are disposed of in the yeld state, and others in milk, or at the calving, bought in to fill their place, and these receive a large allowance of turnips, with perhaps a little hay. On such farms, little regard is paid to the breed of the cow, the circumstance of a good milker being the only criterion of excellence.

1222. On true dairy farms, the winter season is unfavourable to the making of butter and cheese for sale. The cows are in calf during this season, and receive raw turnips and hay until they calve. As soon as they calve they receive prepared food.

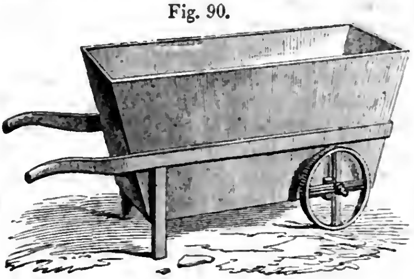
1223. The food is prepared in this manner:—Topped and tailed, though not washed turnips

* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 63. † *Ibid.*, vol. xi. p. 462–4.

are put into a large boiler until it is about half filled, and a few handfuls of salt strewn over them. The boiler is then filled and heaped up with cut hay; as much water is poured into it as nearly to fill it; a board is placed upon the hay, and the fire is then kindled in the furnace. By this process the turnips are boiled soft, and the hay steamed or stewed; and in about three hours the mess is ready to be put into a cooler, the hay undermost, the turnips above it, and the water from the turnips poured over both, and they all remain in it until parted amongst the cows.

1224. *The Cooler.*—The cooler is an oblong box, fig. 90, having the sides perpendicular, and the ends bevelled, and provided with two wheels,

Fig. 90.



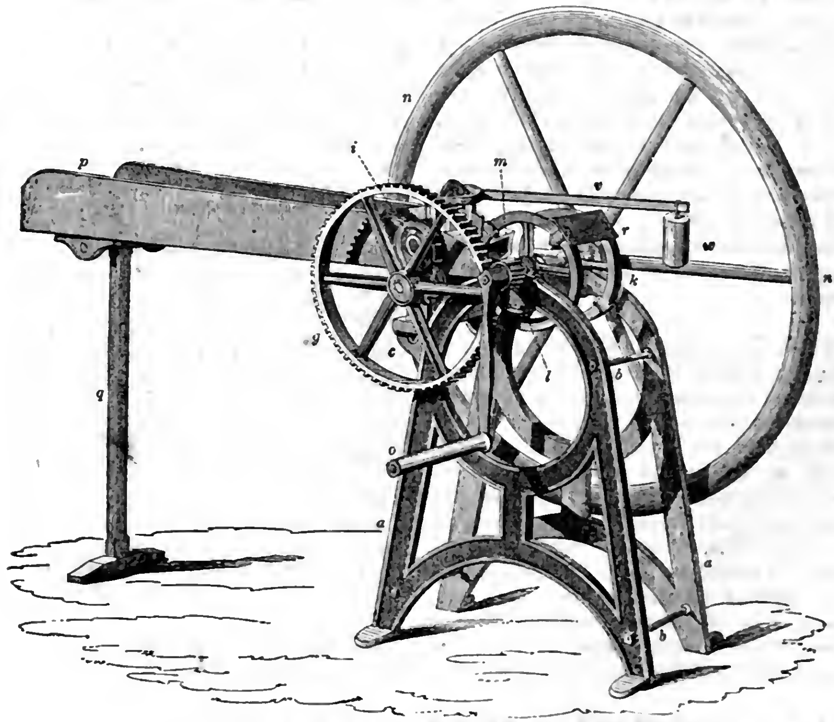
THE COOLER FOR A BYRE.

mounted on a bent axle, which passes under the bottom of the box, and two handles, for the purpose of moving the cooler to where it is wanted. The cooler may be constructed of any dimensions, to suit the size of the dairy; and one 6 feet long, 2 feet wide, 2½ feet deep, will contain as much food as will serve 20 cows at one meal.

1225. Before serving out the mess to the cows, the cooler is either wheeled into the byre, or to its door from the boiling-house. The turnips are broken and mashed with a small graip, against one of the bevelled ends of the cooler,—the one next the handles being the more convenient of the two to stand at. While a portion of the turnips is thus broken, it is mixed with a little of the hay, well shaken up, and the turnip water. A proportion to each cow is put into a small tub, receiving a little of broken oil-cake, bruised linseed, or bean meal, and emptied into its feeding-trough in the byre. A prepared mess of this description is given to the cow twice a day, morning and afternoon. Should the mess be rather warm, it will easily be cooled by the addition of cold water into the cooler.

1226. *The Cylinder Straw-cutter.*—So named from having the cutters (generally two, but sometimes four) placed on the periphery of a skeleton cylinder, each cutter lying nearly in the plane of revolution. Besides the cutting cylinder, they necessarily have a pair of feeding

Fig. 91.



THE CYLINDER STRAW-CUTTER WITH STRAIGHT KNIVES.

rollers, which bring forward the substance to be cut, and also, from the velocity of their motion, regulate the length of the cut. Two forms of the machine exist, the essential difference of which is, that, in the one, the cutters are placed upon the cylinder with a large angle of obliquity to the axis, generally about 35°, and are therefore bent and twisted until their edges form an oblique section of the cylinder, while the box, or the orifice through which the substance is protruded for being cut, lies parallel to the axis of the feeding rollers. In the other variety, the knives are placed parallel to the axis of the cylinder, and therefore straight in the edge; while the cutting-box is elongated into a nozzle, and is twisted to an angle of 15° with the axis of the feeding-rollers. I prefer this latter variety, because the knives, being straight, are easily taken off and put on, and sharpened by any common smith or carpenter, and twisted knives are generally very heavy to work.

1227. The cylinder straw-cutter with straight knives, as constructed by Mr James Slight, Edinburgh, at prices from £7, 10s. to £8, 10s., is represented by fig. 91, being a view in perspective of the machine. The machine is made entirely of iron, chiefly cast-iron. The two side-frames *a a*, are connected together by the stretcher bolts *b*, one being formed of the bed-plate *c*, which is bolted to a projecting bracket, and carries the cheeks or frame of the feeding-rollers. The lower roller carries upon its axle the driving-wheel *g*, and also the feeding-wheel, which works into its equal wheel *i*, fitted upon the axle of the upper roller. In the apex of the side-frames, bearings are formed for the axle of the cutter-wheels *k*, which form the skeleton cylinder, and whose axle carries also the driving-pinion *l*, acting upon the wheel *g*. Intermediate between the feeding-rollers and the cutter-wheels is placed the twisted cutting-box or nozzle *m*, bolted to the roller-frame. On the further end of the cutter-wheel axle the fly-wheel *n* is fixed; and on the near end of the same the winch-handle *o*, by which the machine is worked. The feeding-trough *p* is hooked to the roller-frame at the mouth, and supported behind by the jointed foot *q*. The cutters *r* are made of the finest steel, backed with iron. The cutters are fixed upon the cylinders, each with two screw-bolts, as seen at *r*, passing through the ring of the wheel, and they are placed slightly eccentric to it; the cutting-edge being about ¼ inch more distant from the centre than the back. To secure the regular feed of the rollers, the lower one turns in fixed bearings; but the other is at liberty to rise and fall in the fork of the roller-frame. In order further to secure a uniform pressure on this roller, a bridge is inserted in the fork, resting on both journals of the roller. A compensation lever *v* has its forked fulcra through a strap, which is hooked on to pins in the roller-frame; and it thus bears upon the bridge at both sides by means of the forked end. A weight *w* is appended to the extremity of the lever, which, thus arranged, keeps a uniform pressure on the upper roller, while it is always at liberty to rise or fall according to the thickness of the feed which the rollers are receiving.

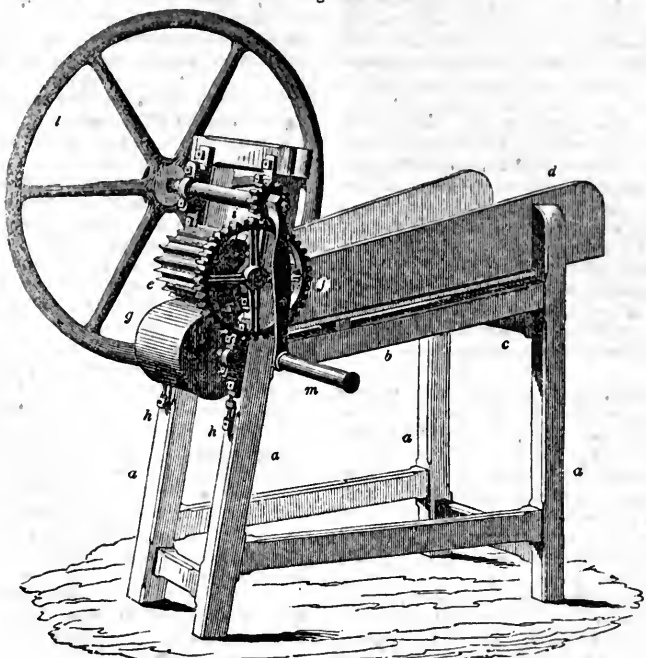
1228. *The Canadian Straw-cutter.*—Besides this machine, I shall give a figure of a simple and efficient straw-cutter, which has been imported from Canada, as its name implies, and which is preferred by some persons to any other kind. A description of this machine was sent from Canada by Mr Fergusson of Woodhill, now of Fergus, Upper Canada, to the Highland and Agricultural Society, in whose Transactions it was first published;* but the present figure is taken from the machine as made by Mr Slight, Edinburgh, who has greatly improved the construction of the cutting cylinder. Fig. 92 is a view in perspective of this machine. It consists of a wooden frame, of which *a a a a* are the four posts, the front pair being higher than the back pair. These are connected by two side-rails, one of which is seen at *b*, and a cross-rail *c*, which last serves also to support the bottom of the feeding-spout. The posts are further connected by four light stay-rails below; and the frame, when thus joined, supports the rollers at the front. The feeding-spout is *d*. The acting part of this straw-cutter consists of the cutting cylinder *e*, armed with cutters or knives; its axle runs in plummer-blocks, bolted upon the posts, and carries likewise the wheel *f*. The pressure cylinder *g* is a plain cylinder of hardwood, beech or elm, turned true upon an iron axle, which runs in plummer-blocks similar to the former, and carries no wheel, but revolves by simple contact with the cutting cylinder. The pressure cylinder is furnished with a pair of adjusting screws at *h h*, which act upon the plummer-blocks of the cylinder, and afford the means of regulating the pressure of the one cylinder upon the other. The shaft *i*, which has also its plummer-blocks, carries at one end a pinion, which acts upon the wheel *f*, while, at the other end, it carries the fly-wheel *l*. The winch handle *m* is also attached to the shaft *i*, and serves to put the machine in motion.

1229. As this machine acts entirely by direct pressure, it will readily be observed that, in working it, the straw being laid in the trough *d*, and brought in contact with the cutting cylinder and its antagonist, the hay or straw will be continuously drawn forward by means of the two cylinders; and when it has reached the *line of centres* of the two, it will be cut through by the direct pressure of the cutting edges of the one against the resisting surface of the other cylinder, and the process goes on with great rapidity. The straw is cut into lengths of about ¾ inch; and though it passes in a thin layer, yet the rapidity of its motion is such that, when driven by the hand, at the ordinary rate of 44 turns of the handle per minute, the number of cuts made by the cutting cylinder in that time is 360; and the quantity, compared by weight, will be three times nearly what any other straw-cutter will produce, requiring the same force to work it,—that is to say, a man's power. There is one objection to this machine, which is, the wearing out of the resisting cylinder; but this is balanced by the excess of work performed, and by the circum-

* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 336.

stance that the moving cylinder can be removed at an expense of 2s., and it will last from three to six months. The price of the Canadian straw-cutter is £6, 10s.

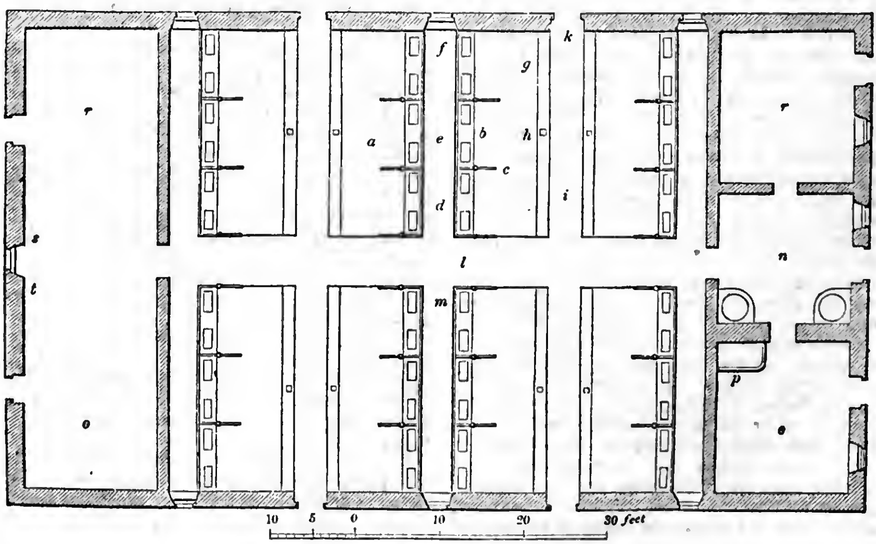
Fig. 92.



THE CANADIAN STRAW-CUTTER.

1230. The *Disc Straw-cutter* is, for the most part, employed in England, and is the most numerous of this class of machines. The principal feature, the cutting knife, fixed upon the fly-wheel, is invariable, except that it at times carries one, and at others, two knives.

Fig. 93.



PLAN OF A BYRE FOR A LARGE DAIRY-FARM.

1231. In a large dairy farm, comprehending from 40 to 60 cows, the most economical arrangement is to place them all under one roof in one byre, situate close beside the boiling-house and hay-house, when the food can be prepared and dealt out, the byre cleansed, and the cows milked, under the immediate superintendence of the head dairymaid. I shall give a plan of such a byre, which may be extended in width and length, to contain any number of cows desired. Fig. 93 represents such a byre, capable of accommodating 48 cows in double stalls, and so arranged that the stalls of 24 cows may be cleaned at one time, and the mangers of from 12 to 24 replenished from the same passage: *a* are the double stalls, 8 feet wide, and 7½ feet long from manger to gutter: *b* the stone troughs or mangers, 27 inches long and 16 inches wide, and 8 inches deep inside; two are placed in each double stall, and each 6 inches from the side of the stall, and its upper edge 18 inches above the floor: *g* the gutter or grupes for receiving the dung and urine, 15 inches wide, in each of which is a grating *h* communicated by a drain with those which convey the urine to the liquid-manure tank: *i* are the foot-paths, 4 feet wide, from the outer doors *k* to the stalls, along which the cows leave and enter their stalls, and by which the cattle-man removes, in his barrow, by the doors, the dung and litter from the gutters and stalls to the dunghill: *d* are the passages along the heads of the stalls, 4 feet wide, from which the food and fodder are put into the mangers; the principal passage *l*, 6 feet wide, being the one along which the cooler, fig. 90, is drawn, with the prepared food, from the boiling-house: *k* are the outer doors at the end of each footpath *i*, by which each division of cows leave and enter the byre, without disturbing the rest: *f* are the windows, such as fig. 78, situate one at the end of each passage *d*, along the heads of the stalls: *m* is the central position of the water-cock, to supply the cattle-man and assistant dairymaids for washing down the footpaths *i*, the gutter *g*, and the mangers *b*: the water thus used and enriched, on finding its way into the liquid-manure tank, keeps the drain clear: *c* are the travis-boards, 2 feet long across the mangers, and 3 feet in front of the travis post, from which they slope in a triangular form to the floor; *e* is the boarding, 2½ feet high, along the heads of the stalls, and over which the food and fodder are put into the mangers *b*. Thus furnished, the byre, containing 48 cows, will be 64 feet in length, and 54 feet in breadth.

1232. Connected with the byre is the apartment *n*, 15 feet by 16, containing two large boilers, which are heated alternately, to prepare the food by turns, and is provided with an outer door 3½ feet wide, and a window—the door being opposite the one of the byre, also 3½ feet wide, at the end of the principal passage *l* of the byre—and with a water-cock to each boiler.

1233. The store *o* is 17½ feet by 16, and contains the topped and tailed turnips for the boilers, also provided with a door for taking in the turnips, and a window to give light to the assistant dairymaid, when replenishing the boilers with turnips, through the door into the boiling house *n*. This apartment is also furnished with a convenient space *p*, for containing the coals used in the furnaces; and, being here, the boiling-house is kept free of dust.

1234. The hay-house *r*, 18½ feet by 16, adjoins the boiling-house, provided with a door for taking in the hay, and a window to afford light to cut and take away the cut hay to the boilers, through the door into the boiling-house *n*. In this apartment stands the straw-cutter, fig 91, for preparing the hay, near the window, and may here be driven by hand or power.

1235. At the other end of the byre is a large apartment, 54 feet by 16, at the one end of which is a turnip store o, for the turnips to be given raw to such of the cows as have not calved, and are not in milk. The turnips are put into the store by an outer door. The hand-lever turnip-slicer, fig. 86, would stand conveniently here for use.

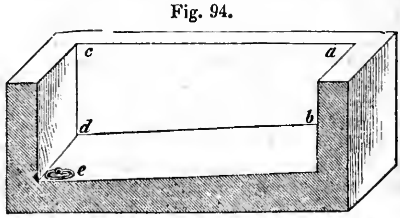
1236. Opposite to this turnip store is the hay house *r*, for the hay given to the cows as ordinary fodder. The hay is taken into the apartment by an outer door. An inside door, 3½ feet wide, allows both the turnips and hay to be taken along the principal passage *l*.

1237. A window is placed opposite the inside door, on either side of which, *s* and *t*, may stand the oilcake breaker, fig. 53, the linseed crusher, fig. 97, and the barrels to contain the bruised linseed and bean-meal. Thus every convenience wanted for a byre may be obtained, by such a plan, under one roof, the entire building being 101 feet in length by 58 feet in breadth, over the walls.

1238. It will be observed that the width of this byre is much beyond that of ordinary steadings; but the construction of the trussed form of roof is now so well understood that it is perfectly safe on ordinary thickness of walls; and as a large number of cows can be easily taken care of under one roof, this form of byre seems well adapted for the purposes of a large dairy. Figure *s* of this sort of roof will be given when we come to consider the construction of steadings in general.

1239. To keep the stone troughs always sweet and clean, they should be washed out and scrubbed with a heather rinse once a-day; and,

Fig. 94.



SECTION OF A STONE TROUGH FOR A BYRE.

that the water may be conveniently got rid of, the troughs should be formed as in fig. 94, with the bottom sloping both along it from *a* to *c*, and across it from *d* to *e*, where is a metallic sucker and stopper, to allow the water to escape to the drain underneath; and this drain, of course, communicates with the other drains. A convenient form and size of trough is 27 inches in length, 16 inches in width, and 8 inches in depth at *a*, increasing to 9 inches at *c*, and 10 inches at *e*, the lowest point.

1240. A hydraulic apparatus is sometimes provided to such byres, for the supply and removal of cold water from the troughs, by means of the action of a lever operating at each trough; and as long as the apparatus works well, its convenience is certainly great, but it is apt to get out of proper action, when its presence becomes a continual source of annoyance.

1241. The cows of a farm in the immediate neighbourhood of towns, and those in the towns' dairies themselves, are fattened when the milk leaves them, and not allowed to breed again,—the time in which they would remain dry being regarded as lost; and new-calved cows, or just about to calve, are purchased from the country in their stead. A market is held in most towns every week for the purchase of such cows, which are usually brought from a distance. The calves are sold, and not attempted to be fattened. The dairyman in and near large towns must always have milk to supply his customers; and it is his interest to render the milk as palatable as possible. For this purpose he purchases cows early to calve at all seasons, and prepares the whole food given them.

1242. The cows in the public dairies in Edinburgh are supported in winter on a variety of substances—namely, turnips, brewers' and distillers' grains called draff, dreg, malt comins, barley, oats, hay seeds, chaff, and cut hay. One or more of these substances, with turnips, are cooked together, and the usual process of doing this, and administering the cooked food, is as follows:—Turnips, deprived of tops and tails, and washed clean, are put into the bottom of a boiler, and covered near to its top with a quantity of malt comins, cut hay, hay seeds, chaff, or barley, or more than one of these, as the articles can be procured. Water is then poured into the boiler sufficient to boil them, and a lid placed upon it. After being thoroughly boiled and simmered, the mess is put into tubs, when a little pounded rock-salt is strewed over it, and chopped into a mash with a spade. As much dreg is then poured upon the hot mash as to make it lukewarm, and of such a consistence as a cow might drink up. From 1 to 1½ stable pailfuls of this mixture,—from 40 to 60 pints imperial,—according to the known appetite of the cow, is then poured into the trough belonging to each cow. The trough is afterwards removed and cleaned, and the manger is ready for the reception of fodder—hay or straw. This mess is given 3 times a day, *after* the cows have been milked, for dairymen well understand that animals should not be disturbed while eating their food. The times of milking are 6 A.M., 12 noon, and 7 P.M. The sweet milk and cream obtained by these means, and received direct from the dairy, are pretty good. The former sells in Edinburgh at 1d., and the latter at 1s. the imperial pint. Dr Cleland states the price of sweet milk in Glasgow at 1½d. the imperial pint.

1243. It will be observed in the enumeration of the articles given to cows, that none are so expensive as oil-cake, cabbages, kohl-rabi, or cole-seed. These products were employed by the late Mr Curwen, in his experiments to ascertain the cost of producing milk for supplying the poor, and his results show they leave very little profit.*

1244. There is little milk in winter on a farm of mixed husbandry, which only supports cows for breeding stock, the supply being derived from one or two cows that are latest of calving in spring. All the spare milk may probably be eagerly bought by cottars who have no cows; but should this not be the case, a little butter may be made once in 10 days or a fortnight, which, if not palatable for the table, may be used in making paste, and other culinary purposes. A little saltpetre, dissolved in water, and put into the new warm milk, certainly modifies the rank taste of turnips in both butter and milk. Cows are not bought in but bred on such farms.

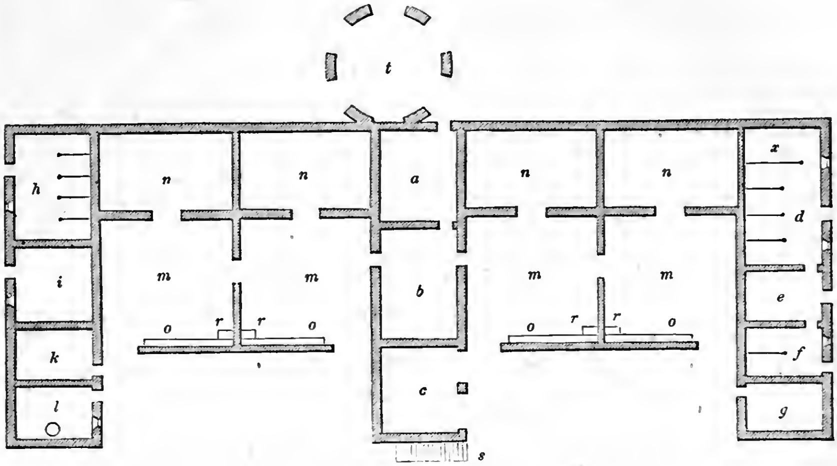
1245. In pastoral farms, where cattle are wholly bred and no sheep, the cattle in winter, and especially the young ones, require both food and shelter, though both are not unfrequently denied them. There should be provided arable land to raise turnips, and courts and sheds to shelter them. Suppose we take the same extent of arable land as we took for a sheep pastoral farm, namely, 100 acres, which is the least compass for a pastoral farm of tolerable extent. Under a four-course rotation, 100 acres will afford 25 acres of green crop, 50 acres of straw, and 25 acres of cutting grass every year. What the young cattle want is a few turnips a-day, and shelter in sheds at night.

1246. This form of steading seems suitable to such a farm, where *a*, fig. 95, is a corn-barn and chaff-house, 25½ by 18 feet, with an upper barn above them, containing a four-horse thrashing-machine; *b*, a straw-barn 26 feet by 18 feet; *c*, a cart shed 20 feet by 18 feet, with two ports, to contain four carts and other larger implements, with a granary above it having access by an outside stair *s*; *d* is the work-horse stable, 32 feet by 18 feet, having four stalls of 6 feet in width each, a loose box *x* 8 feet wide, and two windows; *e* is the hay house, 12 feet by 18 feet; *f* the riding-horse stable, 12 feet by 18 feet; *g* a turnip store, 12 feet by 18 feet; *h* is the cow-byre, 25 feet by 18 feet, having 5 stalls of 5 feet in width each; *i* is an out-house for putting the smaller implements in, 18¼ feet by 18 feet: should it be desired to give the cow-byre another stall, this apartment may be made

* Curwen's *Agricultural Hints*, p. 47-52.

as much smaller; *k* is another turnip-store, 12 feet by 18 feet; *l* is the boiling-house, 12 feet by 18 feet, provided with a boiler and furnace; *m* are four courts for the cattle, and *n* the sheds

Fig. 95.



A PLAN OF A STEADING FOR THE CATTLE OF A PASTORAL FARM.

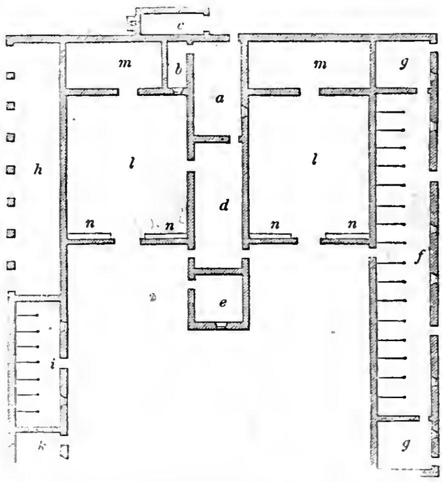
belonging to them, 15 feet in width. In the drawing the sheds are represented at 18 feet in width, to render the appearance of the steading uniform; but 15 feet is sufficient width for sheds. The courts *m* will be 30 or 33 feet in length from the gates, according as the sheds are made 15 or 18 feet in width: *o* are turnip-troughs placed against the southern walls of the courts; and *r* are water-troughs. The courts are supplied with straw from the doors of the straw-barn *b*, the most distant ones also through the gates in the walls between the courts; and the turnips are put over the front wall into the troughs from the barrowfuls brought from the respective stores at *g* and *k*; *t* is the horse-course 26 feet in diameter.

1247. The lengths of the wings of the building containing the work-horse stable, the straw-barn, and cow-byre, is 73½ feet each; and the width of the courts may be extended to any length, and the courts increased to any number, to contain the number of cattle to be accommodated; but the courts should in every case face the south, the meridian sun, to receive its heat and drought, and especially as the straw on a pastoral farm will always be scanty for the number of cattle. Ferns form good litter for such courts.

1248. In carse farms, the accommodation of cattle in winter is made a matter of secondary import, and it is not unusual to see the courts facing the north; but there being abundance of straw on such farms, the animals do not feel the cold so severely as might be expected from the exposure.

1249. This form of steading seems well suited for the accommodation of cattle in a carse farm, in fig. 96, where *a* is the corn-barn and chaff-house, 30 feet by 15 feet, above which is the upper barn and thrashing-machine, which should be one of 8 horse power, driven by steam,

Fig. 96.



A PLAN OF A STEADING FOR THE CATTLE OF A CARSE FARM.

there being so much of the long straw of wheat to thrash; *b* is the engine-house, 8 feet by 18 feet; *c* the boiler-house and chimney-stalk; *d* is the straw-barn, 40 feet by 15 feet, and as high as the upper barn; this barn has two doors outside the courts *l*, for the convenience of carrying straw to the work-horse stable and cow-byre, besides another into one of the courts to take out the chaff by. The straw-barn need not be made very large on a carse farm, though there is abundance of straw, as the fresh straw only is used for fodder, and the rest is stacked up by itself in a convenient place ; *e* is the implement house, 15 feet by 15 feet, to contain the small implements, with a wooden floored apartment above, to hold the meal chest for supplying the ploughmen with meal, and other articles of a cleanly and dry nature, requiring to be placed under lock and key ; *f* is the work-horse stable, 102 feet by 18 feet, containing 16 stalls of 6 feet each, for 8 pairs of horses, and provided with two doors and four windows, with a passage by a back-door, opposite *f*, by which the straw from the straw-barn *d* is brought and the dung and litter wheeled out into the court ; *g g* are hay-houses, one at each end of the stable, each 18 feet by 18 feet ; *h* is the cart-shed, 80 feet by 15 feet, containing 8 ports for carts and heavy implements ; *i* is the cow-byre, 40 feet by 15 feet, to contain 8 cows if required, to provide the ploughmen with milk ; *k* is the boiler-house, 26½ feet by 15 feet, a large size for such a purpose, but where so many horses require prepared food, a large store of Swedish turnips, beside bruised corn and beans, is convenient,—the boiler should either be a large one, or two boilers beside each other ; *l l* are the courts for the cattle, each 46 feet long by 38 feet wide, facing the meridian sun, their dimensions being dependant on the length given to the north range of the building, which is determined by the extent of granary accommodation, which cannot be less than 50 feet to each granary, on a farm where much grain is raised; *m m* are the sheds, 18 feet wide, belonging to the courts, one being 38 feet long, the others only 30 feet, on account of the room for the engine ; *n n* are the troughs placed against the south walls of the courts, to contain turnips or bean chaff, as the case may be ; the granaries are over the sheds *m m*, one of the hay-houses *g*, and part of the cart-shed *h* ; over which last place the corn to be driven to market should be kept, to allow the carts to be easily loaded with it; and the other granary will answer for seed and horse-corn, the latter being sent down by a spout into the corn-chest in the hay-house below. Water-troughs should be provided in the cattle-courts.

1250. The outer wings of this steading extend to 141½ feet over the walls.

1251. There are no wintering cattle kept on farms in the neighbourhood of large towns ; the few cattle being fed for the butcher either in byres or hammels.

1252. I have minutely described in what manner the steading of a farm of mixed husbandry is occupied in winter, and how cattle, in general, are fed on turnips ; but cattle are fed on other substances than turnips, either by themselves or in conjunction with turnips. Hitherto potatoes have been the most common substance used for this purpose; but they cannot now be depended upon as a crop, and will probably be a costly food for the future. Oil-cake is used in large quantities, though very expensive. As a substitute for oil-cake, it has been proposed to raise linseed at home, and feed cattle on it in a bruised state. Linseed oil, absorbed in cut straw and hay, has been recommended. Many cattle are fed on the refuse derived from distillation and brewing, commonly called *draff* and *dreg*—the former being in the state of grains, the latter in that of a liquid. Oats, barley-meal, peas-meal, bean-meal, have all been pressed into the service of feeding cattle. We shall now direct our attention to the results of the various substances which have been given to cattle, with a view to expediting their condition towards maturity, as also to the actual states in which these substances should be administered as food to them.

1253. *The Potato.*—The potatoes used in feeding cattle are either the common kinds known in human food, or others raised on purpose, such as the yam and ox-noble ; and they are given either alternately or with turnips. In feeding cattle with potatoes of any kind, and in any way, there is considerable risk of flatulency and choking. To prevent the latter, the potatoes should be smashed with a hammer, or with a instrument like a paviour's rammer; and though some juice will come out in the operation, no great loss would perhaps be incurred. To prevent flatulence from potatoes is no easy matter; but a friend of mine used a plan which completely answered the purpose, which was, mixing some cut straw with the broken potatoes. The straw obliging the cattle to chew every mouthful before being swallowed, may prevent too large a quantity of gas being generated in the paunch, which bruised potatoes alone might do, and it is the pressure from this gas which occasions the distressing complaint called *hoven*. A farm-steward, who had considerable experience in feeding cattle on potatoes on a led-farm, always placed as many potatoes, whole, before the cattle as they could consume, and they never swelled on eating them ; because, as he conjectured, and perhaps rightly, they do not eat them so greedily when in their power to take them at will, as when doled out in small quantities at distant periods. This fact confirms the propriety of mixing cut straw amongst potatoes when given in small quantities, in order to satisfy the appetite, and fill the paunch with unfermentable matter. The only precaution required in giving a full supply of potatoes is, to give only a few, and frequently at first, and gradually to increase the quantity.

1254. The nutrient powers of the potato was carefully examined by Dr Fromberg in 1846. The potato contains a very large proportion of water, on an average about 76 per cent, or three-fourths of its entire weight. The proportion of dry or nutritive matter must, therefore, be on the average only 24 per cent, or one-fourth of the weight.

1255. The quantity of water in the potato depends very much upon the state of ripeness the crop has attained. Young unripe potatoes give 82 per cent, and ripe full-grown ones only 68·6 per cent of water, the solid matter varying from 31·4 per cent in the ripest, to only 18 per cent in the unripest. The water also differs in quantity from the different parts of the potato, the rose end containing the most, the middle next, and the heel end the least; but these distinctions cannot be made available in feeding.

1256. The proportions in the component parts of the potato vary much in those in the natural and in the dry state. For example:—

	Natural.		Dry, in round numbers.
Water	75·52		...
Starch	15·72		64·
Dextrin	0·55		...
Sugar	3·30	and Gum	15·
Albumen, casein, gluten	1·41	Protein compounds	9·
Fat	0·24		1·
Fibre	3·26		11·
	100·00		100·

1257. The ash of the potato consists of, according to—

	Boussingault.	Fromberg. Lanark.	Drummore.	Mean.
Potash	59·95	57·58	49·73	55·75
Soda	traces	3·66	1·93	1·86
Lime	2·09	0·81	3·31	2·07
Magnesia	6·28	4·53	5·03	5·28
Oxide of iron and alumina	0·59	0·42	0·56	0·52
Phosphoric acid	13·16	9·98	14·58	12·57
Sulphuric acid	8·27	14·63	18·04	13·65
Chlorine	3·14	5·16	4·51	4·27
Silica	6·52	3·68	2·49	4·23
	100·00	100·45	100·18	100·20
Per-centage of ash in the dry state	4·00	4·01	3·75	3·92

1258. As the fibrous part forms an important element in the general composition of the potato, the composition of its ash becomes interesting, which is as follows, according to Mr Filgate —

	Fibre.
Potash and soda, with a little common salt	3·72
Lime	50·84
Magnesia	10·21
Oxide of iron	3·82
Phosphoric acid	19·66
Sulphuric acid	5·74
Silica	5·54
	99·53
Per-centage of ash	1·40

"These analyses show," observes Professor Johnston, "that the fibre leaves only one-third of the quantity of ash which is left by the whole potato, and that this ash consists chiefly of lime in the state of carbonate and of phosphate. It appears, therefore, that the alkaline matter of the potato exists chiefly in the sap, while the phosphate of lime is principally attached, in an insoluble state, to the fibre." In feeding, therefore, with potatoes, calves would be most benefited by the fibre, while the sap might be most useful to milk cows.

1259. The quality of nutritive matter derived from a crop of potatoes of 6 tons, or 13,500 lbs., or about 25 bolls per acre, is as follows,—540 lbs. of husk or woody fibre; 2,400 lbs. of starch, sugar, &c.; 270 lbs. of gluten, &c.; 45 lbs. of oil or fat; and 120 lbs. of saline matter.

1260. On comparing the nutritive properties in the solid matter of the potato with other roots, it is found that the potato and yellow turnip do not differ much, though the advantage is on the side of the turnip, but that the mangold-wurtzel exceeds the potato in protein compounds in the ratio of 15½ to 9. "This is a very important fact," remarks Professor Johnston, "and is deserving of further investigation. If, as at present supposed, the protein compounds serve the purpose, when eaten, of supplying to animals the materials of their muscle, the mangold-wurtzel ought to be considerably superior to the potato in this respect. Even in their natural state this should be the case, since 100 lbs. of the mangold-wurtzel contain, of these protein compounds, 2¼, while the potato contains on an average only 2 lbs. It is to be desired, therefore, that the mangold-wurtzel should be more generally cultivated, wherever circumstances are favourable to its growth."*

1261. *Linseed*.—The seed of the flax plant, or linseed, has long been known by farmers to be a very nutritious substance; as well as one that may be used to advantage in certain complaints of cattle, as a safe and efficacious medicine. The whole seed boiled soft, and, together with the water in which it has been boiled, is given in many parts of the country as a cordial drink to cows after calving, and as a tonic to promote recovery after an illness. But, like all seeds having a strong envelope, when administered in a whole state, even on being boiled, is apt to pass through the digestive organs of ruminating animals unaltered. To derive all its nutrient property, it should be used only when bruised or converted into meal. In the form of meal it has long been used, after being boiled into a porridge or jelly, as an assistant food to milk for the older calves, until they are weaned. Linseed meal, when boiled and used hot, forms also an excellent poultice for the drawing of any sore that may affect an animal.

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, pp. 384, 421, 916, 928. To those desirous of following the progress of Dr Fromberg's analysis of the potato, I would refer to his interesting memoir in the *Transactions of the Highland and Agricultural Society* for March 1847, p. 637-98.

1262. The composition of linseed is as follows, according to Leo Meier :—

Oil	11·3
Husk, &c. . . .	44·4
Woody fibre and starch .	1·5
Sugar, &c. . .	10·8
Mucilage . . .	7·1
Soluble albumen (casein?)	15·1 ?
Insoluble do. . .	3·7
Fatty matter . .	3·1
Loss	3·0
	100·0

Beside oil, linseed, we see, contains a considerable proportion of gum and sugar, and a large quantity here called *soluble albumen*, having a great resemblance to the curd of milk. In this respect it resembles the oat, instead of containing gluten. "Besides its *fattening* property," observes Professor Johnston, "which this seed probably owes in a great measure to the oil it contains, this peculiar albuminous matter ought to render it very *nourishing* also ;—capable of promoting the growth of the growing, and of sustaining the strength of the matured animal."

1263. The composition of the ash of linseed is as follows :—

		Riga. Johnston.	Dutch. Johnston.
Potash . .	25·85	17·59	30·01
Soda . .	0·71	6·92	1·88
Lime . .	25·27	8·46	8·12
Magnesia . .	0·22	14·83	14·52
Oxide of iron .	3·67	1·25	0·68
Phosphoric acid .	40·11	36·42	37·64
Sulphuric acid .	...	2·47	2·16
Sulphate of lime .	1·70	...	...
Chlorine . .	...	0·17	0·29
Chloride of sodium (common salt) . .	1·55	...	...
Silica . .	0·92	10·58	5·60
	100·00	98·69	100·90
Per centage of ash	4·63*		

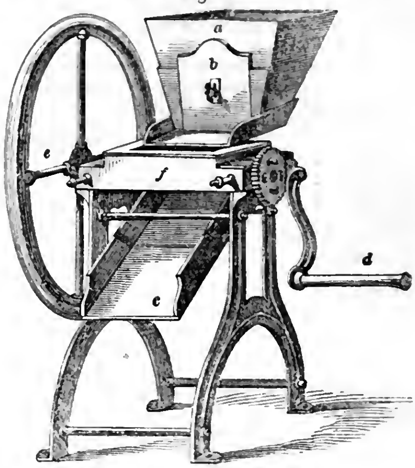
1264. The importation of linseed from abroad is considerable. The Russian seed is the best for sowing, and is of course the highest in price ; but I suppose the inferior seeds, such as the Dutch, will answer every purpose of feeding cattle. In Lithuania, the raising of linseed of the finest quality is an especial object of the cultivators of flax ; and to attain this object they sacrifice the quality of the flax. Accordingly, we find the flax imported from Riga is generally of a coarse quality. The quantity of linseed imported of all kinds, was—

In 1842 . . .	367,700 quarters.
1843 . . .	470,539
1844 . . .	616,947
1845 . . .	633,293
Average of the 4 years	522,120

Taking this average, and assuming the average price at £2, 5s. per quarter, it gives £1,174,770.†

1265. There are several efficient enough machines for bruising linseed into meal, though, from the oleaginous nature of the seed, the rollers are apt to clog up and get out of working order. As simple and cheap a machine for the purpose as is perhaps made, is the one by Mr A. Dean, Birmingham, which is driven by hand, and costs £6, 5s., and is represented by fig. 97, where

Fig. 97.



THE LINSEED BRUISER.

a is the hopper for containing the seed; *f* the box containing the crushing rollers ; *c* the spout down which the meal descends ; *d* the winch-handle which gives motion to the rollers; *e* the fly-wheel ; and *b* the slide which regulates the feed to the rollers.

1266. *Oil-cake.*—Oil-cake has been long and much employed in England for the feeding of cattle, and is making its way in that respect into Scotland. It consists of the compressed husks of linseed, after the oil has been expressed from it, when it is formed into thin oblong cakes. The cakes, when used, are broken into pieces by the machine, fig. 53. Cattle are never entirely fed on oil-cake, which is always associated with other substances, as turnips, potatoes, cut hay, or cut straw. When given with cut hay or straw, an ox will eat from 7 to 9 lbs. of it a-day; and the hay or straw induces rumination, which the cake itself would not do. Oil-cake and cut meadow-hay form a very palatable and nutritious diet for oxen, and is a favourite one in England. When given with turnips or potatoes, 3 lbs. or 4 lbs. a-day will suffice.

1267. The importation of foreign oil-cake is stated at as much as 75,000 tons annually ; and when it is considered that it is very seldom sold so low as £7 per ton, and sometimes as high as £12, an idea may be formed of the large sum sent out of the country every year for the purchase of food for animals. What may be the annual consumption of oil-cake in the kingdom

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 381 and 921.
† *Journal of the Agricultural Society of England*, vol. viii. p. 443.

cannot be ascertained, as a considerable quantity of it is manufactured in this country by the oil-crushers. The English oil-cake bears the highest price in the market, seldom under £11 per ton; and of the foreign, that from Flensburg in Schleswig is most in repute, and sells at from £9 to £10 per ton. There is no doubt that foreign oil-cake is adulterated with the husks of other seeds; and yet no sufficient motive exists for doing this, since the cake is formed when the oil is compressed—unless, indeed, other oil-producing seeds are purposely mixed with the linseed, for adulterating the linseed oil. It seems to me an impossible process to break down pure linseed-cake, and, after mixing it with the husks of other seeds, to compress it again into a solid cake. The oil, therefore, must be adulterated before the cake; and, in that case, the purchasers of foreign linseed oil for feeding cattle would be as much imposed on as when purchasing foreign cake—unless the oil of other seeds is as nutritious as linseed oil, in which case, by a parity of reasoning, the husks of those seeds ought to be as nutritious as those of the linseed. The matter is then brought to this, that the feeder must either purchase pure linseed or raise it for himself.

1268. The nutritive properties of oil-cake have been ascertained by analysis by Professor Johnston. The composition of the oil-cake of commerce is as follows:—

	English linseed-cake.	American linseed-cake.
Water	10·05	10·07
Mucilage	39·10	36·25
Albumen and gluten	22·14	22·26
Oil	11·93	12·38
Husk	9·53	12·69
Ash and sand	7·25	6·35
	100·00	100·00

The large per-centage of protein compounds is nearly equal to that of pease and beans—a result somewhat unexpected, since the value of oil-cake for feeding stock has hitherto been supposed to depend on its power of laying on fat. The proportion of oil, too, is greater than in any of the grains, oats having 7, while the cake has 12 per cent.

1269. Oil-cake leaves 6 per cent of ash. The composition of the ash is as follows:—

	English linseed-cake.	American linseed-cake.
Alkaline salts	31·55	38·20
Phosphate of lime and magnesia	47·67	56·26
Lime	4·88	1·24
Magnesia	1·51	trace.
Silica	10·81	4·04
Sand	3·86	...
	100·28	99·74

The American cake seems one of pure quality. The phosphates are large in quantity, and twice as valuable for making bone as oats or barley. The dung derived from oil-cake is richer than that from even grain, because it contains more phosphate than the animals can use, which therefore must pass away into the dunghill; the oil is in larger quantity than can be appropriated, and must also find its way into the dunghill; and as full-grown animals scarcely appropriate any of the phosphates, when oil-cake is given them to fatten, these will all pass into the dunghill.*

1270. The valuable property of oil-cake, then, is its containing a large proportion of the phosphates. From the consideration of this property, Professor Johnston has recommended a mixture which contains all the ingredients found by analysis in oil-cake, and which, theoretically, ought to produce similar results; but these can only be ascertained by experiment. If such a mixture could be made at less cost than the price of oil-cake, it would be the farmer's interest to use it, instead of taking the trouble of seeking and paying for oil-cake; and if it could be manufactured into the form of durable cakes, it might be transmitted to any part of the country. The mixture is this:—

Bruised linseed	40 lbs.
Bean meal	60
Bone meal, (ground bones)	4
	104

the constituents of which are, in every 100 lbs.:—

Starch	40 lbs.
Protein compounds	27
Fat	11
Saline matter	7
Water and husk	15
	100†

1271. It seems to me extremely doubtful that any such mixture can be made so low in price as to come seriously into competition in the market with oil-cake, because oil-cake will be made, whether or not it can be sold at a high price, as long as oil shall be crushed from seed; and if a high price cannot be obtained for the cake, the oil-crushers will take any price for it rather than keep it. The high price of cake either keeps the price of oil lower than it would be, or gives a higher profit to the oil-crushers. Should the price of oil remain as it is, after farmers shall have manufactured mixtures at home for feeding their cattle, it will show that oil-cake has hitherto realised extravagant prices, which I have long suspected to be the case, as I cannot understand why an article that must be made at all events, should realise in a public market so large a price as £10 per ton, unless the demand for it was inordinate.

1272. The importation of oil-cake from abroad was:—

In 1842	67,293⅓ tons.
1843	63,267¼
1844	85,890
1845	74,681¼
Average of the 4 years	72,783

Taking this average quantity, and assuming the

* *Transactions of the Highland and Agricultural Society* for Jan. 1846, p. 202-4. † *Ib.* p. 207.

average price at £8, 10s. per ton, it gives £618,655, 10s.*

1273. *Distillery Dreg.*—Draff is the exhausted husks of the barley used in distillation, and dreg is the refuse of the still. Dreg is in a state of thin and thick liquid.

1274. Five gallons of thin, and two gallons of thick dreg yield 3 lbs. of dry food. One gallon of the thin, on evaporation, leaves 4,235 grains, and the same quantity of the thick 10,884 grains of dry solid matter.

1275. The 4,235 grains of solid matter from the thin dreg, affords of

Organic matter	3,871 grains.
Inorganic matter	364
	4,235

And the 10,884 grains from the thick dreg, gives of

Organic matter	10,290 grains
Inorganic matter	594
	10,884

Hence weight for weight of the thick dreg contains as little water, and as much organic and inorganic matter, as the turnip.

1276. The 364 grains of the inorganic matter of the thin dreg, and the 594 grains of the thick, contain, on analysis, the following ingredients :—

	Thin dreg.		Thick dreg.	
		Or a gallon contains,		Or a gallon contains,
	Per cent.	Grains.	Per cent.	Grains.
Potash and soda, with a little muriatic and sulphuric acids	46·24	168	38·36	226
Phosphoric acid, combined in the liquid with some of the above potash and soda	21·67	79	24·35	145
Phosphate of magnesia and lime	28·88	104	15·90	94
Siliceous matter	2·56	10	20·95	124
Loss	0·65	3	0·44	5
	100·00	364	100·00	594

Here the alkaline phosphates abound ; and the large proportion of siliceous matter in the thick dreg is probably derived from the husk of the malt, and would render the dreg a good manure for corn and grass, as well as food for young stock. The dairymen in large towns, as I have already noticed, (1242,) give large quantities of dreg to their milk cows, as a drink ; and the nourishing drink is therefore attended with little trouble in its use.†

1277. *Brewers' Draff or Grains.*—Brewers' draff, it is generally understood, contains less nutritive matter than that of distillers.

1278. The composition of brewers' draff is as follows, in every 100 lbs. :—

Water	75·85
Gum	1·06
Other organic matter, chiefly husk	21·28
Organic matter, containing nitrogen, (protein compounds,)	0·62
Inorganic matter, as ash	1·19
	100·00

Here is an evident deficiency in the protein compounds.

1279. The ash is thus composed :—

	Per cent of ash.	In 1000 parts of wet draff.	In 1000 parts of dry draff.
Alkaline salts (chlorides, with a small quantity of sulphates) and alkali	7·60	0·90	3·72
Phosphoric acid in combination with the alkali	2·11	0·25	1·04
Earthy phosphates	48·00	5·81	24·06
Silica	41·51	4·94	20·46
	99·22	11·90	49·28

1280. A bushel of draff weighs about 46 lbs. and costs from 3d. to 3½d. Albumen can be obtained cheaper in oil-cake, but the draff affords the phosphates more economically.

1281. Draff is best used as food when accompanied with other substances, such as turnips, oil-cake, or beans.‡

1282. *Barley Sprouts or Comins.*—"When barley begins to sprout," says Professor Johnston, "it throws its roots immediately outwards from the one extremity, while the young germ (acrospire) proceeds beneath the husk towards the upper extremity of the grain. The maltster arrests the growth before the young germ escapes from the husk ; and when he dries his malt, the young root falls off in considerable quantity. They are known by the name of barley sprouts or comins, and are employed both as a manure and in the feeding of cattle."

1283. Comins, when burned, leave 7·25 per cent of ash, which contain the following ingredients :—

Potash and soda	36·78
Lime	3·09
Magnesia	5·46
Oxide of iron	1·09
Phosphoric acid	24·87
Sulphuric acid	4·84
Chlorine	7·95
Silica, soluble in water	1·80
Insoluble silica	13·96
	99·84

* *Journal of the Agricultural Society of England*, vol. viii. p. 443.
† *Transactions of the Highland and Agricultural Society* for March 1846, p. 305-6.
‡ *Ibid* for January 1847, p. 582.

1284. Comins are thus rich in alkaline salts and phosphoric acid, and silica, and may therefore be advantageously employed, both as food for animals and a manure to plants.*

1285. *Malt.*—Of late years a desire has been expressed by some agriculturists to have the duty taken off malt,—to have the excise restrictions, in fact, removed from the manufacture of this commodity, that they may be enabled to malt their own barley for the purpose of feeding live stock. If this restriction should ever be removed, which I have no doubt will be whenever the necessities of the public revenue allow it, it is interesting to inquire into the changes effected in barley in the process of malting, and thus to ascertain whether barley is really rendered more nutritious by malting, as seems to be the general impression amongst feeders of stock.

1286. According to Dr R. D. Thomson, the composition of the same barley is thus altered by malting:—

	Barley. Natural state	Barley. At 212°	Malt. Natural state	Malt. At 212°
Carbon	41·64	46·11	42·44	43·93
Hydrogen	6·02	6·65	6·64	7·00
Nitrogen	1·81	2·01	1·11	1·29
Oxygen .	37·66	41·06	43·08	46·51
Ash .	3·41	4·17	1·68	1·27
Water .	9·46	...	5·05	...
	100·00	100·00	100·00	100·00

Hence, if these figures are reduced to their equivalents, it appears that barley loses carbon in the process of malting, without doubt, in the form of carbonic acid, and also nitrogen, in the shape of albumen,—possibly in part as ammonia; whilst the malt has gained hydrogen and oxygen—that is water; and 100 parts by weight of barley is reduced to 80 parts by weight of malt.

1287. As regards the comparative nutritive power of barley, when converted into malt, Dr Thomson observes, that "The quantity of nitrogen in different parts of the same sample of malt varies very remarkably—indeed to such a degree that the results obtained by three analysts, who had obtained almost identical numbers for the nitrogen in barley, differed as much as from 1·19 to 1·62. This, indeed, is a circumstance which might be anticipated, from the nature of the process of malting, and is one which renders malt a very objectionable substance as an article of nourishment, since, in the same specimen, different portions would vary so much, according to the preceding data, as that 73 lbs. of one part would produce as much effect in the nourishment of an animal as 100 lbs. of another portion. . . . . So that the nutritive powers of barley and malt, according to these estimates, are as follows:—

59 barley = 100 malt, according to the lowest estimate.
79 ... = ... highest ... "

1288. The comparative composition of the ash of barley and malt is as follows:—

	Barley.	Malt.
Potash . . .	16·00	14·54
Soda . . .	8·86	6·08
Lime . . .	3·23	3·89
Magnesia . . .	4·30	9·82
Oxide of iron . .	0·83	1·59
Phosphoric acid . .	36·80	35·34
Sulphuric acid . .	0·16	...
Chlorine . . .	0·15	trace.
Silica . . .	29·67	28·74
	100·00	100·00
Per-centage of ash	3·05	2·52

1289. The loss sustained by barley in malting may, perhaps, be stated as follows:—

Water	6·00
Saline matter . . .	0·48
Organic matter . . .	12·52
	19·00†

1290. *Barley-meal.*—Barley, when reduced to meal, is used in the feeding of stock, and especially of pigs. Whole grains of barley are boiled in water as a mash for horses. I have just given the composition of both barley and malt, and shall now state the quantity of nutritive matter afforded by an acre of land, from a crop of barley producing 40 bushels per acre:—40 bushels, weighing 2100 lbs., gives of husk or woody fibre 315 lbs.; starch, sugar, &c. 1260 lbs.; gluten, &c. from 250 lbs. to 310 lbs.; oil or fat from 42 lbs. to 63 lbs.; and 60 lbs. of saline matter.‡

1291. *Oats.*—Oats are seldom given to animals as food in the form of meal, but horses are greatly supported, during most part of the year, on the grain of oats, while the meal is used by the labouring people of the farm. The quantity of nutritive matter afforded by an acre of land, from a crop of oats producing 50 bushels per acre, is as follows:—50 bushels, weighing 2100 lbs., give 420 lbs. of husk or woody fibre; 1050 lbs. of starch; from 290 lbs. to 400 lbs. of gluten, &c.; from 75 lbs. to 150 lbs. of oil or fat, and 80 lbs. of saline matter.§

1292. The composition of the grain of the oat is as follows:—

	Hopetoun oats. Ayrshire. Fromberg.	Potato oats. Northumberland. Norton.
Starch . .	64·80	65·60
Sugar . .	2·58	0·80
Gum . .	2·41	2·28
Oil . . .	6·97	7·38
Casein (avenine) .	16·26	16·29
Albumen . .	1·29	2·17
Gluten . .	1·46	1·45
Epedermis . .	2·39	2·28
Alkaline salts, and loss	1·84	1·75
	100·00	100·00

* Johnstone's *Lectures on Agricultural Chemistry*, 2d edition, p. 425-6.
† Thomson's *Experimental Researches into the Food of Animals*, p. 106-121.
‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 928. § *Ibid.*

1293. "The quantities of *oil* given above," Mr Norton observes, "are large, but I think correct. The earlier analyses of oats give from three to four-tenths of a per cent of oil. Both Boussingault and Johnston, however, have recently found from 6 to 8 per cent. This oil is of a beautiful pale yellow colour, and its smell may be perceived on heating oatmeal cakes. The fattening qualities of the oat must be very great. The maize or Indian corn is celebrated for fattening animals, and Dumas gives only 9 per cent as its maximum of fatty matters. Boussingault gives 7 per cent as the average; while Liebig has denied that it contains more than 5 per cent. If we take 7 per cent as the average, the meal of the oat, so far as the oil is concerned, should nearly equal that of the Indian corn."

1294. The per-centage of ash in the oat I have already given, (462,) and the composition of that ash is as follows :—

	Potato oats.	Northumberland. Norton.
Potash	31·56	16·27
Soda		...
Lime	5·32	10·41
Magnesia	8·69	9·98
Peroxide of iron	0·88	5·08
Peroxide of manganese	...	1·25
Sulphuric acid	...	...
Phosphoric acid	49·19	46·26
Chloride of sodium (common salt)	0·35	...
Chloride of potassium	...	5·32
Soluble silica	0·89	...
Insoluble silica	0·98	3·70
	97·86	98·27

"In every part of the plant but the grain," observes Mr Norton, "we have found sulphuric acid in the watery solution of the ash; in the grain it seems to give way to phosphoric acid. In the only instance in which sulphuric acid was present, the grain was from a poor crop, grown on an exhausted soil; and it is possible that the sulphuric acid may have been present only because the crop found it impossible to obtain a full supply of phosphoric acid. The large quantity of phosphoric acid is remarkable; in nearly every case it constitutes almost or quite one half of the ash. It is easy, therefore, to see how the addition of bones or guano should benefit the oat crop. Silica is very small in quantity in the grain, compared with that in other parts of the plant."*

1295. *Pease-meal.*—The pea in the grain, and boiled, is given as food to pigs, while pease-meal is used in bread by the labouring population of the south of Scotland; and it is boiled to the form of jelly, and given to calves amongst milk.

1296. The quantity of nutritive matter derived from an acre of pease is as follows, from a crop producing 25 bushels per acre: 25 bushels = 1600 lbs., give of husk or woody fibre 130 lbs.; of starch, gum, &c., 800 lbs.; of gluten, 380 lbs.; of oil or fat, 34 lbs.; and of saline matter, 48 lbs.

1297. *Bean-meal.*—The bean, when bruised or boiled, is a favourite food of the horse when mixed with oats, or in a mash of boiled barley; and bean-meal is highly relished by fattening oxen.

1298. The quantity of nutritive matter derived from an acre of beans producing 30 bushels, or 1,900 lbs. per acre, is, of husk or woody fibre, 190 lbs.; of starch, sugar, &c., 760 lbs.; of gluten, &c., from 450 lbs. to 530 lbs.; of oil or fat, from 38 lbs. to 57 lbs.; and of saline matter, 57 lbs.

1299. The chemical composition of these grains has not yet been carefully investigated. Let this statement suffice:—

	Composition of the *Grain.*			Composition of the *Meal.*		
	Water.	Husk.	Meal.	Starch.	Legumin.	Gum, &c.
Peas	14·0	10·5	75·5	65·0	23	12
Field beans	15·5	16·2	68·3	69·0	19	12

1300. The proportion of the ash of the pea and bean I have already given (462) and the composition of that of the field-bean and field-pea is as follows :—

	Bean ash. Mean of 3 analyses.	Pea ash. Mean of 4 analyses.
Potash	33·56	36·05
Soda	10·60	7·42
Lime	5·77	5·29
Magnesia	7·99	8·46
Oxide of iron	0·56	0·99
Phosphoric acid	37·57	33·29
Sulphuric acid	1·00	4·36
Chlorine	0·73	...
Silica	1·15	0·51
Chloride of sodium (common salt)	...	3·13
	98·93	99·50

It will be observed from these analyses that those leguminous grains contain a very large proportion of the protein compounds, and are therefore eminently useful in supplying the waste of muscular matter.†

1301. *Indian Corn.*—This grain is very nourishing to every kind of stock. It is raised in very large quantities in America, and is there used both by man and beast. In southern Germany, the horses are chiefly supported upon it, the grain being simply steeped in water for several hours before being used. In Italy, cakes are made of its flour, which are much relished when new baked, but become flinty and hard on being kept. The flour, having a somewhat chalky flavour, will not likely be much relished in this country as a part of the food of the people; but the grain seems well adapted for the fattening of all the domesticated animals, especially poultry.

* *Transactions of the Highland and Agricultural Society* for July 1846, p. 346-53.
† Johnston's *Lectures on Agricultural Chemistry,* 2d edition, p. 377, 895, 928.

1302. The nutritive matter afforded by an acre of this grain, producing 30 bushels, or 1800 lbs., is as follows:—of husk or woody fibre, 100 lbs.; of starch, sugar, &c., 1260 lbs.; of gluten, &c., 216 lbs.; of oil or fat, from 90 lbs. to 107 lbs.; and of saline matter, 27 lbs. The most remarkable result in these particulars is the large quantity of fat contained by this grain.

1303. Its composition when dried, according to Payen, is this:—

Husk	5·9
Gluten, &c.	12·3
Starch	71·2
Sugar and gum	0·4
Fatty matter	9·0
Saline matter or ash	1·2
	100·0

1304. The composition of the ash of the grain from a mean of two analyses, obtained from the United States, by Fromberg, and from Germany by Letellier, is as follows:—

Potash Soda	32·48
Lime	1·44
Magnesia	16·22
Oxide of iron	0·30
Phosphoric acid	44·87
Sulphuric acid	2·77
Chlorine	0·18
Silica	1·44
	99·70

According to the analysis of Letellier, Indian corn consists almost entirely of the phosphates of potash, soda, and magnesia.*

1305. *Warnes' Compound.* — Mr Warnes, Trimingham, in Norfolk, recommends a composition for feeding both sheep and cattle, consisting of linseed and barley, which he says is much superior in nutrition to the best oil-cake; and to this composition he has given the name of Compound.

1306. *Compound for Sheep.*—The directions he gives for making the compound for sheep are these:—Let a quantity of linseed be reduced to a fine meal, and barley flattened into the thickness of a wafer by means of a crushing-mill with smooth rollers. Put 168 lbs. of water into an iron boiler, and as soon as it boils, not before, stir in 21 lbs. of linseed meal, and let the water again boil, which it may do in about 5 minutes. Then let 63 lbs. of crushed barley be sprinkled by hand by one person upon the boiling mucilage, while another person rapidly stirs the mass, cramming in the barley. After the water, linseed, and barley, have entirely incorporated, which will not occupy above 10 minutes, put the lid upon the boiler, and throw the furnace-door open; and should the fire be strong, rake it out, when the mass will continue to simmer, until the barley shall have absorbed all the linseed mucilage. When this has been accomplished, the barley will have resumed nearly its original shape, and may be compared to small oil-cakes, which, when cold, will be devoured by sheep with avidity. After a little practice, the eye will be a sufficient guide as to the proportions of the materials, without the trouble of weighing them. The compound is then put into tubs out of the boiler, and pressed down with a rammer to exclude the air, and prevent rancidity. If properly made, the compound ought to be like clay when made into bricks, in which state it will keep a long time. It will be seen that these proportions consist of 3 parts of barley to 1 of linseed, and of 2 parts of water to 1 of barley and linseed included. Also, that the weight of the whole is 18 stones when put into the boiler, but, after it has been made into compound and becomes cold, it will be found in general reduced to something less than 15 stones.

1307. *Compound for Oxen.*—In making the compound for oxen, the same process as to the cookery is followed, but the barley should be ground into fine meal, the water reduced to 150 lbs., and the fire extinguished, the meal becoming sufficiently cooked by immersion in the hot water and mucilage: the above quantity of 15 stones will afford 1 bullock for a fortnight 1 stone per day, containing 1½ lb. of linseed.

1308. The compound for cattle may be formed into cakes, on being put into moulds with a trowel, while in a hot state, the mould having no bottom, and resting on a board, upon which the cakes are cooled. When cold, the cakes may be cut into pieces like bread, and given to the cattle, but Mr Warnes considers this a troublesome, expensive, and unnecessary proceeding.

1309. The linseed mucilage may be made into a compound with other materials than barley or grain of any kind, the compound with pease and bean meals being a very nutritious mixture. The mixture with turnips, carrots, and mangold-wurtzel, is effected in this way: Let the roots be washed and sliced, and boiled in the boiler with a small quantity of water: when sufficiently boiled, some of the roots are put into a tub with a little linseed meal, and the mass is beaten with a rammer, while another person turns it over until it becomes uniform. In this way one portion after another is prepared. Cut hay or straw and fine chaff may be prepared in the same manner with the mucilage. For example, 1 peck of fine linseed meal is stirred in 20 gallons of boiling water, and in about 10 minutes the mucilage is ready to be poured over 2 bushels of cut hay in a trough at a time, until the mucilage is exhausted; and its absorption by the hay is promoted by beating with a rammer, and on being pressed down.

1310. This quantity of compound will serve 21 scores of sheep for a day, the peck of linseed costing 1s. 9d., or 1d. per score, including the trouble of crushing and boiling it. It is not

* Johnston's *Lectures on Agricultural Chemistry*, p. 892 and 928.

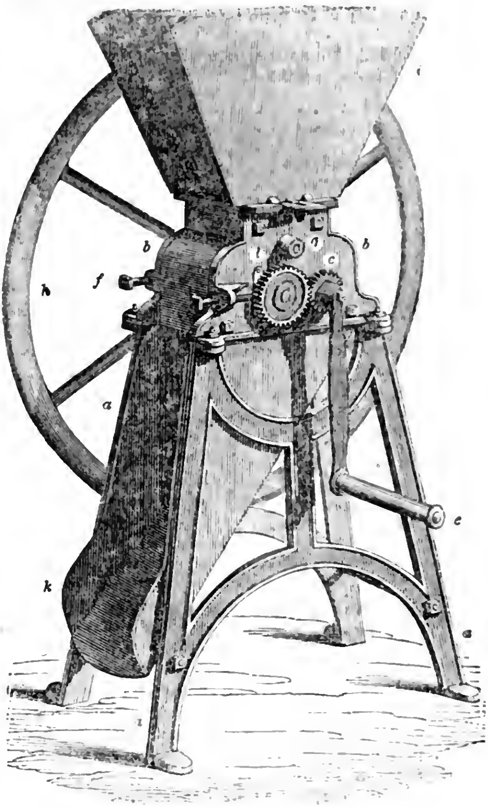
easy to determine the quantity of this which an ox may require, so much depending on the size and condition of the animal; but 1 lb. of linseed meal per day mixed in mucilage, with 2 or 3 skeps of cut straw or hay, along with boiled Swedish turnips, according to experience, will advance the condition of an ox.

1311. The compound may be formed with any kind of farm-produce, provided it contains a proper quantity of the linseed. If barley, beans, or pease be used, they must first be ground into meal; if grass, clover, hay, straw, or pea and bean haulm be used, they must first be cut into chaff; if turnips, carrots, mangold-wurtzel, cabbages, or potatoes, are used, they must first be boiled or steamed; after which all or any of the above materials may be formed into the compound, by admixture of the linseed boiled in water. The compounds are essentially of three kinds—the corn and pulse compound, the root compound, and the grass and chaff compound. These may all run into and mingle with each other, according to circumstances, but they constitute the three leading distinctions, and in one or other of which all the cattle-compounds may be classed—linseed being, however, the chief ingredient for fattening.

1312. The apparatus required for the making of compounds according to Mr Warnes' method, is,—a linseed crusher, a barley mill and bruiser, a boiler, one or two half-hogsheads, and two or three pails, with a ladle, stirrer, and rammer.*

1313. *Corn-bruiser.*—This machine is shown in perspective in fig. 98. It is constructed almost entirely of cast-iron, except the hopper and discharging-spout; but its frame or standard may with propriety be formed of hardwood, when circumstances render the adoption of that material desirable. In the figure, *a a a* is the frame-work, consisting of two separate sides connected by two stretcher-bolts. A case, *bb*, formed of cast-iron plates, is bolted upon the projecting ears at the top of the frame, and contains the bruising cylinders. The cylinders are of cast-iron or of steel, and have an axle of malleable iron passing through them. The spur-wheels *c* and *d* are fitted upon the axle of the cylinders. The cylinder corresponding to *d* is perfectly smooth, while that of *c* is grooved into sharp edges. The grooves lie obliquely on the face of the cylinder. The winch-handle *e* is attached to the axle of the roller *c*, whose bearings are permanent, while those of *d* are movable, being formed in separate plates, and fitted to slide to a small extent in a seat, for the adjustment of the cylinder to any desired grist. This adjustment is effected by means of the screws *f*, which act upon the sliding-plates of the bearings: *g* is one of the bearings of a feeding-roller, placed also within the case; it is turned by means of a toothed wheel fitted upon the further end of its axle, and which is driven by another wheel on the axle of the cylinder *d*. The fly-wheel *h* is fitted upon the axle of the cylinder *c*; *i* is the feeding-hopper, attached to the top of the case by two small hooks; and *k* is a wooden spout to convey the bruised grain from the case. This is a very efficient machine for bruising either oats or beans. From the different velocities of the two cylinders,

Fig. 98.



THE HAND CORN-BRUISER.

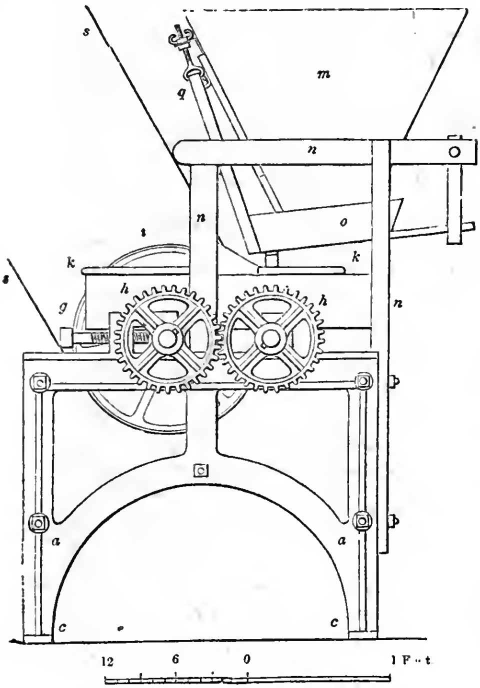
the grooved one being the fastest, it produces a cutting as well as a bruising action, which renders its effects on the grain more perfect than simple pressure. It can be worked by one man, who will bruise 4 bushels of oats in an hour. The price of the machine is £6, 10s.

1314. *Plain Corn-bruiser for power.*—When corn is desired to be merely flattened and not reduced to the mealy state, it is necessary to use plain rollers, and these cannot be worked effectually but by power. Fig. 99 is an elevation of such a machine. It is a very efficient one, and adapted to power. In the figure, *a a* is one of the side-frames of cast-iron, which are connected together by stretcher-bolts, and the frame so formed is bolted to a floor through the palms at *c c*. On the top bar of the frames there are two strong snugs cast sufficient to resist the pres-

* Warnes *On the Cultivation of Flax,* 2d edition, p. 134-266.

sure of the rollers, and are formed also to receive the brass bushes in which the journals of the two rollers are made to run. The two rollers are fitted with malleable iron shafts; one roller runs in permanent bearings, but the other has its bushes movable, for adjustment to the degree of bruising required, and this adjustment is effected by the adjusting screws *g*. The shaft of each roller carries a wheel *h*; one roller has also upon its

Fig. 99.



AN ELEVATION OF THE POWER CORN-BRUISER.

shaft the driving-pulley *i*, which, by means of a belt *s s* from any shaft of a thrashing-machine, or other power having a proper velocity, puts the rollers in motion. The rollers are enclosed in a square wooden case *k k*, in the cover of which a narrow hopper-shaped opening is formed, to direct the grain between the rollers. A hopper *m*, for receiving the grain, is supported on the light wooden frame-work *n n*, which also supports the feeding-shoe *o*, jointed to the frame at *p*, and suspended by the strap *q*, which last is adjustable by a screw at *q*, to regulate the quantity of feed. After passing the rollers, the grain is received into a spout, which either delivers it on the same floor, or through a close spout in the floor below. The price of this machine, as manufactured by Mr Slight, Edinburgh, is £10.

1315. I have now shown you how cattle are treated and fed on turnips in winter, and enumerated a variety of ingredients which are employed separately, or in conjunction with turnips, to fatten cattle. I shall now relate some experiments showing the comparative value in feeding of some of these ingredients and turnips, and then exhibit the comparative advantages of treating cattle in winter in various ways.

1316. The late Earl Spencer made an experiment to ascertain the comparative values of mangold-wurtzel and Swedish turnips in feeding cattle. He selected two steers equally well bred, rising 2-years old, and on the 24th of December 1825, he put one on Swedish turnips, and the other on mangold-wurtzel. Their weights were determined by measurement, both being 4 feet 10 inches in length by 6 feet 5 inches in girth, weighing 668 lbs. each. On the 23d January 1826, one had consumed 1624 lbs. of Swedish turnips, giving an increase of weight to 703 lbs. or absolutely an increase of 35 lbs., which was at the rate of 48¼ lbs. for every ton of turnips consumed. The other consumed 1848 lbs. of mangold-wurtzel, giving a weight of 721 lbs., or absolutely 53 lbs., or at the rate of 65½ lbs. for every ton of the root.

1317. As this difference may have arisen from a greater propensity to fatten, the food was exchanged, and on the 20th February No. 1 had consumed 1884 lbs. of mangold-wurtzel, giving an increase to 734 lbs., having absolutely increased in weight 31 lbs., or at the rate of 36¾ lbs. for every ton of the root. No. 2 had consumed 1880 lbs. of Swedish turnips, making him weigh 734 lbs., or making an increase of 13 lbs., or at the rate of 15½ lbs. to every ton of turnips consumed.

1318. They were then both put on mangold-wurtzel, dividing the food equally between them. On the 19th March they had each consumed 1792 lbs., and No. 1 weighed 784 lbs., giving an increase of 50 lbs., and No. 2 weighed 765 lbs., with an increase of 31 lbs.

1319. It would appear that the propensity to feed in No. 1 was greater than No. 2, in the proportion of 50 to 31; but notwithstanding this, in the first month, when No. 1 was upon Swedish turnips, and No. 2 upon mangold-wurtzel, No. 2 beat No. 1 in the proportion stated above, of 65½ to 48¼. No. 2 in the first month, when feeding on mangold-wurtzel, increased in girth 3 inches, and in the next month, when fed upon Swedish turnips, did not increase in girth at all, indicating a stoppage of growth. "It appears," observes his lordship, "as if there could be no great inaccuracy in estimating the relative weight of the animals, as, soon after the experiment was concluded, I sold No. 1 to a butcher in the county for £24, 3s., and No. 2 at Smithfield for £24."*

1320. It would appear, from experiments made by the late Mr Moubray of Cambus, Clackmannanshire, that cattle may be fed on turnips and hay as cheaply as on turnips and straw, because, when straw is given, more turnips are consumed,

* *Journal of the Agricultural Society of England*, vol. ii. p. 297.

and, therefore, when turnips are scarce, hay may be used with advantage.

1321. It would also appear, from other experiments made by him, that cattle may be fed cheaper on distillery draff and dreg than on turnips and straw; but the distillery refuse requires more time to bring cattle to the same condition, which in some circumstances may be an inconvenience.*

1322. Linseed oil has been successfully employed by Mr Curtis of West Rudham, in Norfolk, to feed cattle. His mode of using the oil is this:—First ascertain how much cut straw the oxen intended to be fed will consume a-week, then sprinkle the oil on the cut straw, layer upon layer, at the rate of 1 gallon per week per ox. The mixture, on being turned over frequently, is kept 2 days before being used, when a slight fermentation takes place, and then the oil will scarcely be discerned, having been entirely absorbed by the straw, which should, of course, be the best oat straw. This mixture, when compared with oil-cake, has stood its ground.

1323. Linseed of fine quality weighs 52 lbs. per bushel, and yields from 11 to 12 gallons of oil per quarter, weighing 9⅓ lbs. per gallon, or about 25 per cent of its weight. The price of linseed oil is about 34s. per cwt. of 12¼ gallons, which makes the feeding of an ox only cost 2s. 10d. per week.†

1324. Mr Curtis has fed cattle for upwards of 20 years upon what he calls *green malt*, which consists of steeping light barley "for 48 hours in soft water, when the water is let off, and the barley is thrown into a round heap, in a conical form, till it gets warm and begins to sprout freely. It is then spread out and turned over repeatedly as it grows. The only care required is, that the sprout or future blade does not get cut off, as the malt will then loose much of its nutritious quality." He finds this substance, which costs with its labour 1s. a stone, preferable to oats at 10d. in their natural state.‡ It is questionable, however, that, if this mode of treating barley were generally adopted by feeders of stock, they would not become amenable to the Excise laws. The experiment might be dangerous; and every question with the Excise, as is well understood, invariably leaves its opponent the loser.

1325. Mr Brodie, Abbey Mains, East Lothian, made an experiment on feeding cattle, from October 1836 to June 1837, on different kinds of food. There were 4 lots of cattle, consisting of 5 each. The first lot was fed on turnips and straw, which, being the usual treatment, formed the standard of comparison. The second lot had half the weight of turnips and 30 lbs. of oil-cake a-day. A third lot was fed on the last quantity of turnips and bean-meal and bruised oats. And the fourth had distillery grains and ground beans. The value of the cattle, when put up to feed, was £11 a-piece, and they were of the Aberdeenshire polled breed. This is a summary of the cost of feeding:—

		£	s.	d.
Lot 1.	White turnips at 8s. 4d., swedes at 12s. 6d. per ton, cost .	£53	9	10
	Average cost of each beast per week	0	6	3
Lot 2.	Turnips as above, oil-cake, £7, 15s. per ton, cost . .	£48	16	0
	Average cost of each beast per week	0	5	9
Lot 3.	Turnips as above, bean-meal, 5s., bruised oats, 3s. 6d. per bushel, cost . . .	£58	8	1
	Average cost of each beast per week	0	6	8
Lot. 4.	Turnips and bean-meal, as above, draff, 4s. 6d. per quarter, dreg, 2s. 6d. per puncheon, cost .	£63	3	2
	Average cost of each beast per week	0	7	2

The ultimate results are as follows:—

Lots.	Live weight.	Beef.	Tallow.	Hide.
	st.	st. lbs.	st. lbs.	st. lbs.
1.	536	283 3	36 10	27 13
2.	552	295 10	41 6	29 6
3.	517	280 7	37 2	26 13
4.	545	280 0	36 11	25 7

"Upon the whole," concludes Mr Brodie, "it is evident, by these experiments, that feeding with turnips as an auxiliary has been the most advantageous mode of using turnips, as, by the above statement, it is apparent that if the cattle of the first lot had only been allowed half the quantity of turnips which they consumed, and had got oil-cake in lieu of the other half, as was given to the second lot, the expense of their keep would have been lessened £4, 13s., and from superior quality of beef, their value would have been increased £10, making together £14, 13."§

1326. Some remarks occur to me on the progress of this experiment,—that if the cattle had been sold on the 7th April 1837, when they were adjudged by competent farmers, they would not have repaid the feeder his expenses, as the price of lot first, with the cost of feeding to that time, amounted to £95, 1s. 8d., and they were only valued at £82; lot second cost £90, 12s., and were valued at £88, 10s.; lot third £93, 4s., and valued at £77; and lot fourth £97, 4s. 5d., and their value was only £81, 10s. And this is almost always the result of disposing of cattle before the *end of the feeding season*, because it is only after they attain high condition that the quality of the meat improves so rapidly as to enhance its value so as to leave a profit. As with sheep so with cattle, the inside is first filled up before the outside indicates condition. This result should be a useful hint to you to weigh well every consideration before disposing of your fattening beasts in the middle of the feeding

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv., p. 61. † *Ibid.* p. 587.
‡ *Ibid.*, p. 588. § *Quarterly Journal of Agriculture*, vol. viii. p. 331.

season. The cattle of the first lot continuing to receive the same sort of food they had been accustomed to, throve more rapidly at first than those in the other lots, but afterwards lost their superiority; thereby corroborating the usual experience of stock not gaining an advantage immediately on a change of food, even of a better description, such as from turnips to grass.

1327. Pollard or bran has been often recommended to be given to feeding cattle. Mr Dobito gave, in the early part of the season of feeding with white turnips, half a stone of bran to each beast a-day, with an equal quantity of oat-hay or straw, and no oil-cake. "Some persons," observes Mr Dobito, "may fancy this food is of too loosening a nature; but I can assure them, from several years' experience, that although pollard is loosening by itself, it has the effect of preventing the watery white turnips from purging too much. Although the bullocks do not gain much in weight during this time, yet I am satisfied they go on faster afterwards,—the reason of which, I suspect, is, that their bodies are more prepared for the artificial state they have to live in for the next few months." In November swedes are given 1 bushel, cut with a slicer, for the day's consumption; then a dry bait, consisting of 2 lbs. of oil-cake, 3 lbs. of bran, and a little hay-chaff; and turnips again. The bran can be purchased for £4, 15s. a ton.* Would not oil-cake answer all the purposes of bran as to preparing the bodies of the cattle for the feeding they are afterwards to receive? I think it would.

1328. At one time it was a question whether cattle would thrive better on food prepared or cooked for them by means of fire. It was well understood that horses and pigs both fattened and continued healthy upon prepared food; and the experience of dairymen in large towns established the fact, that cows gave a much greater quantity of milk on prepared than on raw food. Still it was believed that cattle would not fatten well on boiled or steamed food, from the opinion, that food given in a comminuted state to cattle, which are ruminating animals, the cud would be prevented being chewed. Be that as it may, the Highland and Agricultural Society, by premium, induced several farmers to put the matter to the test of experiment, and independent of the supposed effect of prepared food upon the system of ruminating animals, it was desirable to ascertain whether, even should cattle be found to thrive equally well on prepared as on raw food, the trouble incurred in preparing it would be repaid by the superior condition of the cattle, for unless this was decidedly the case, there would be no use of undertaking the trouble.

1329. The results of the experiments undertaken in consequence of the Society's premium were, that no profit attends the feeding of cattle on prepared food. The first instance I shall notice, in support of this conclusion, are the experiments of Mr Walker, Ferrygate, East Lothian. He selected, in February 1833, 6 heifers of a cross between country cows and a short-horn bull, that had been on turnips, and were advancing in condition, and divided them into 2 lots of 3 heifers each, and put one lot on steamed food, and fed them three times a-day, at daybreak, noon, and an hour before sunset. The food consisted of as many swedes as they could eat, with 3 lbs. of bruised beans and 20 lbs. of potatoes, with ½ stone of straw and 2 ounces of salt to each beast. The three principal ingredients were mixed together in a tub placed over a boiler of water, and cooked by steaming. The lot on raw food also got as many swedes as they could eat, and bruised beans were given them at noon, and one-half of the potatoes in the morning and another half in the afternoon. It was soon discovered that the lot on the cooked food consumed more turnips than the other, the consumption being exactly 37 cwt. 16 lbs., whilst, when eaten raw, it was only 25 cwt. 1 qr. 14 lbs., the difference being 55 lbs. every day, which continued during the progress of the experiment for 3 months.

1330. Steers were experimented on as well as heifers, there being 2 lots of 2 each. They also got as many Swedish turnips as they could eat, and had 30 lbs. of potatoes and 4½ lbs. bruised beans, 2 oz. of salt, and ½ stone of straw each, every day.

1331. The cost of feeding the heifers was as follows:—

3 heifers on *steamed* food—

Consumed of.	Cwt.	qr.	lb.	per cwt.	£	s.	d.
Swedish turnips,	37	0	16	at 4d.	£0	12	4¾
Potatoes .	3	3	0	at 1s. 3d.	0	4	8
Beans, 1 bushel	0	2	7	.	0	3	0
Salt				.	0	0	0¾
Coals and extra labour .				.	0	2	0
Cost of 3 heifers 1 week .					£1	2	1½
or 7s. 4½d. per week each.							

3 heifers on *raw* food—

Consumed of.	Cwt.	qr.	lb.	per cwt.	£	s.	d.
Swedish turnips	25	1	14	at 4d.	£0	8	6¼
Potatoes, beans, and salt, as above					0	7	8¾
Cost of 3 heifers 1 week .					£0	16	3
or 5s. 5d. each per week.							

2 steers on *steamed* food—

Consumed of.	Cwt.	qr.	lb.	per cwt.	£	s.	d.
Swedish turnips	28	2	0	at 4d.	£0	7	10
Potatoes .	3	3	0	at 1s. 3d.	0	4	8
Beans . .	0	2	7	.	0	3	0
Salt				.	0	0	0½
Coals and extra labour .				.	0	1	6
Cost of 2 steers for 1 week .					£0	16	0½
or 8s. 6¼d. each per week.							

2 steers on *raw* food—

Consumed of	Cwt.	qr.	lb.	per cwt.	£	s.	d.
Swedish turnips	17	2	0	at 4d.	0	5	10
Potatoes, beans, and salt, as above					0	7	8½
Cost of 2 steers for 1 week .					£0	13	6½
or 6s. 9¼d. each per week.							

* *Journal of the Agricultural Society of England*, vol. vi. p. 77.

1332. The following table shows the progress of condition made by these heifers and steers.

Cattle.	Average live-weight of 3 at commencement of feeding.	Average live-weight of 3 at end of feeding.	Average increase of live-weight in 3 months.	Average dead-weight of beef.	Average weight of tallow.	Average weight of hide.	Average weight of offal.
	St.	St. lbs.	St. lb.	St. lbs.	St. lbs.	St lbs.	St. lbs.
Heifer on steamed food	74	90 0	16 0	50 0	7 11	3 12	26 9
Heifer on raw food .	74	89 3	15 0	50 1	8 4	4 4	26 10
Steer on steamed food	84	103 4	19 0	56 19	8 11	5 12	28 3
Steer on raw food .	90	106 5	15 0	58 6	8 8	5 4	30 4

1333. The comparative profits on the cooked and raw food stand thus :—

Live-weight of 1 heifer, when put to feed on *steamed* food, 74 st.=42 st. 4 lbs. beef, at 5s. 6d. per stone, sinking offal	£11	12	7
Cost of keep 12 weeks 5 days, at 7s. 4½d. per week	4	19	0
Total cost .	£16	11	7
Live-weight of the same heifers, when finished feeding on steamed food, 90 st.=50 st. 9 lbs., at 6s. 6d. per stone, sinking offal	16	9	1½
Loss on steamed food on each heifer	£0	2	6½
Live-weight of 1 heifer, when put to feed on *raw* food, 74 st.=42 st. 4 lbs. beef, at 5s. 6d. per stone, sinking offal,	11	12	7
Cost of keep 12 weeks 5 days, at 5s. 5d. per week	3	8	10½
Total cost	£15	1	5½
Live-weight of the same heifer when finished feeding on raw food, 89 st. 3 lbs.=50 st. 1 lb., at 6s. 6d. per stone, sinking offal	16	5	5½
Profit on raw food on each heifer	£1	4	0
Live-weight of 1 steer when put up to feed on *steamed* food, 84 stones=50 st. 4 lbs., at 5s. 6d. per stone, sinking offal	£13	4	0
Cost of keep 12 weeks 5 days, at 8s. 6¼d. per week	5	8	4
Total cost	£18	12	4
Live-weight of the same steer after being fed on steamed food, 104 st. 7 lbs.= 56 st. 10 lbs., at 6s. 6d. per stone, sinking offal	£18	8	7½
Profit on each stot on steamed food	£0	3	8¼
Live-weight of 1 steer when put on *raw* food, 90 st. = 51 st. 6 lbs., at 5s. 6d. per stone, sinking offal	£14	2	10¼
Cost of 12 weeks 5 days' keep, at 6s. 9¼d. per week	4	6	1
Total cost	£18	8	11¼
Live-weight of the same steer after being fed on raw food 106 st. 7 lbs.=58 st. 6 lbs. at 6s. 6d. per stone, sinking offal	18	19	9¼
Profit on each steer on raw food	£0	10	10

1334. The facts brought out in this experiment are these:—It appears that the turnips lose weight on being steamed. For example, 5 tons 8 cwt. only weighed out 4 tons 4 cwt. 3 qrs. 16 lbs. after being steamed, having lost 1 ton 3 cwt. 12 lbs., or ⅕ of weight; and they also lost ⅕ of bulk when pulled fresh in February; but on being pulled in April, the loss of weight in steaming decreased to ⅙. Potatoes did not lose above $\frac{1}{38}$ of their weight by steaming, and none in bulk. The heifers on steamed food not only consumed a greater weight of fresh turnips, in the ratio of 37 to 25; but after allowing for the loss of steaming, they consumed more of the steamed turnips. Thus, after deducting ⅕ from 37 cwt. 16 lbs.—the weight lost in steaming them—the balance 29 cwt. 2 qr. 17 lbs. is more than the 25 cwt. 1 qr. 14 lbs. of raw turnips consumed, by 4 cwt. 1 qr. 3 lbs. All the cattle on the steamed and raw food relished salt; so much so, that when it was withheld, they would not eat their food with the avidity they did when it was returned to them.

1335. Steamed food should always be given in a fresh state—that is, new made; and if old, it becomes sour, when cattle will scarcely touch it. and the sourer it is they dislike it the more. "In short," says Mr Walker, "the quantity they would consume might have been made to agree to the fresh or sour state of the food when presented to them. . . . We are quite aware, that to have done a large quantity at one steaming would have lessened the expense of coal and labour, and also, by getting sour before being used, saved a great quantity of food; but we are equally well aware, that, by so doing, we never could have fattened our cattle on steamed food."

1336. An inspection of the above table will show that both heifers and steers increased more in live-weight on steamed than on raw food; the larger profit derived from the raw food arising chiefly from the extra expense incurred in cooking the food. It appears, however, that a greater increase of tallow is derived from raw food. The results appear nearly alike with heifers and steers of the same age; but if the steers were of a breed possessing less fattening propensity than cross-bred heifers,—and Mr Walker does not mention their breed,—then they would seem to acquire greater *weight* than heifers, which I believe is the usual experience. The conclusion come to by Mr Walker is this: "We have no hesitation in saying that, in every respect, the advantage is in favour of feeding with raw food.

But it is worthy of remark, that the difference in the consumption of food arises on the turnips alone. We would therefore recommend every person wishing to feed cattle on steamed food to use potatoes, or any other food that would not lose bulk and weight in the steaming process; as there is no question that, in doing so, they would be brought much nearer to each other in the article of expense of keep. . . . Upon the whole, we freely give it as our opinion, that steaming food for cattle will never be attended with beneficial results under any circumstances whatever; because it requires a more watchful and vigilant superintendence during the whole process, than can ever be delegated to the common run of servants, to bring the cattle on steamed food even upon a footing of equality, far less a superiority, to those fed on raw food." *

1337. One of the steers fed on raw, and another on steamed food, were kept and put to grass. In their external condition, no one could have said how they had been fed. They were put to excellent grass on the 20th May, and the steer on raw food gained condition until 20th July, when, perhaps, the pasture may have begun to fail. That on steamed food lost to that time 3 stones live-weight. On 20th August both were put on cut grass, and both improved, especially the one that had been on steamed food, until the 18th October, when both were put on turnips, and both gained alike by the 10th November—that is, the steer on raw food increased from 108 to 120 stones, and the other from 106 to 118 stones, live-weight.

1338. One instance in a question of this nature will not suffice. Similar results as to profit were obtained by the experiments of Mr Howden, Lawhead, East Lothian. "To me," he says, "it has been most decidedly shown that preparing food in this way [by steaming] is any thing but profitable. Local advantages—such as fuel and water being at hand—may enable some others to steam at less expense; but in such a situation as mine, I am satisfied that there will be an expense of more than 10s. a-head upon cattle incurred by the practice. A single horse-load of coals, carriage included, costs me 10s.; and exactly 6 cart-loads were required and used in preparing the food for the cattle, equal to 6s. 8d. each, and probably as much more would not be an over-estimate for the additional labour in the 3 months." A few facts, worthy of attention, have been brought to light by Mr Howden's experiment, and we shall attend to these without going into details. It seems that raw potatoes and water will make cattle fat,—a point which has been questioned by some of our best farmers. Potatoes, beans, and oats, taken together, will feed cheaper, in reference to time, than turnips or potatoes separately; and from this fact may be deduced these others, namely, that potatoes, when used alone, to pay their expense, would require the beef fed by them to fetch 4d. per lb.; turnips alone 3½d.; while potatoes and corn together would require 3d., and the beef of finer quality. This is a curious fact. Of 6 heifers, 1 in a lot of 3 weighed 1022 lbs.; and another, in another lot of 3, weighed also 1022 lbs., on 5th March, when both were put up to be experimented on, the one on raw and the other prepared food; and on the 5th June following, after both had consumed 140 lbs. of turnips a day, they were of the same weight, namely, 1176 lbs., exactly showing an increase of 154 lbs. This is a remarkable coincidence; but here it ends, and the superiority of cooked food becomes apparent; for the beef of the heifer fed on raw turnips weighed 43 stones, and its tallow 5 stones 10 lbs.; whereas that of the one fed on steamed turnips was 44 stones 4 lbs., and its tallow 6 stones 12 lbs. How is this to be accounted for? Partly, no doubt, on the food being cooked, but partly, I should suppose, from the superior state of the animal, indicated by its thinner hide, being 8 lbs. lighter, imparting a greater disposition to fatten. Mr Howden, however, mentions this fact. The turnips for the experiment were stored against a wall, one store having a northern and another a western aspect; but whether from aspect, or dampness, or other cause, those intended to be eaten *raw* had fermented in the store a while before being observed, and thus, becoming unpalatable, of the 18 tons 15 cwt. stored, about 2¼ tons were left unconsumed; so that, in fact, the heifers upon the raw turnips did not receive their food in so palatable a state as those on the steamed. Steaming renders tainted turnips palatable as well as musty hay, while it has a contrary effect on tainted potatoes, the cattle preferring the raw. Turnips require a longer time to steam, and, according to Mr Howden's experience, they lose ⅛ or $\frac{1}{10}$ more of their weight than potatoes.† You may observe, from the state of the turnips in the store, the injudiciousness of storing them *against a wall*, as I have before observed (831.)

1339. Mr Boswell of Kingcausie, in Kincardineshire, comes to the same conclusion as to the unprofitableness of feeding cattle on cooked food. He observes, "that it is not worth the trouble and expense of preparation to feed cattle on boiled or steamed food; as, although there is a saving in food, it is counterbalanced by the cost of fuel and labour, and could only be gone into profitably where food is very high in price and coal very low." His experiments were made on 10 dun Aberdeenshire horned cattle, very like one another, and their food consisted of the Aberdeen yellow bullock turnips and Perthshire red potatoes. The 5 put on raw food weighed alive 228 stones 11 lbs., and the other 5 on cooked, 224 stones 6 lbs. imperial. When slaughtered, the butcher considered both beef and tallow "to be perfectly alike." Those fed on raw food cost £32, 2s. 1d., on cooked £34, 5s. 10d., leaving a balance of £2, 3s. 9d. in favour of the former. Circumstances attending the feeding of cattle are not alike in all cases. Thus, Mr Boswell found, "That the lot on raw consumed much more food than those on steamed," a result directly the opposite of that stated by Mr Walker, (1329.) "Twice a-week, on fixed days," he

* *Prize Essays of the Highland and Agricultural Society*, vol. x. p. 253-266. † *Ibid.* p. 266-70.

observes, "both lots got a small quantity of the tops of common heath, which acted in the way of preventing any scouring; in fact, turnip-cattle seem very fond of heather as a condiment.

1340. The dung of the steamed lot was from first to last in the best state, without the least appearance of purging, and was free of that abominable smell which is observed when cattle are fed on raw potatoes, or even when a portion of their food consists of that article. Another fact was observed, that after the steamed lot had taken to their food, they had their allowance finished sooner than the raw lot, and were therefore sooner able to lie down and ruminate."

1341. Mr Boswell mentions a curious fact regarding the preference or dislike shown by cattle for food in different states. "When *raw* turnips and potatoes were put into the stall at the same time, the potatoes were always eaten up before a turnip was tasted; while, on the other hand, steamed turnips were eaten in preference to steamed potatoes."*

1342. Before leaving this subject, I shall mention some interesting conclusions arrived at by Mr Robert Stephenson, Whitelaw, East Lothian, while experimenting on the feeding of cattle. He put up three lots of 6 each, one fed on oil-cake, bruised beans, bruised oats, with whatever turnips they could eat, and potatoes on the last few days of the experiment: another lot received the same sort of food, with the exception of the oil-cake; and the third had turnips entirely. The live-weights of the lots varied from $346\frac{1}{2}$ to 486 imperial stones. The experiment was conducted for 17 weeks, from November 1834 to March 1835.

1343. Each beast that got—

Oil-cake cost . . .	6s.	per week.
Corn	4s. 6d.	...
Turnips	2s. 3d.	...

1344. Estimating the value of fed beef at 6s. 6d. per imperial stone, the—

Loss incurred by the oil-cake was		$12\frac{1}{3}$	per cent.
Gain left ...	corn ...	$8\frac{1}{2}$	...
... ...	turnips ...	22	...

1345. It took—

90 lbs. of turnips to produce 1 lb. of live-weight.
40 lb. of potatoes ... ...
$8\frac{7}{10}$ lbs. of corn ... ...
$21\frac{8}{10}$ lbs. of oil-cake ... ...

1346. The cost of doing this was as follows:—

	Per 1 lb. of live-weight.
90 lbs. of turnips, at 4d. per cwt.,	$3\frac{3}{10}$d.
40 lbs. of potatoes, at 1s. 6d. per cwt.,	$6\frac{4}{10}$d.
$8\frac{7}{10}$ lbs. of corn at 3s. 3d. per bushel of 40 lbs.	$5\frac{6}{10}$d.
$21\frac{7}{10}$ lbs. of oil-cake, at $\frac{3}{4}$d. per lb, or £7 per ton, . . .	$16\frac{3}{10}$d.

1347. These numbers are not absolute and invariable, and apparently similar circumstances in the feeding of cattle will produce dissimilar results. What the circumstances are which regulate the tendencies of cattle to fatten, are yet unknown. The fact is, cattle consume very different quantities of turnips in different states of condition, consuming more when lean, in proportion to their weight, than when fat. A lean beast will eat twice, or perhaps thrice, as many turnips as a fat one, and will devour as much as $\frac{1}{6}$ part of his own weight every day, while a very fat one will not consume $\frac{1}{10}$. Some steers of Mr Stephenson's, in November ate $2\frac{7}{10}$ lb. for every stone of live-weight they weighed; the year after the quantity decreased to $1\frac{9}{10}$ lb., and after the experiment was concluded, when their live-weights were nearly doubled, they consumed only $1\frac{5}{10}$ lb. I had a striking example of this one year, when I bought for £6, in April, a very lean 2-year-old steer, a cross betwixt a short-horn bull and Angus cow; a large-boned thriving animal, but his bones were cutting the skin. He was immediately put on Swedish turnips; and the few weeks he had them, before being turned to grass, he could hardly be satisfied, eating three times as much as the fat beasts in the same hammel. He was grazed in summer, and fed off on turnips and sold in April following for 17 guineas.

1348. The results of these experiments were, that oil-cake is an unprofitable food for cattle, that corn yields a small profit, that turnips are profitable, and that when potatoes can be sold at 1s. 6d. per cwt. they are also unprofitable. "When any other food than turnips," observes Mr Stephenson, "is desired for feeding cattle, we would recommend bruised beans, as being the most efficient and least expensive: on this account we would prefer bruised beans alone to distillery offal. As regards linseed-cake, or even potatoes, they are not to be compared to beans. . . . . We give it as our opinion, that whoever feeds cattle on *turnips alone* will have no reason, on the score of *profit*, to regret their not having employed more expensive auxiliaries to hasten the fattening process. This opinion has not been rashly adopted, but has been confirmed by a more extended and varied experience in the feeding of cattle than has fallen to the lot of most men."

1349. Whether cattle consume food in proportion to their weights, Mr Stephenson observes, "that cattle consume food something nearly in proportion to their weights, we have very little doubt, *provided they have previously been fed in the same manner, and are nearly alike in condition.* Age, sex, and kind, have little influence in this respect, as the quantity of food consumed depends much on the length of time the animal has been fed, and the degree of maturity it has arrived at,—hence the great difficulty of selecting animals to be experimented upon. To explain our meaning by an example, we would say that 2 cattle of the same weight, and which had been previously kept for a considerable time on similar food, would consume about the same quantity. But, on the contrary, should 2 beasts of the same

* *Prize Essays of the Highland and Agricultural Society*, vol. x. p. 271.

weight be taken, the one fat and the other lean, the lean beast would perhaps eat twice, or perhaps thrice, as much as the fat one; more especially if the fat one had been for some time previously fed on the same food, as cattle eat gradually less food until they arrive at maturity, when they become stationary in their appetite."

1350. "We shall conclude," he says, "by relating a singular fact"—and a remarkable one it is, and worth remembering,—"that *sheep* on turnips will consume nearly in proportion to *cattle*, weight for weight; that is, 10 sheep of 14 lbs. a-quarter, or 40 stones in all, will eat nearly the same quantity of turnips as an ox of 40 stones; but turn the ox to grass, and 6 sheep will be found to consume an equal quantity. This great difference may perhaps," says Mr Stephenson, and I think truly, "be accounted for by the practice of sheep cropping the grass much closer and oftener than cattle, and which, of course, prevents its growing so rapidly with them as with cattle."*

1351. Notwithstanding these results, which were undoubtedly obtained from carefully conducted experiments, instances are not awanting in which cattle have been very profitably fattened upon prepared food. Mr Warnes, for example, has fattened bullocks on his compound of linseed, with barley and beans, or any other of the substances I have enumerated in describing the method of making it for cattle. (1307.) It will be necessary to quote a few instances of Mr Warnes' success. "The last of my experimental bullocks for 1841," he observes, "was disposed of at Christmas, at 8s. 6d. per stone. He weighed 60 st. 5 lbs. imperial; cost £7, 17s. 6d. thirteen months previously; so that he paid £17, 10s. for little more than one year's keeping. His common food was turnips and grass: 14 lbs. a-day of barley or pease compound were given him for 48 weeks, and an unlimited quantity the last five weeks; when, considering the shortness of that time, his progress was perfectly astonishing,—not only to myself, a constant observer, but to many graziers and butchers who had had occasional opportunities of seeing him. Altogether, the weight of compound consumed did not exceed 2 tons 4 cwt., at the cost of only £3, 16s. per ton." . . . . "A few bullocks were shown by Mr Warnes as proofs of the fattening properties of the compound; and, as much difference of opinion was expressed respecting the weight, 2 were killed on the spot, viz., a Devon steer, and a young home-bred heifer. The following are the particulars of the cattle slaughtered:—the Devon bullock, purchased on the 8th of January, at £9, 15s., killed on the 28th October following, weighed 58 st. 10 lbs., loose fat 8 st. 7 lbs., value of the carcass at 8s. per stone, £23, 10s.; which, after deducting the cost price, and £8, 11s. for compound, leaves a balance of £5, 4s., with the manure for turnips and grass, the real value of which was trifling, on account of the small quantity consumed. The home-bred was only 11 months old, and was purchased in May at £3. It weighed 29 st. 12 lbs., loose fat 4 st. 2 lbs., value of the carcass at 8s. per stone, £12, leaving a balance of £9 for compound and grass; latterly it had a few turnips and potatoes, but no milk or any other food whatever." The lowest priced beasts always pay the best when fed on compound. Two small bullocks purchased by Mr Warnes, and one bred on the farm, were worth £4, £3, 3s., and £4, 10s. respectively. "Two of them were Durham heifers, the other Norfolk bred; their ages 18 months each when killed. The first weighed 46 st. 7 lbs.; the second 41 st. 2 lbs.; the third 35 st. imperial, making 122 st. 9 lbs., which, at 6d. per lb. the current price of beef in the neighbourhood, amounts to £42, 18s. 6d.; and had I sold them by weight," observes Mr Warnes, "would have afforded a balance of £31, 5s. 6d., and a profit unexampled in the agricultural history of this county—unexampled on account of the shortness of time, the size of the animals, the smallness of the outlay, and the food being entirely a home production Should it be asked, what was their condition when purchased? I refer to the cost price."

1352. These instances are, perhaps, sufficient to establish the intrinsic value of the compound as a fattener of cattle; but it is of importance to establish its superiority over oil-cake, and if it be not, there is little likelihood of people taking the trouble of making compound, for it must be admitted, on all hands, that its use is attended with considerable trouble. To make the comparison, 6 beasts selected to be fed on compound weighed 602 st., and 6 beasts on oil-cake, 590 st., the former 6 having the advantage of weight to neat cattle of 12 st. When fat, the former weighed 725 st. and the latter 705 st., giving a balance in favour of the former of 20 st.; from which falls to be deducted the 12 st. originally possessed by them, thus leaving still a balance in their favour of 8 st. But a greater difference than this was shown by the dead-weight; which, of beef, loose fat, and hides, was 38 st. 6 lbs. more of the compound-fed than of the oil-cake-fed beasts. Nor would the mere value of the beef and fat show the superiority of the compound-fed, as these consumed a smaller quantity of turnips, and their compound only cost £19, 6s. 1½d., while the oil-cake was £21, 14s. 9d.†

1353. This, however, does not exhaust the subject of feeding cattle on linseed. Mr Joseph Marshall, Holme Lodge, Bedale, Yorkshire, has presented it to the notice of agriculturists in another aspect. On his farm, the food is prepared, and all other work connected with the system performed, by one man, except the grinding of the corn, which is done at the mill. He uses Dean's hand-mill, fig. 97, for crushing the linseed, and Clawdray's chopper to cut the straw.

1354. The best artificially prepared food which he has hitherto found, is boiled linseed, ground corn, and cut straw, along with some

* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 61.

† Warnes *On the Cultivation of Flax*, 2d edition, p. 27, 133, and 174.

raw turnips, given at intervals. The crushed linseed is boiled in water, 1 lb. of linseed in 1¼ gallon of water, for 2 or 3 hours. The ground corn and chopped straw are mixed together first, and then the boiled linseed is poured over them and mixed with them, on a floor, with a shovel; the heap allowed to stand 1 or 2 hours, and given while yet warm: for, if allowed to stand a few hours, the mass ferments and quickly turns sour. Hence the necessity for the strictest cleanliness in all the vessels and implements made use of. Linseed may be boiled 3 times every day,—twice for the feeding beasts, and once for the store beasts, consuming about 1 cwt. of coal.

1355. The apparatus used by Mr Marshall for boiling the linseed consists of a small steam boiler and furnace, which supplies steam by a pipe to a double-cased iron vessel, one placed within the other, like a small hat within a large one, the inner one resting, by its rim, upon that of the outer. The steam is introduced between the two vessels, and boils, by its heat, the water and linseed contained in the inner one.

1356. A heifer weighing from 40 to 50 st. will consume, daily, 2 lbs. of crushed linseed, 5 lbs. of ground corn, 10 lbs. of chopped straw, and about 80 or 90 lbs. of yellow bullock turnips, with a little straw, not cut, placed in its rack at night.

1357. The cost of preparing this food is as follows, in which no charge is made for straw and turnips, but ample allowance made for coal, labour, and outlay of capital.

Cost of preparing food for 22 cattle and 3 draught horses, for 8 weeks, in 1844 and 1845:—

2688 lbs. of linseed, or 48 lbs. per day.
192 lbs. ... ... not used on Sundays deducted.

2496 lbs., or 46⅕ bushels of 54 lbs. at 6s. per bushel	£13	18	0
458 st. of ground oats, at 11½d. per st.	21	18	11
8 weeks' wages, at 13s. per week .	5	4	0
1 cwt. of coal per day, at 15s. per ton	1	1	0
Interest on outlay of £50, tear and wear	1	5	9
	£43	7	8
Average cost of 25 beasts per week for 8 weeks	0	4	4

1358. The mode in which the cattle are fed is as follows:—At 6 A. M. each beast is supplied with about 40 or 45 lbs. of yellow bullock turnip, sliced, fig. 86; at 10 A. M. 1 lb. of linseed, boiled and prepared as above, 2½ lbs. ground corn, and 5 lbs. of chopped straw are given; at 1 P. M. the turnips are repeated; and at 5 P. M. the prepared food is repeated. At night a little straw is placed in the rack. If any beasts refused their messes they were removed and given to those that had finished theirs and were desirous of more. No prepared food is given on Sunday, to save the cattleman some trouble; and on this omission of the food, the cattle return to it with increased appetite.

1359. One advantage derived from the use of this kind of food is, that it saves the consumption, and makes the beasts pretty independent of the turnip crop, which is always an expensive one to raise, and cannot, in all seasons, be reckoned to grow fully. This advantage may be made to appear in this way:—assuming 1 acre of land to grow 20 tons of yellow bullock turnips, worth £6, 15s. per acre, each beast will eat 85 lbs. per day, with the prepared food; so that 20 tons of turnips will feed 20 beasts for 26 days at a cost of 1s. 8d. per week per head. Again, assuming 1 acre of land to yield 20 tons of swedes, worth £8, 5s. per acre, each beast will eat 63 lbs. daily, with prepared food. Hence 20 tons will supply 20 beasts for 35 days, at a cost of 1s. 8d. per week per head; and hence, also, 5 acres of swedes, yielding 20 tons per acre, will suffice for 20 beasts for 25 weeks.

1360. An instance or two of the comparative effects of this mode of feeding may suffice to show its superiority over the one with oil-cake. Mr Hutton of Sowber Hill, near Northallerton, fed two lots of beasts of 8 each, against each other for 8 weeks. The cost of doing so was as follows:—

	s.	d.
Linseed-cake, 3 st., at 13½d. per stone	3	4½
Turnips, 980 lbs. . .	3	0
Labour, &c. . . .	0	5½
Cost per week per head	6	10
Linseed and ground corn . .	4	4
Turnips, 490 lbs. . .	1	6
Labour, &c. . . .	0	5½
Coals . . .	0	6
Cost per week per head	5	9½

The two lots of beasts were sold at Bedale market; and those fed on prepared food realised £2, 6s. 6d. more than those otherwise fed.

1361. Mr Thompson of Moat Hall, by York, also tried the experiment, and fed two beasts with prepared food against other two fed on oil-cake and bean meal, with turnips. The cost of the two methods was as follows:—

	s.	d.
10½ lbs. of linseed, at 7s. per bushel of 56 lbs. per bushel, or 1½ per lb. .	1	3¾
35 lbs. bean meal, at 1s. per stone .	2	6
100 lbs. of coal daily at 14s. per ton .	0	2¾
Extra wages, 4s. per week .	0	2½
Cost per head per week	4	3
21 lbs. of oil-cake, at £10 per ton .	1	10½
21 lbs. of bean meal, at 1s. per stone	1	6
20 stones of turnips extra, say .	0	11½
Cost per head per week	4	4

The cost of the two methods is about the same. "If we compare, however," observes Mr Thompson, "the increase of weight of the two bullocks fed on the old plan for 31 days, viz. 8 st. 2 lbs., with the increase of the same bullocks when fed on prepared food for 31 days, viz., 14 st. 5 lbs., the superiority of the latter is very apparent." *

1362. On comparing the effect of feeding beasts on linseed with oil-cake or bean meal, it would seem that the superiority lies entirely in the linseed, which, containing a large proportion of oil and of soluble albumen, fully supports on trial the high character of its nutritive properties indicated by chemical analysis, (1262.) "Experience alone," says Mr Warnes, "will convince any one that whether hay, peas or potatoes, beans or barley, are employed, the office of all mainly consists in conveying linseed to the stomach of the animal, and that a great error would be committed by a parsimonious use of that potent ingredient." "One of the main causes of the rapid progress of cattle, when fed on prepared food," observes Mr Thompson, "is, I conceive, the perfect state of health the animals enjoy. Linseed oil is a mild purgative, and when combined with meal, especially bean meal, the bowels and skin are kept uniformly in a state of health, which, I think, cannot be surpassed, and which I never before saw equalled." "What I have seen of this system," observes Mr Hutton, "convinces me that certainly double the quantity of stock can be maintained with the same quantity of turnips as was consumed by the old method of feeding cattle. The manure is of the best quality, and very soon fit for use. No manure I have seen has equalled, in efficacy, that derived from this process. Hence, it is hard to fix any precise limits to the number of stock that may be maintained on a farm, with a moderate supply of turnips, when this method is rightly carried out, and persevered in. It seems peculiarly adapted to stiff soils, where the turnips cannot be consumed on the land. It is also applicable to light land, where only a small quantity of turnips can be taken away; as the whole of the straw, by this method, may be made into a much better quality of manure."

1363. Of the two methods of using the linseed presented to public notice by Mr Warnes and Mr Marshall, I would prefer the latter, as being the more natural one—to give the cattle some raw turnips every day; and I cannot get over the fact of boiled or steamed turnips having been proved to bestow no benefit, as evinced by those carefully-conducted experiments I have described above (1329.) The steam boiler recommended by Mr Marshall serves no good purpose, in my opinion, and is attended with much outlay at first—not less perhaps than £40 or £50. Now, a simple boiler and furnace would be much cheaper, and answer every purpose more easily and readily, and there is no risk of the apparatus going wrong. If the linseed burning in the pan, or it boiling over, is dreaded, from want of care on the part of the person whose business it is to prepare the food, the risk may be easily avoided by putting the metallic vessel in which the linseed and water are into the boiler, containing water, and both waters may easily be boiled at one time. Indeed the steaming process, for any purpose, is going fast out of use, and the old-fashioned open boiler is again being resorted to daily.

1364. There are objections to Mr Warnes' method of making the compound, which are well expressed by Mr Thompson thus:—"The cheapest, and I think the best way of making this compound, is to mix it on a smooth brick floor, immediately adjoining the pan or boiler in which the linseed mucilage is prepared. Upon the floor throw down the cut straw or chaff; mix with it, whilst dry, the meal intended to be given; upon this heap, flattened at top, pour the mucilage by bucketfuls: nothing more remains to be done but to turn the heap over with a shovel. The partial cooking of the mixture by its own heat, is perfectly well effected in a heap such as I have described, if smoothed over with a shovel, and left for half an hour before being served out to the cattle. The advantages of this mode of mixing are—that it is more quickly done; that there is scarcely any limit to the quantity of food that can be prepared without any additional utensils; and that a few minutes suffice to wash the floor clean after each mixing. In tubs, the compound cannot be thoroughly mixed without a liberal use of the stirrer and rammer; and where there are many cattle, and consequently several tubs, the whole process of putting successive layers, stirring and ramming, has to be repeated in each. Taking the compound out of the tubs also, after it has been rammed down tight, especially from near the bottom, is tedious compared with shovelling it up from a heap on the floor; and each tub must be washed and scraped very clean, otherwise the small fragments remaining turn sour, and give a disagreeable taste to the next mixing. In all the feeding establishments in Yorkshire that I am acquainted with, mixing on the floor is preferred to the use of tubs."†

1365. Still another question remains to be considered in reference to the feeding of cattle in winter, which is—whether they thrive best in *hammels* or in *byres at the stake*? The determination of this question would settle the future construction of steadings; for, of course, if more profit were certainly derived by the farmer in feeding his cattle in hammels than in byres, not only would no more byres be erected, but those in use would be converted into hammels—and this circumstance would so materially change the form of steadings as to throw open the confined courts, embraced within quadrangles, to the influence of the sun, at the only season these receptacles are required, namely in winter. Some facts have already been decided regarding the comparative effects of hammels and byres upon cattle. Cattle are much cleaner in hammels than in byres. No doubt they *can* be kept clean in byres; but not being so, there must be some difficulty incidental to byre-management—and it consists, I presume, in the cattle-man finding it more troublesome to keep the beasts clean in a byre than in hammels; otherwise the fact is not easily to be accounted for, for he takes no

* Marshall *On the Feeding of Stock with Prepared Food*, p. 4-11.

† *Journal of the Agricultural Society of England*, vol. viii. p. 481-2. *Note.*

special care to keep beasts in hammels clean. Perhaps when cattle have liberty to lie down where they please, they may choose the driest, because the most comfortable spot: whereas, in a byre, they must lie down upon what may be, and which they cannot see behind them. There is another advantage derived from hammels—the hair of cattle never scalds off the skin, and never becomes short and smooth, but remains long and mossy, and is all licked over, and washed clean by rain, until it is naturally *cast* in spring; and this advantage is felt by cattle when sent to market in winter, where they can withstand much more wet and cold than those which have been fed in byres. A third advantage is, that cattle from hammels can travel the road without injury to their feet, being accustomed to be so much upon their feet, and to move about. It has been alleged in favour of byres, that they accommodate more cattle on the same space of ground, and are less expensive to erect at first than hammels. That in a given space more beasts are accommodated in byres there is no doubt—and there is as little doubt that more beasts are put in a byre than should be—but I have great doubts that it will cost more money to accommodate a given number of cattle in a hammel than in a byre; because hammels can be constructed in a temporary form with wood and straw, and they make beasts very comfortable, at a moderate charge, whereas byres cannot be formed in that fashion; and even in the more costly form of roofs and walls, the shedding of hammels requires, comparatively to a byre, but a small stretch of roof; and it is well known that it is the roof, and not the bare masonry of the walls, that constitutes the most costly part of a steading. I have seen a set of hammels, having stone and lime walls, and feeding-troughs, and a temporary roof, erected for £1 for every beast it could accommodate, and no form of byre could be built at that cost. But all these advantages of hammels would be of trifling import, if it could be proved by experience that cattle return larger profits on being fed in byres; and unless this superiority is established in regard to either, the other is undeserving of preference. How, then, stands the fact?—has experiment ever tried the comparative effects of both on any thing like fair terms? Mr Boswell of Balmuto has done so both in Fifeshire and at Kingcausie, in Kincardineshire, to give variety to the experiment, and it shall now be my duty to make you acquainted with the results.

1366. At Balmuto, 4 three-year-olds were put in close byres, and 4 in open hammels, and the same number of two-year-olds were accommodated in a similar manner at Kingcausie. Those at Kingcausie received turnips only, and of course straw; at Balmuto a few potatoes were given at the end of the season, in addition to the turnips. The season of the experiments extended from 17th October 1834 to 19th February 1835. The results were these:—

	St.	lbs.	St.	lbs.
The 4 hammel-fed 2-year-olds at Kingcausie gained of live weight			45	8
— 4 ... 3 year-olds at Balmuto — —			46	0
			91	8
— 4 byre-fed 2-year-olds at Kingcausie gained of live weight	32	7		
— 4 — 3-year-olds at Balmuto — —	36	0		
			68	7
Gain of live weight by the hammel-fed			23	1

This is, however, not all gain, for the hammel-fed consumed more turnips, the Aberdeen yellow bullock, than the byre-fed.

	Ton.	cwt.	qr.	lbs.
Those at Kingcausie consumed more by	1	7	2	6
And those at Balmuto — —	2	4	3	22
Total more consumed	3	12	2	0

In a pecuniary point of view, the gain upon the hammel-fed was this:—23 stones 1 lb. live weight, = 13¾ stones beef, at 6s. per stone, gives £4, 2s.; from which deduct the value of the turnips, at 4d. per cwt., £1, 4s. 2d., leaving a balance of £2, 7s. 10d. in favour of hammel-feeding.

1367. It is a prevalent opinion amongst farmers, that young cattle do not lay on weight so fast as old. But this experiment contradicts it; for the two-year-olds in the hammels at Kingcausie gained 45 stones 8 lbs. on their united weights of 320 stones 7 lbs., in the same time that the three-year-olds in the hammels of Balmuto, weighing together 350 stones, were of gaining 46 stones. Besides, the young beasts in the hammels at Kingcausie gained over those in the byre 13 stones 1 lb., whilst the older cattle in the hammels at Balmuto gained over those in the byre only 10 stones. So that, in either way, the young cattle had the advantage over the older.

1368. Mr Boswell observes, that "hammels ought never to be used unless when the climate is good, and the accommodation of courts dry and well sheltered; and, above all, unless when there is a very large quantity of litter to keep the cattle constantly clean and dry." Shelter is essential for all sorts of stock in any situation, and the more exposed the general condition of the farm is, the more *need* there is of shelter; but let the situation be what it may, it is, in my opinion, quite possible to render any hammel sheltered enough for stock, not only by the distribution of planting, but by temporary erections upon the weather-side ; and these means will be the more effectual when the hammel is placed facing the meridian sun, which it should be in every case. If these particulars are attended to, and rain-water spouts placed along the eaves in front to prevent the rain from the roof falling into the court, and well-built drains, with convenient gratings, connected with all the courts, are properly made, the quantity of straw required will not be inordinate, as I have myself experienced when farming dry turnip-soil. Mr Boswell's testimony in favour of hammels is most conclusive, and it is this,—" From the result of my own experiment, as well as the unanimous opinion of every agriculturist with whom I have conversed on the subject, I feel convinced that there is no point more clearly established than that cattle improve quicker, or, in other words, *thrive better in open hammels* than in close byres."*

1369. A method of accommodating cattle while feeding has been practised in some parts of England for a few years past, and it is called *box-feeding.* The boxes, as they are termed, consist of several railed in spaces under one roof, or a series of them protected by a roof against a high wall as lean-to's, or upon low walls as a shed roof. They form, in short, a series of loose boxes or cribs. They are made from 10 feet to 8 feet square, and are intended for the accommodation of a single beast each. The crib out of which the beast takes its food is made to move up and down between two posts, according as the litter becomes high by accumulation, or low by removal. The bottom of the box is sunk into the ground, say 2 feet, and the hollowed space is built round the sides with brick work, or mason work, to the level of the ground, and causewayed or paved in the bottom. A passage, from which the food is supplied, runs along one end of the boxes. Compound and cut straw are regularly supplied to the cattle, and litter strewn in sufficient quantity to keep them clean ; and, thus supplied with food and litter, they are represented as being very comfortable in such boxes.

1370. Mr Warnes says, that when these boxes are erected with rough materials, they cost only 30s. a-piece. Timber of all kinds is sold, I believe, very cheap in the rural districts of England ; but in Scotland, no accommodation for cattle kept constantly under roof, and affording requisite shelter in winter, can be erected at so small a cost. But if cattle are to be really benefited by comfortable accommodation, why grudge them it, since benefit to them is profit to their owners ? A space of 8 feet square seems too small for an ox that will attain 50 stones ; and as to the ox having room to shy away from any person going beside him, in such a limited space, is out of the question—especially when the two upper rails, which form two sides of the box, are obliged to be left as wide as to allow the head of the beast to pass between them, on turning himself.† I feel the same objection to cattle being so confined when feeding, as I did to the sheep in their confined cribs and stalls, (967 ;) and the question of the feeding is not to be ascribed to the boxes, but to the superior nature of the linseed upon which they are fed. Indeed, I should consider the dampness inherent to a situation dug 2 feet into the ground, in rendering even dry straw unwholesome in it as a bed, as having a tendency to injure the progress of an ox towards maturity rather than otherwise ; and I am sure that exposure *at will* to the sun and air, and even rain in winter, is much more conducive to the health of an ox than constant confinement under a roof. It is true that box-feeding affords much more liberty to the animal than when feeding at the stake in a byre : but in what respects box-feeding should excel small hammels it is not easy to discover. The cost of constructing small hammels, to hold two or three oxen together, is not great,—two is the number I would always prefer, as affording society, and avoiding contention on the one hand, and loneliness on the other,—but the cost of constructing accommodation for cattle I consider a secondary consideration, in comparison to affording them the greatest comfort ; and greater comfort than a hammel may afford is scarcely possible to be attained by any other means—certainly not by such boxes ; and the manure would be equally as well compressed and good in hammels as in boxes.

1371. Surely Mr Warnes endeavours to make too much of box-feeding, to compare it with the worst method of feeding cattle, when he truly observes, that "in a yard the master cattle consume the choicest parts of the turnips. They delight in goading and driving the underlings about, and allow them but little rest. . . . In fact, the system of feeding cattle in boxes can be regulated to the greatest nicety, while that in the yard must ever remain slovenly, wasteful, and imperfect." Compare this picture with the general system adopted in the north of England and the south of Scotland, in fattening cattle in small hammels, and it will be found to possess all the advantages derivable from boxes, in which, as Mr Warnes informs us, "every bullock can eat at his leisure, ruminate unmolested, and take his rest."‡ Small hammels and boxes are thus the receptacles for cattle that admit of a legitimate comparison with one another, for affording them shelter, health, and comfort, and not open courts or yards.

1372. It is a very common practice in Ireland to turn out cows, when even giving milk, upon the pasture in winter, where, of course, very little subsistence can be obtained by them ; and the objectionable practice exists by necessity, as no turnips have been raised for their support. To show the loss incurred by such a practice, I shall give an instance of the increased value of the

* *Prize Essays of the Highland and Agricultural Society*, vol. xi. p. 461.
† See *Journal of the Agricultural Society of England*, vol. viii. p. 473.
‡ Warnes *On the Cultivation of Flax*, 2d. edition, p. 166-7

produce of a single small cow, naturally a bad milker, from being so treated, to receiving prepared food in the byre. Mr John Lynch, the owner, thus writes :—

1844.

"Nov. 7, I had her milked at 11 o'clock A.M., in the presence of workmen—the milk measured was 1 quart and 3 naggins, and at night her milk was but 3 naggins.

... 9, Milked before the workmen, at 10 o'clock A.M., 1 quart and 1 naggin ; and in the evening again, before them, 3 naggins.

... 11, I got her in to house-feed, after the following manner :—

1st feed,	6	o'clock	A.M.,	Cut straw, hay, and turnips, all boiled together.
2d ...	8	...	...	Raw turnips.
	10	...	...	Let out on the field till 12 o'clock.
3d ...	12	...	M.	Hay.
4th ...	3	...	P.M.	Prepared food same as in the morning.
5th ...	6	...	...	Raw turnips and mangold-wurtzel leaves, &c.
6th ...	8	...	...	Hay.

The result was an increase from the 1st day to the 3d, when she milked 2 quarts in the morning and the same at night ; on the 8th day 2½ quarts at each milking ; and on the 12th day after being put in she milked 3 quarts at a time, and continued so for four days. Being limited in my supply of green food, (as I then thought,) I curtailed her a little in the different feeds, consequently she did not increase.

	£	s.	d.
From the day on which she was got in to house-feed, up to the first of April, (being 140 days,) her milk averaged 5 quarts per day, at 1½d. per quart	4	7	6
On the 1st of April, the turnips and mangold-wurtzel not being nearly consumed, I increased her feeds again, when she averaged 6 quarts a-day for the first fortnight, and 7 quarts during the remainder of the month—being 6½ quarts per day for 30 days, or 195 quarts, at 1½d. per quart . . .	1	4	4½
9th May.— The vetches were now fit for cutting, and the supply of turnips and mangold-wurtzel continuing up to the 15th of June, she frequently milked 9 quarts a-day. Her milk at this date (1st August) is 9 quarts, allowing an average from the 1st of May to the present date (being 92 days) at 8 quarts per day, or 736 quarts, at 1½d. per quart . . .	4	12	0
Total amount from 11th Nov. to 1st August	10	3	10½
Deduct the value of 21 cwt. of hay, at £2 per ton	2	2	0
	£8	1	10½

The quantity of ground under green food was—

Mangold-wurtzel . .	10½	perches English.
Swedish turnips . .	21	... ...
Aberdeen yellows .	9½	... ...
Vetches and rape .	15	... ...
Statute measure	56=35	perches Irish.

An Irish acre of ground bearing crops such as the above, and being turned to the same advantage, would (notwithstanding the cow being such a poor milker) bring in a return of £46, 10s., (minus the price of hay,) together with a large quantity of manure, and the cattle well fed. My cow is at present in excellent condition. Had she not been house-fed, I would have had to buy milk and butter for my family during the winter, and to pay about 30s. for sea-weed or guano."*

1373. I have dwelt the longer on the subject of feeding cattle, because of its great importance to the farmer, and also because of the uncertainty sometimes attending its practice to a profitable issue ; and whether it leaves a profit or not depends, no doubt, upon the mode in which it is prosecuted. Many are content to fatten their cattle in any way, or because others do so, provided they know they will not actually lose money by it; but if they do not make them in the ripest state they are capable of being made, they are, in fact, losing part of their value. But how are they, you may ask, best to be made ripe? There lies the difficulty of the case—and it must be attended with much difficulty before a man of the extensive experience in fattening cattle as Mr Stephenson has had, would express himself thus :—" We have had great experience in feeding stock, and have conducted *numbers of experiments* on that subject with all possible care, both in weighing the cattle alive, and the whole food administered to them, and in every experiment we made *we discovered something new*. But we have seen enough to convince us, that were *the art of feeding better understood, a great deal more beef and mutton might be produced from the same quantity of food* than is generally done." So far should such a declaration deter you from fattening cattle—it should rather be a proof of the wideness of the field still open for you to experiment in ; and fortunately, of late years, facilities have daily presented themselves. Oil-cake is now a more general favourite than it was some years since, and linseed and linseed-oil now rank themselves amongst the richest class of cattle food. Chemistry has also stepped forward to inform us of the substances which afford most bone, those which supply most muscular fibre, and those which deposit most fat. The theory of the digestion of the domesticated animals, and of the combined effects of various sorts of food, is now better understood than it was ; and to these we shall direct our attention, after you have learnt the mode of feeding every kind of animal found on a farm.

1374. There are but few *diseases* incidental to cattle in a state of confinement in winter, these being chiefly confined to the skin, such as the

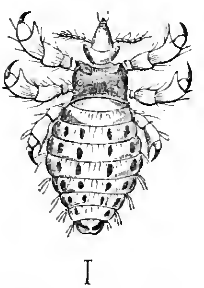
* *Dublin Farmers' Gazette,* of 9th August 1845.

affection of *lice*, and to accidents in the administration of food, as *hoven* and *obstruction of the gullet* may be termed.

1375. *Lice.*—When it is known that almost every species of quadruped found in the country, and in a state of nature, is inhabited by one or more pediculidæ—sometimes peculiar to one kind of animal, at other times ranging over many—it will not excite surprise that they should also occur on our domestic ox. Indeed, domestication, and the consequences it entails—such as confinement, transition from a lower to a higher condition, high feeding, and an occasional deviation from a strictly natural kind of food—seem peculiarly favourable to the increase of these parasites. Their occurrence is well known to the breeder of cattle, and to the feeder of fat cattle; and they are not unfrequently a source of no small annoyance to him. Unless when they prevail to a great extent, they are probably not the cause of any positive evil to the animal; but, as their attacks are attended with loss of hair, an unhealthy appearance of the skin, and their presence is always more or less unsightly, and a source of personal annoyance to the cattle, they may much impair the animal's look, which, when it is designed to be exhibited in the market, is a matter of no small consequence. As an acquaintance with the appearance and habits of these creatures must precede the discovery and application of any judicious method of removing or destroying them, I shall describe the species now which are most common and noxious to the ox, and afterwards such as infest the other domestic animals of the farm. They may be divided into two sections, according to a peculiarity of structure, which determines the mode in which they attack an animal—namely, those provided with a mouth formed for sucking, and such as have a mouth with two jaws formed for gnawing. Of the former there are three species, which are very common, attacking the ox, the sow, and the ass.

1376. *Ox-louse* (*Hæmatopinus eurysternus*,) fig. 100.—It is about 1 or $1\frac{1}{2}$ line in length—the line being the twelfth part of an inch, as seen by the line below the figure—the head somewhat triangular, and of a chestnut colour, the eyes pale brown, antennæ pale ochre-yellow; thorax darker chestnut than the head, with a spiracle or breathing-hole on each side, and a deep furrow on each side anteriorly; the shape nearly square, the anterior line concave; abdomen broadly ovate, greyish-white, or very slightly tinged with yellow, with four longitudinal rows of dusky horny excrescences, and two black curved marks on the last segment; legs long and strong, particularly the two fore pairs, the colour chestnut; claws strong and black at the extremity. This may be called the common louse that infests cattle. It is most apt to abound on them when tied to the stall for winter feeding, and a notion prevails in England that its increase is owing to the cattle feeding on straw. The fact probably is, that it becomes more plentiful when the animal is tied up, in consequence of its being then less able to rub and lick itself, and the louse is left to propagate, which it does with great rapidity, comparatively undisturbed. It generally concentrates its forces on the mane and shoulders. As the parasite is suctorial, if it is at all the means of causing the hair to fall off, it can only be by depriving it of the juices by which it is nourished, which we can conceive to be the case when the sucker is inserted at the root of the hair; but it is more probable that the hair is rubbed off by the cattle themselves, or is shorn off by another louse to be just noticed. The egg or nit is pear-shaped, and may be seen attached to the hairs.

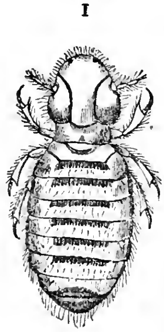
Fig. 100.



THE OX-LOUSE, HÆMATOPINUS EURYSTERNUS.

1377. *Ox-louse* (*Trichodectes scalaris*,) fig. 101.—This parasite, which was described by Linnæus and the older naturalists under the name of *Pediculus Bovis*, is minute, the length seldom exceeding $\frac{1}{2}$ a line. The head and thorax are of a light rust colour, the former of a somewhat obcordate shape, with two dusky spots in front; the third joint of the antennæ longest, and spindle-shaped (in the horse-louse, *Trichodectes Equi*, that joint is clavate;) abdomen pale—tawny, pubescent, the first 6 segments with a transverse dusky or rust-coloured stripe on the upper half, a narrow stripe of the same colour along each side, and a large spot at the hinder extremity of the abdomen; legs, pale tawny. Plentiful on cattle; commonly found about the mane, forehead, and rump, near the tail-head. It has likewise been found on the ass. It is provided with strong mandibles, with 2 teeth at the apex, and by means of these it cuts the hairs near the roots with facility. Both these vermin are destroyed by the same means as the sheep-louse, (1067.)

Fig. 101.



THE OX-LOUSE, TRICHODECTES SCALARIS.

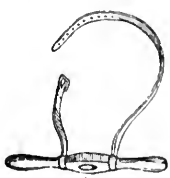
1378. *Choking.*—When cattle are feeding on turnips or potatoes, it occasionally happens that a piece larger than will enter the gullet easily is attempted to be swallowed, and obstructed in its passage. The accident chiefly occurs to cattle receiving a limited supply of turnips, and young beasts are more subject to it than old. When a number of young beasts in the same court only get a specified quantity of turnips or potatoes once or twice a-day, each becomes apprehensive, when the food is distributed, that it will not get its own share, and therefore eats what it can with much apparent greediness, and, not taking sufficient time to masticate, swallows its food hastily. A large piece of turnip, or a small potato, thus easily escapes beyond the power of the tongue, and, assisted as it is by the saliva, is sent to the top of the gullet, where it remains. Cattle that project their mouths forward in eating, are most liable to choke. When turnips are sliced and potatoes broken, there is less danger of the accident occurring, even amongst young cattle. The site of the obstruction, its consequent effects, and remedial measures for its removal, are thus described by Professor Dick. "The obstruction usually occurs at the bottom of the pharynx and commencement of the gullet, not far from the lower part of the larynx, which we have seen mistaken for the foreign body. The accident is much more serious in ruminating animals than in others, as it immediately induces a suspension of that necessary process, and of indigestion, followed by a fermentation of the food, the evolution of gases, and all those frightful symptoms which will be noticed under the disease *hoven*. The difficulty in breathing, and the general uneasiness of the animal, usually direct at once to the nature of the accident, which examination brings under the cognisance of the eye and hand. *No time must be lost in endeavouring to afford relief;* and the *first* thing to be tried is, by gentle friction and pressure of the hand upwards and downwards, to see and rid the animal of the morsel. *Failing in this*, we mention first the great virtue we have frequently found in the use of mild lubricating fluids, such as warm water and oil, well boiled gruel, &c. The gruel is grateful to the animal, which frequently tries to gulp it, and often succeeds. Whether this is owing to the lubrication of the parts, or to the natural action superinduced, it is unnecessary to inquire; but the fact we know, that a few pints of warm gruel have often proved successful in removing the obstruction. *If this remedy should be ineffectual*, the foreign body may perhaps be within the reach of the small hand which a kind dairy-maid may skilfully lend for the purpose. *If this good service cannot be procured*, the common probang must be used, the cup-end being employed. Other and more complicated instruments have been invented, acting upon various principles,—some, for example, on that of bruising the obstructing body—and the use of these requires considerable skill. *Disappointed in all*, we must finally have recourse to the knife."* You may try all these remedies, with the exception of the knife, with perfect confidence. The friction, the gruel, the hand, and the probang, I have successfully tried; but the use of the knife should be left to the practical skill of the veterinary surgeon.

1379. The common *probang* is represented in fig. 102, *a* being the cup-end, which is so formed that it may partially lay hold of the piece of turnip or potato, and not slip between it and the gullet, to the risk of rupturing the latter; and being of larger diameter than the usual state of the gullet, on being pressed forward it distends the gullet, and makes room for the obstructing body to proceed to the stomach. Formerly the probang was covered with cane, but is now with India-rubber, which is more pliable. It is used in this manner: Let the piece of wood, fig. 103, be placed over the opened mouth of the animal as a bit, and the straps of leather attached to it buckled tightly over the neck behind the horns, to keep the bit steady in its place. The use of the bit is, not only to keep the mouth open without trouble, but to prevent the animal injuring the probang with its teeth, and it offers the most direct passage for the probang towards the throat. Let a few men seize the animal on both sides by the horns or otherways, and let its mouth be held projecting forward in an easy position, but no fingers introduced into the nostrils to obstruct the breathing of the animal, nor the tongue forcibly pulled out of the side of the mouth. Introduce now the cup-end *a* of the probang, fig. 102, through the round hole *b* of the mouth-piece, fig. 103, and push it gently towards the throat until you feel the piece of the turnip obstructing you; push then with a firm and persevering hand, cautioning the men, previous to the push, to hold on firmly—for the starting of the piece of turnip by the instrument may give the animal a smart pain, and cause it to wince and even leap aside. The obstruction will now most likely give way, especially if the operation has been performed before the parts around it began to swell; but if not, the probang must be used with still more force, whilst another person rubs with his hands up and down upon the distended throat of the beast. If these attempts fail, recourse must be had to the knife, and a veterinary surgeon sent for instantly.

Fig. 102.

THE CATTLE PROBANG.

Fig. 103.



THE MOUTH-PIECE FOR THE CATTLE PROBANG.

1380. The probang, fig. 102, is 5 feet 1 inch in length, three-quarters of an inch in diameter, with pewter cup and ball ends $1\frac{1}{2}$ inch diameter. The mouth-piece, fig. 103, is 5 inches long and 3 inches wide, with two handles, 5 inches long each. Price of the probang is 12s., and with the mouth-piece 14s.

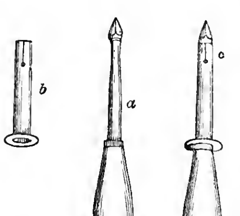
1381. *Hoven.*—The hoven in cattle is the corresponding disease to the gripes or batts in

* Dick's *Manual of Veterinary Science*, p. 46.

horses. The direct cause of the symptoms are undue accumulation of gases in the paunch or large stomach, which, not finding a ready vent, causes great pain and uneasiness to the animal, and, if not removed in time, rupture of the paunch and death ensue. The cause of accumulation of the gases is indigestion. "The structure of the digestive organs of cattle," says Professor Dick, "renders them peculiarly liable to the complaint, whilst the sudden changes to which they are exposed in feeding prove exciting causes. Thus, it is often witnessed in animals removed from confinement and winter feeding to the luxuriance of the clover field ; and in house-fed cattle, from the exhibition of rich food, such as pease-meal and beans, often supplied to enrich their milk. We have already mentioned that it sometimes proceeds from obstructed gullet. The symptoms bear so close a resemblance, both in their progress and termination in rupture and death, to those so fully described above, that we shall not repeat them. The treatment mostly corresponds, and it must be equally prompt. The mixture of the oils of linseed and turpentine is nearly a specific."* The recipe is, linseed oil, raw, 1 lb. ; oil of turpentine, from 2 to 3 oz. ; laudanum, from 1 to 2 oz., for one dose : or hartshorn, from ½ to 1 oz., in 2 pints imperial of tepid water. In cases of pressing urgency, from 1 to 2 oz. of tar may be added to ½ pint of spirits, and given diluted, with great prospect of advantage. These medicines are particularly effective in the early stage of the disease, and should therefore be tried on the first discovery of the animal being affected with it. Should they not give immediate relief, the probang may be introduced into the stomach, and be the means of conveying away the gas as fast as it is generated ; and I have seen it successful when the complaint was produced both by potatoes and clover ; but I never saw an instance of hoven from turnips, except from obstruction of the gullet. The trial of the probang is useful to show whether the complaint arises from obstruction or otherwise, for should it pass easily down the throat, and the complaint continue, of course the case is a decided one of hoven. Placing an instrument, such as in fig. 103, across the mouth, to keep it open, is an American cure which is said never to have failed. But the gas may be generated so rapidly that neither medicines nor the probang may be able to prevent or convey it away, in which case the apparently desperate remedy of *paunching* must be had recourse to. "The place for puncturing the paunch," directs Professor Dick, "is on the left side, in the central point between the lateral processes of the lumbar vertebra, the spine of the ileum, and the last rib. Here the *trochar* may be introduced without fear. If air escape rapidly, all is well. The canula may remain in for a day or two, and on withdrawal, little or no inconvenience will usually manifest itself. If no gas escapes, we must enlarge the opening freely, till the hand can be introduced into the paunch, and its contents removed, as we have sometimes seen, in prodigious quantities. This done, we should close the wound in the divided paunch with 2 or 3 stitches of fine catgut, and carefully approximate and retain the sides of the external wound, and with rest, wait for a cure, which is often as complete as it is speedy."† To strengthen your confidence in the performance of this operation, I may quote a medical authority on its safe effects, on the human subject, even to the extent of exposing the intestines as they lay in the abdomen. "I should expect no immediately dangerous effects from opening the abdominal cavity. Dr Blundell has stated, that he has never in his experiments upon the rabbit observed any marked collapse when the peritoneum was laid open, although in full expectation of it. The great danger to be apprehended is from inflammation, and the surgeon, of course, will do all in his power to guard against it."‡ I once used the trochar with success in the case of a Skibo stot which had been put on potatoes from turnips, and as he was in very high condition, took a little blood from him after the operation, and he recovered very rapidly. In another year I lost a fine one-year-old short-horn quey by hoven, occasioned by potatoes. Oil and turpentine were used, but as the complaint had remained too long, before it was notified to myself, late at night, the medicine had no effect. The probang went down easily, proving there was no obstruction. The trochar was then thrust in, but soon proved ineffectual ; and as I had not the courage to use the knife to enlarge the opening the trochar had made, and withdraw the contents of the paunch by the hand, the animal sank, and was immediately slaughtered. The remedies cannot be too soon applied in the case of hoven.

1382. The *trochar* is represented in fig. 104. It consists of a round rod of iron *a*, 5 inches in length, terminating at one end in a triangular pyramidal-shaped point, and furnished with a wooden handle at the other. The rod is sheathed in a cylindrical cover or case *b*, called the canula, which is open at one end, permitting the point of the rod to project, and furnished at the other with a broad circular flange. The canula is kept tight on the rod by means of a slit at its end nearest the point of the rod, which, being somewhat larger in diameter than its own body, expands the slitted end of the canula until it meets the body, when the slit collapses to its ordinary dimensions, and the canula is kept secure behind the enlarged point, as at *c*. On using the trochar, in the state as seen in *c*, it is forced with a thrust into the place pointed out above, through

Fig. 104.



THE TROCHAR.

* Dick's *Manual of Veterinary Science*, p. 54. † *Ibid.* 54-5.
‡ Stephens *On Obstructed and Inflamed Hernia*, p. 183-4.

the skin into the paunch; and on withdrawing the rod by its handle,—which is easily done, notwithstanding the contrivance to keep it on,—the canula is left in the opening, and retained in its place by the flange, to permit the gas to escape through the channel. On account of the distended state of the skin, the trochar may rebound from the thrust; and in such an event, a considerable force must be used to penetrate the skin. The spear of the trochar is 5 inches long, and the handle 4 inches, and price 3s. 6d.

1383. The *fardlebound* of cattle and sheep is nothing more than a modification of the disease in horses called stomach-staggers, which is caused by an enormous distention of the stomach. "In this variety, it has been ascertained," says Professor Dick, "that the *maniplies* are most involved, its secretions are suspended, and its contents become dry, hard, and caked into one solid mass. Though the constipation is great, yet there is sometimes the appearance of a slight purging, which may deceive the practitioner."* The remedial measures are, at first, to relieve the stomach by large drenches of warm water, by the use of the stomach-pump. Searching and stimulating laxatives are then given, assisted by clysters, and then cordials.

1384. *Warts* and *angle-berries* are not uncommon excrescences upon cattle. They are chiefly confined to the groin and belly. I have frequently removed them by ligature with waxed silk thread. Escharotics have great efficacy in removing them; such as alum, bluestone, corrosive sublimate.

1385. *Encysted tumours* sometimes appear on cattle, and may be removed by simple incision, having no decided root or adhesion. I had a one-year-old short-horn quey that had a large one upon the front of a hind foot, immediately above the coronet, which was removed by a veterinary surgeon by simple incision. What the true cause of its appearance may have been, I cannot say; but the quey, when a calf, was seen to kick its straw rack violently with the foot affected, and was lame in consequence for a few days; after which, a small swelling made its appearance upon the place, which, gradually enlarging, became the loose and unsightly tumour which was removed.

1386. A gray-coloured scabby eruption, vulgarly called the *ticker*, sometimes comes out on young cattle on the naked skin around the eyelids, and upon the nose between and above the nostrils. It is considered a sign of thriving, and no doubt it makes its appearance most likely on beasts that are improving from a low state of condition. It may be removed by a few applications of sulphur ointment.

1387. In winter, when cows are heavy in calf, some are troubled with a complaint commonly called a *coming down of the calf-bed*. A part of the womb is seen to protrude through the vaginal passage when the cow lies down, and disappears when she stands up again. It is supposed to originate after a very severe labour. Bandages have been recommended, but, in the case of the cow, they would be troublesome, and indeed are unnecessary; for if the litter is made firm and a little higher at the back than the front part of the stall, so as the hind-quarter of the cow shall be higher than the fore when lying, the protrusion will not occur. I had a cow that was troubled with this inconvenience every year, and as she had no case of severe labour while in my possession, I do not know whether, in her case, it was occasioned by such a circumstance; but she may have been sold on account of that complaint, which gave her no uneasiness, after the above preventive remedy was resorted to.

1388. It not unfrequently happens to cattle in large courts, and more especially to those in the court nearest the corn-barn, that an oat-chaff gets into one of their eyes in a windy day. An irritation immediately takes place, causing copious watering from the eye, and, if the chaff is not removed, a considerable inflammation and consequent pain soon ensue, depriving the sufferer of the desire for food. To have it removed, let the animal be firmly held by a number of men,—and as beasts are particularly jealous of having any thing done to their eyes, a young beast even will require a number of men to hold it fast. The wetted fore-finger should then be gently introduced under the eyelid, pushed in as far as it can go, and being moved round upon the surface of the eye-ball, is brought to its original position, and then carefully withdrawn, and examined, to see if the chaff has been removed along with it, which it most likely will be; but if not, repeated attempts will succeed. A thin handkerchief around the finger will secure the extraction at the first attempt. Fine salt or snuff have been recommended to be blown into the eye when so affected, that the consequent increased discharge of tears may float away the irritating substance; but the assistance of the finger is much less painful to the animal, and sooner over,—and as it is an operation I have frequently performed with undeviating success, I can attest its efficacy and safety. Another remedy recommended is, to take an awn of barley, and, on seeing the position of the chaff, to use its butt-end to take hold of it, which, it is said, it will do, by drawing the awn towards you against its serrated teeth; and, I have no doubt, cures have been effected with it; but, to secure its success, a barley awn must be at hand, which it may not be at the time, and in using it, should the animal give a start and break the awn and leave it in the eye, the cure would be worse than the cause of the complaint.

ON THE CONSTRUCTION OF STABLES FOR FARM-HORSES.

1389. With the exception of a few weeks in summer, when they are at grass,

* Dick's *Manual of Veterinary Science*, p. 57.

farm-horses occupy their stable all the year round. The stable is situate at O, Plate I., where its front elevation, with two doors and two windows, is seen surmounted with two ventilators, as fig. 81, on the roof. The plan of it is seen at O, Plate II., containing 12 stalls and a loose box.

1390. The length of a work-horse stable, of course, depends on the number of horses employed on the farm; but in *no instance should its width be less* than 18 feet, for comfort to the horses themselves, and convenience to the men who take charge of them. This plan being made for a definite size of farm contains stalls for 12 horses, with a loose box, the entire length being 84 feet. Few stables for work-horses are made wider than 16 feet, and hence few are otherwise than hampered for room. A glance at the particulars which should be accommodated in the width of a work-horse stable, will show you at once the inconvenience of this narrow breadth. The length of a work-horse is seldom less than 8 feet; the width of a hay-rack is about 2 feet; the harness hanging loosely against the wall occupies about 2 feet; and the gutter occupies 1 foot; so that in a width of 16 feet there is only a space of 3 feet left from the heels of the horses to the harness, to pass backward and forward, and wheel a barrow and use the shovel and broom. No wonder, when so little room is given to work in, that cleanliness is so much neglected in farm-stables, and that much of the dung and urine are left to be decomposed and dissipated by heat in the shape of ammoniacal gas, to the probable injury of the breathing and eyesight of the horses, when shut up at night. To aggravate the evil, there is very seldom a ventilator in the roof; and the windows are generally too small for the admission of light and air; and what is still worse, a hay-loft is placed immediately above the horses' heads; and, to render the condition of the stable as bad as possible, as regards cleanliness, its walls are never plastered, and their rough stones form receptacles of dust and cobwebs.

1391. Some imagine that twelve horses are too great a number in one stable, and that 2 stables of 6 stalls each would be better. Provided the stable is properly ventilated, no injury can arise to a larger than a smaller number of horses in it; and there are practical inconveniences in having 2 stables on a farm. These are, that neither the farmer nor farm-steward can personally superintend the grooming of horses in two stables; that the orders given to the ploughmen by the steward must be repeated in both stables; and that either all the ploughmen must be collected in one of the stables to receive their orders, or part of them not hearing the orders given to the rest, there cannot be that common understanding as to the work to be done which should exist among all classes of work-people on a farm.

1392. Another particular in which most stables are improperly fitted up, is the narrowness of the *stalls,* 5 feet 3 inches being the largest space allowed for an ordinary-sized work-horse. A narrow stall is not only injurious to the horse himself, by confining him peremptorily to one position, in which he has no liberty to bite or scratch himself, should he feel so inclined, but it materially obstructs the ploughman in the grooming and supplying the horse with food. No work-horse, in my opinion, should have a narrower stall than 6 feet from centre to centre of the travis, in order that he may stand at ease, or lie down at pleasure with comfort.

1393. It is a disputed point of what form the *hay-racks* in a work-horse stable should be. The prevailing opinion may be learned from the general practice, which is to place them as high as the horses' heads, because, as it is alleged, the horse is thereby obliged to hold up his head, and he cannot then breathe *upon* his food. Many better reasons, as I conceive, may be adduced for placing the racks low down. A work-horse does not require to hold his head up at any time, and much less in the stable, where he should rest as much as he can. A low rack permits the neck and head, in the act of eating, to be held in the usual position. He is not so liable to put the hay among his feet from a low as as from a high rack. His breath cannot contaminate his food so much in a low as in a high rack, inasmuch as the breath naturally ascends; and as breathing is employed by the horse in choosing his food by the sense of smell, he chooses his food at pleasure from a low rack, whereas he is first obliged to pull it out of the high one before he knows he is to like what he pulls. He is less fatigued eating out of a low than from a high rack, every mouthful having to be pulled out of the latter, from its sloping position, by the side of the mouth turned upwards. For this reason mown grass is much more easily eaten out of a low than a high rack. And, lastly, I have heard of peas falling out of the straw, when pulled out of a high rack, into an ear of a horse, and therein setting up a serious degree of inflammation.

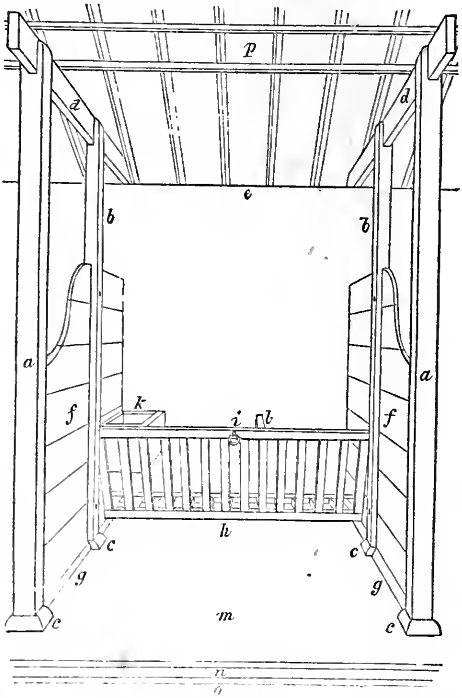
1394. The *front rail* of the *low rack* should be made of strong hardwood, in case the horse should at any time playfully put his foot on it, or bite it when groomed. The front of the rack should be sparred, for the admission of fresh air among the food, and incline inwards at the lower end, to be out of the way of the horses' fore-feet. The bottom should also be sparred, and raised at least 6 inches above the floor, for the easy removal of the hay seeds that may have passed through the spars. The manger should be placed at the near end of the rack, for the greater convenience of supplying the corn. A spar of wood should be fixed across the rack from the front rail to the back wall, midway between the travis and the manger, to prevent the horse tossing out the fodder with the side of his mouth, which he will sometimes be inclined to do when not hungry. The *ring* through which the stall collar-shank passes, is fastened by a staple to the hardwood front-rail. I have seen the manger, in some new steadings, made of stone, on the alleged plea that stone is more easily cleaned than wood after prepared food. I do not think wood more difficult of being cleaned than stone, when cleaned in a proper time after being used. As ploughmen are proverbially careless, the stone manger has perhaps been substituted on the supposition that it will bear much harder usage than wood; or perhaps the proprietors could obtain stone cheaper from their own quarries than good timber from abroad: but whatever may have been the reasons for preferring stone in such a situation, it has a clumsy appearance and feels uncomfortable, and is injurious to the horses' teeth when they seize it suddenly in grooming, and even work-horses will bite any object when groomed; and I suppose that stone would also prove hurtful to their lips when collecting their food at the bottom of the manger.

1395. The best *hind-posts* of *travises* are of cast iron, rounded in front, grooved in the back as far as the travis-boards reach, and run with lead at the lower ends into stone blocks. These posts are most durable and able to withstand the kicks of the horses, some of whom always strike out when groomed. When wooden posts are used, they are fastened at the upper ends to battens stretching across the stable from the ends of the couple legs where there is no hay-loft, and from the joists of the flooring where there is, and sunk at the lower ends in stone blocks placed in the ground. The *head-posts* are divided into two parts, which clasp the travis-boards between them, and are kept together with screw-bolts and nuts, and their lower ends are also sunk into stone blocks. Their upper ends are fastened to the battens or joists when the hind-posts are of wood. The *travis-boards* are put endways into the groove of the hind-post, and pass between the two divisions of the head-post to the wall before the horses' heads; and are there raised with a sweep so high as to prevent the horses putting their heads over it.

1396. The *floor* of all stables should be made hard, to resist the action of the horses' feet. That of a work-horse stable is usually causewayed with small round stones, imbedded in sand, such as are to be found on the land or on the sea-beach. This is a cheap but not good mode of paving. Squared blocks of whinstone (trap rock, such as basalt, greenstone, &c.) answer the purpose much better. Flags make a smoother pavement for the feet than either of these materials, and they undoubtedly make a floor that can be kept quite clean, as the small stones are apt to retain the dung and absorb the urine around them, which, on decomposition, cause filth and a constant annoyance to horses. To avoid this inconvenience in a great degree, it is advisable to form the gutter behind the horses' heels of hewn freestone, containing a continuous channel, along which the urine runs easily, and all filth is completely swept away with the broom. This channel should have a fall of at least 1½ inch to the 10 feet of length. But pavement makes too smooth a floor for a work-horse stable; and the feet of work-horses are apt to slip upon it: causewaying is therefore better for such a stable. The causeway on both sides should incline towards the gutter, the rise in the stalls being 3 inches in all. In some stables, such as those of the cavalry and of carriers, the floor of the stalls rise much higher than 3 inches; and on the Continent, particularly in Holland, I have observed it to be considerably more than in any stables in this country. Some veterinary writers say that the position of the feet of the horse imposed by the rise, does not throw an injurious strain on the back tendons of the hind legs.* This may be, but it cannot be denied that, in this position, the toes are raised above the heels much higher than on level ground. I admit that a rise of 3 inches is necessary in stalls in which geldings stand, as they eject their water pretty far on the litter; but in the case of mares, so great a rise is unnecessary. It is indisputable that a horse always prefers to stand on level ground, when he is free to choose the ground for himself, and much more ought he to have level ground to stand on in a stable, which is his place of *rest*. It is no argument in this case to call for instances in which the horse has been lamed by standing in a stall having a great declivity; for the question is, not whether or not the horse can be rendered lame, in any degree or in any way, but how to afford the greatest ease, and even comfort, to the work-horse while in the stable.

1397. Fig. 105 gives a view of the particulars of a *stall for work-horses*, fitted up with wooden travis-posts, which is yet the common method: *a a* are the strong hind-posts; *b b*, the head-posts, both sunk into the stone blocks *c c c c*, and fastened to the battens *d d*, stretching across the stable from the wall *e* to the opposite wall; *f f*, the travis-boards, let into the posts *a a* by grooves, and passing between the two divisions of the posts *b b*; the boards are represented high enough to prevent the horses annoying each other; *g g* are curb-stones set between the hind and fore posts *a* and *b*. to receive the side of the travis-boards in grooves, and thereby secure them from

Fig. 105.



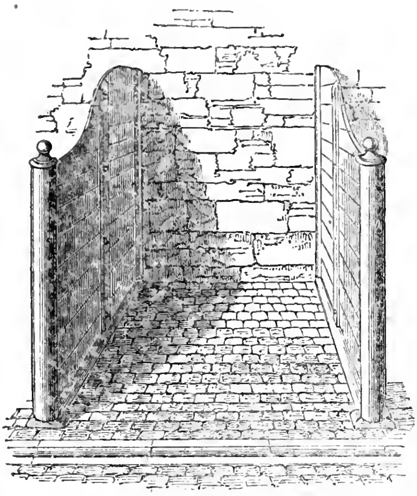
A STALL FOR A WORK-HORSE STABLE.

decay by keeping them above the action of the litter; *h* is the sparred bottom of the hay-rack, the upper rail of which holds the ring *i* for the stall collar-shank; *k* the corn-manger or trough; *l* the bar across the rack, to prevent the horse tossing out the fodder; *m* the pavement within the stall; *n* the freestone gutter for conveying away the urine to one end of the stable; *o* the pavement of the passage behind the horses' heels; *p* are two parallel spars fastened over and across the battens, when there is no hay-loft, to support trusses of straw or hay, to be given as fooder to the horses in the evenings of winter, to save the risk of fire in going at night to the straw-barn or hay-house with a light.

* Stewart's *Stable Economy*, p. 17.

1398. I think it right also to give a figure of a stall, furnished with cast-iron hind-posts, as in fig. 106.

Fig. 106.



A STALL WITH CAST-IRON HIND-POSTS.

1399. The *roof* of a *work*-stable should always be open to the slates, and not only so, but have openings in its ridge, protected by ventilators, fig. 81; and such are absolutely necessary for a work-horse stable. It is distressing to the feelings to inhale the air in some farm stables at night, particularly in old steadings economically fitted up, which is not only warm from confinement, moist from breathing, and stifling from sudorific odours, but cutting to the breath, and pungent to the eyes, from the volatilisation of ammonia. The windows are seldom opened, and can scarcely be so by disuse. The roof in such a stable is like a suspended extinguisher over the half-stifled horses. This evil is still further aggravated by a hayloft, the floor of which is extended over and within a foot or less of the horses' heads. Besides its inconvenience to the horses, the hay in it, through nightly roasting and fumigation, soon becomes dry and brittle, and contracts a disagreeable odour. The only remedy for all these inconveniences is complete ventilation.

1400. *Ventilation.*—The object of ventilation, to any apartment which constitutes the abode of animals, is to procure a constant supply of air in sufficient purity to meet the demands of the animal economy. The practice that has long prevailed, as regards ventilation, seems to deny its utility, and to doubt the injury accompanying its neglect. "It is upwards of eight-and-forty years," says Stewart, "since James Clarke of Edinburgh protested against close stables. He insisted they were hot and foul, to a degree incompatible with health, and he strongly recommended that they should be aired in such a manner as to have them always cool and sweet. Previous to the publication of Clarke's work, people never thought of admitting fresh air into a stable; they had no notion of its use. In fact, they regarded it as highly pernicious, and did all they could to exclude it. In those times the groom shut up his stable at night, and was careful to close every aperture by which a breath of fresh air might find admission. The keyhole and the threshold of the door were not forgotten. The horse was confined all night in a sort of hot-house; and, in the morning, the groom was delighted to find his stable warm as an oven. He did not perceive, or did not notice, that the air was bad, charged with moisture, and with vapours more pernicious than moisture. It was oppressively warm, and that was enough for him. He knew nothing about its vitiation, or about its influence upon the horses' health. In a large crowded stable, where the horses were in constant and laborious work, there would be much disease,—glanders, grease, mange, blindness, coughs, and broken wind would prevail, varied occasionally by fatal inflammation. In another stable, containing fewer horses, and those doing little work, the principal diseases would be sore throats, bad eyes, swelled legs, and inflamed lungs, or frequent invasions of the influenza. But every thing on earth would be blamed for them before a close stable." Moreover, he observes, "The evils of an impure atmosphere vary according to several circumstances. The ammoniacal vapour is injurious to the eyes, to the nostrils, and the throat. Stables that are both close and filthy are notorious for producing blindness, coughs, and inflammation of the nostrils; these arise from acrid vapours alone. They are most common in those dirty hovels where the dung and urine are allowed to accumulate for weeks together. The air of a stable may be contaminated by union with ammoniacal vapour, and yet be tolerably pure in other respects. It may never be greatly deficient in oxygen; but when the stable is so close that the supply of oxygen is deficient, other evils are added to those arising from acrid vapours. Disease, in a visible form, may not be the immediate result. The horses may perform their work and take their food, but they do not look well, and they have not the vigour of robust health;—some are lean, hide-bound, having a dead dry coat,—some have swelled legs, some mange, and some grease. All are spiritless, lazy at work, and soon fatigued. They may have the best of food, and plenty of it, and their work may not be very laborious, yet they always look as if half starved, or shamefully overwrought. When the influenza comes among them, it spreads fast, and is difficult to treat. Every now and then one or two of the horses become glandered and farcied."

1401. In order to show in a striking light the necessity there exists of using means to promote ventilation in all places occupied by animals, it may, perhaps, be done in the best manner by stating the estimated quantity of air which is vitiated every day by a cow of ordinary size. Dr Robert D. Thomson, after showing that the large quantity of carbon, 6,172 lbs., daily taken by a cow in its food, is employed for a purpose totally distinct from proper nutrition, proceeds to say,—"We are at present acquainted with only one other purpose for which the carbon of the food can be employed, viz., the generation of animal heat throughout the body, a function undoubtedly carried on, not only in the lungs, but also throughout the entire capillary system of the skin, at least in man and perspiring animals. If this view be correct, then it follows that upwards of 6 lbs. of carbon are expended by a cow daily in the production of animal heat. And as 1 lb. of carbon, when combined with the necessary amount of oxygen to form carbonic acid, gives out as much heat as would melt 104·2 lbs. of ice, it is evident that the quantity of ice capable of being melted by the heat generated by a cow, in one day, would amount to upwards of 625 lbs., or it would heat 1 lb. of water 87,528 degrees. It would consume, at the same time, the enormous quantity of 330,429 cubic inches of oxygen, or 191¼ cubic feet of this gas; and as this amounts to one-fifth of the atmospheric air, we find that a cow, consuming 6 lbs. of carbon for respiratory purposes, would require 956¼ cubic feet of atmospheric air, a sufficient indication of the immense importance of a free ventilation in cow-houses, and of the danger of over-crowding, if the animals are expected to retain a healthy condition."*

1402. Here are data furnished of the quantity of air required to be admitted into a byre, for the necessary use, daily, of a single cow of ordinary size. How, then, is this large quantity of fresh air to be admitted into a byre, when all the doors and windows are shut? This question involves and presupposes another, namely, How is as large a quantity of vitiated air to be expelled from the byre?—for this must first take place ere a ventilation through the byre can be maintained. The popular notions, however, regarding ventilation are very indefinite; as Mr Stewart observes, "Most people do not imagine that one set of apertures is required to carry away the foul, and another to admit the pure air. Even those who know that one set cannot answer both purposes in a perfect manner, are apt to disregard any provision for admitting fresh air. They say there is no fear but sufficient will find its way in somehow, and the bottom of the door is usually pointed to as a very good inlet. It is clear enough, that while air is going out, some also must be coming in, and that if none go in, little or none can go out. To make an outlet without any inlet betrays ignorance of the circumstances which produce motion in the air. To leave the inlet to chance, is just as much as to say that it is of no consequence in what direction the fresh air is admitted, or whether any be admitted. The outlets may also serve as inlets; but then they must be much larger than when they serve only one purpose, and the stable, without having purer air, must be cool or cold. When the external atmosphere is colder than that in the stable, it enters at the bottom of the door, or it passes through the lowest apertures, to supply and fill the

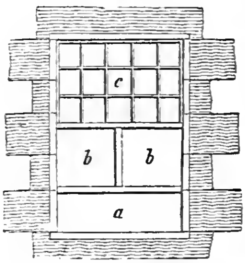
* Thomson's *Researches into the Food of Animals*, p. 113-114.

place of that which is escaping from the high apertures. If there be no low openings, the cooler air will enter from above—it will form a current inwards at the one side, while the warmer air forms another current, setting outwards at the other side. But when the upper apertures are of small size, this will not take place till the air inside becomes very warm or hot."* So little do many people see the necessity of ventilation, that they cannot distinguish between the *warm* air and the *foul* air of a stable; and, consequently, if the admission of fresh air is wanted to expel the foul, they immediately conclude it must be cold, and do harm. Now, it is the proper action of ventilation to let away all, and no more of the warm air of a stable, than what is foul, and then, of course, no more than the same quantity of fresh air can find its way into it.

1403. A ready means of letting out the foul air from a stable, is by a number of ventilators, such as is described at fig. 81, situate on the ridge of the roof; and one means of admitting fresh air below, is by the windows when they are open; but when they are shut, other means must be supplied. As doors and windows are usually situated in farm-stables, the fresh air should not be allowed to enter by them through the night; they should therefore be made tight. Fresh air coming directly from the doors or windows towards the nostrils of a horse, must pass either over his body, or first strike against his limbs—in either case doing more injury than good. The fresh air should come in near the horses' nostrils, where it is really required to be breathed in. An opening through the head wall of the stable, a few feet above the horse's head, seems the most convenient and proper place for the air to find its way. For the supply of every horse alike, an opening should be made above the head of each horse; and being so numerous, they should be small. I cannot particularise the size, as that must depend on many circumstances, — the number of horses, contents of the stable, tightness of the doors and windows, and suchlike. The air, on entering, being colder than that in the stable, will fall downwards, and so retard the velocity of its entrance; the openings should be provided with a covering of perforated plates of zinc; and should the current be still too strong, let it strike against a board fastened to the wall, and so placed as to cause the air to be reflected upwards before it descends. Experience will soon adjust the various parts of the means of ventilation to their proper relative proportions.

1404. The windows of steadings should be of the form for the purpose they are intended to be used. On this account the windows of stables, and of other apartments, should be of different forms. I have already given the forms of those for byres, &c., in figs. 77 and 78. Fig. 107 represents a window for a stable. The opening is 4½ feet in height by 3 feet in width. The frame-work is composed of a dead part *a*, of 1 foot in depth, 2 shutters *b b* to open on hinges, and fasten inside with a thumb-catch, and *c* a glazed sash 2 feet in height, with 3 rows of panes. The object of this form of window is, that generally a number of small articles are thrown upon the sole of a work-horse stable window, such as short-ends, straps, &c., which are only used occasionally, and intended to be at hand when wanted. The consequence of this confused mixture of things, which it is not easy for the farmer to prevent, especially in a busy season, is, that when the shutters are desired to be opened, it is scarcely possible to do it without first clearing the sole of every thing; and, rather than find another place for them, the window remains shut. A cupboard in a wall suggests itself for containing such small articles; but in the only wall, namely, the front one of the stable, in which it would be convenient to make such a cupboard, its surface is occupied by the harness hanging against it; and besides, no orders, however peremptory, will prevent such articles being at busy times thrown upon the window-soles; and

Fig. 107.



A STABLE WINDOW.

* Stewart's *Stable Economy*, pp. 35, 43, and 51.

where is the harm of their lying there at hand, provided the windows are so constructed as to admit of being opened when desired? When a dead piece of wood, as *a*, is put into such windows, small things may remain on the sole, while the shutters *b b* may be easily opened and shut over them.

1405. The *harness* should all be hung against the wall behind the horses, and none on the posts of the stalls, against which it is too frequently placed, to its great injury, in being constantly kept in a damp state by the horses' breath and perspiration, and apt to be knocked down among their feet. A good way is to suspend harness upon stout hardwood pins driven into a strong narrow board, fastened to the wall with iron holdfasts; but perhaps the most substantial way is to build the pins into the wall, when a new stable is building. The harness belonging to each pair of horses should just cover a space of the wall equal to the breadth of the two stalls which they occupy, and when windows and doors intervene, and which of course must be left free, this arrangement requires some consideration. I have found this a convenient one: A spar of hardwood nailed firmly across the upper edge of the batten *d*, fig. 105, that supports both posts of the stall, will suspend a collar on each end, high enough above a person's head, immediately over the passage. One pin is sufficient for each of the cart-saddles, one will support both the bridles, while a fourth will suffice for the plough, and a fifth for the trace harness. Thus 5 pins or 6 spaces will be required for each pair of stalls; and in a stable of 12 stalls—deducting a space of 13 feet for 2 doors and 2 windows in such a stable—there will still be left, according to this arrangement, a space for the harness of about 18 inches between the pins. Iron hooks driven into the board betwixt the pins will keep the cart-ropes and plough-reins by themselves. The curry-comb, hair-brush, and foot-picker, may be conveniently enough hung up high on the hind-post, betwixt the pair of horses to which they belong, and the mane-comb is usually carried in the ploughman's pocket. When the hind-posts are of cast-iron, as recommended already, these small articles cannot be hung upon them; and in such a case, there being no batten to suspend the collars from, hooks must be suspended from the couple legs to hang the collars upon.

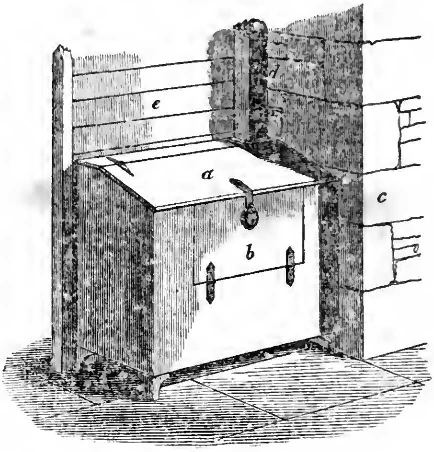
1406. Each horse should be bound to his stall with a *leather stall-collar*, having an iron-chain collar-shank to play through the ring *i* of the hay-rack, fig. 105, with a turned wooden sinker at its end, to weigh it to the ground. Iron chains make the strongest stall collar-shanks, though certainly noisy when in use; yet work-horses are not to be trusted with the best hempen cords, which often become affected with dry rot, and are, at all events, soon apt to wear out in running through the smoothest stall-rings. A simple stall-collar with a nose-band, and strap over the head, is sufficient to secure most horses; but as some acquire the trick of slipping the strap over their ears, it is necessary to have either a throat-lash in addition, or a simple belt around the neck. Others are apt, when scratching their neck with the hind-foot, to pass the fetlock joint over the stall collar-shank, and, finding themselves entangled, to throw themselves down in the stalls, bound neck and heel—there to remain unreleased until the morning, when the men come to the stable. By this accident I have seen horses get injured in the head and leg for some time. A short stall collar-shank is the only preventive against such an accident, and the low rack admits of its being constantly in use.

1407. Besides the ordinary stalls, a *loose-box* will be found a useful adjunct to a work-horse stable. A space equal to two stalls should be railed off at one end of the stable, as represented in the plan, Plate II. It is a convenient place into which to put a work-mare when expected to foal. Some mares indicate so very faint symptoms of foaling, that they frequently are known to drop their foals under night in the stable—to the great risk of the foal's life—where requisite attention is not directed to the state of the mare, or where there is no spare apartment to put her in. It is also suitable for a young stallion, when first taken up and preparing for travelling the road; as also for any young draught-horse, taken up to be broke for work, until he become accustomed to the stable. It might also be, when unfortunately so required, converted into a temporary hospital for a horse, which, when seized with complaint, might be put into it until it is ascertained whether or not the disease is infectious, and if so, removed to the proper hospital. Some people object to having a loose-box in the stable, and would rather have it out of it; but the social disposition of the horse renders such a place useful on such occasions. It is, besides, an excellent place to rest a fatigued horse for a few days. It is also a good place for a foal when its mother is obliged to be absent at work in the fields, until both are turned out to grass.

1408. The *hay-house* should be adjoining the work-horse stable, as at H, Plate II. It is 18 feet in length, 17 feet in width, and its roof is formed of the floor of the granary above. Its floor should be flagged with a considerable quantity of sand to keep it dry, or with asphaltum. It should have a giblet-checked outer door to open outwards, with a hand-bar to fasten it on the inside; it should also have a partly glazed window, with shutters, to afford light, when taking out the hay to the horses, and air to keep it sweet. As the hay-house communicates immediately with the work-horse stable by a door, it may find room for the work-horse corn-chest, which may there be conveniently supplied with corn from the granary above, by means of a spout let into the fixed part of the lid. For facilitating the taking out of the corn, the *end* of the chest should be placed against the wall at the side of the door which opens into the stable, and its back part boarded with thin deals up to the granary floor, to prevent the hay coming upon the lid of the chest. The walls of the hay-house should be plastered.

1409. The form of the corn-chest is more convenient, and takes up less room on the floor when high and narrow than when low and broad, as in fig. 108, which is 5 feet long and $4\frac{1}{2}$ feet high at the back above the feet. A part of the front *b* folds down with hinges, to give easier access to the corn as it gets low in the chest. Part fo the lid is made fast, to receive the spout *d*, for conveying the corn into it from the granary, and to render its movable part *a* lighter, and this is fastened with a hesp and padlock, the key of which should be

Fig. 108.



THE CORN-CHEST FOR THE WORK-HORSES.

constantly in the custody of the farm-steward, or of the person who gives out the corn to the ploughmen, where no farm-steward is kept: *c* is the corner of the doorway into the work-horse stable, and *e* is the boarding behind to prevent the hay falling on the lid. A fourth part of a peck measure is always kept in the chest for measuring out the corn to the horses. You must not imagine that because the spout supplies corn from the granary when required, that it supplies it without measure. The corn appropriated for the horses is previously measured off on the granary floor, in any convenient quantity, and then shovelled down the spout at times to fill the chest. A way to ascertain the quantity of corn at any time in the chest is to mark lines on the inside of the chest indicative of every quarter of corn which it contains. In some parts of the country the corn for the horses is put into small corn chests, one of which is given in charge to every ploughman, who keeps the key, and supplies his horses with corn at stated times. The small chests are generally placed at hand in the stable within the bays of the windows, and in recesses made on purpose in the wall. A certain quantity of corn is put into each chest at the same time, which is to last the pair of horses a certain number of days. This plan may save the steward or some other person the trouble of giving out corn to the horses every day, but it places it too much in the power of the ploughmen to defraud the horses of their corn, and appropriate it for their own purposes; and it is an inconvenient plan when at any time it is proper to give a particular horse, or pair of horses, a little more corn than usual, for some extra work performed by them. There cannot be a safer measure in conducting any farm, than to confine every class of work-people to the performance of their own proper duties.

ON THE TREATMENT OF FARM-HORSES IN WINTER.

1410. Farm-horses are under the immediate charge of the ploughmen, one of whom works a pair, and keeps possession of them generally during the whole period of his engagement. This is a favourable arrangement for the horses, working more steadily under the guidance of the same driver than when changed into different hands; and it is also better for the ploughman himself, as he performs his work most satisfactorily to himself, as well as his employer, with horses familiarised to him. In fact, the man and his horses must become acquainted before they can understand each other; and when the peculiar tempers of each party are mutually understood, work becomes more easy to both, and more attention is bestowed upon it. Some horses show great attachment to their driver, and will do whatever he desires without hesitation; others show no particular regard: and great differences may be remarked of ploughmen towards their horses. Upon the whole, there exists a good understanding in this country between the ploughman and his horses; and, independently of this, few masters are disposed to allow their horses to be ill treated, and there is no occasion for it; as horses which have been brought up on a farm, in going through the same routine of work every year, become so well acquainted with what they have to do, that, when a misunderstanding arises between them and their driver, you may safely conclude that the driver is in the wrong.

1411. The treatment which farm-horses usually receive in winter is this:—The ploughmen, when single, get up and breakfast before day-break, and then go to the stable, where the first thing they do is to take out the horses to the water. The usual place at which horses drink is at the horse-pond; and should ice prevent them, it must be broken. To horses out of a warm stable, water at the freezing point cannot be palatable; and yet it is not easy to devise a better plan—for though the purest water were provided in a trough, it would be as liable to freeze as in a pond; and to have two pailfuls of water thawing all night in the stable, for each pair of horses, is an expense which no farmer will incur, and which, besides, would limit the drink to the horses. The only other plan is to have a cistern within the stable, from which the water could be drawn in pailfuls in the morning; but still the giving every pair of horses water from a cistern from the same pails would cause some loss of time, and the cistern would become useless in mild weather. As matters are arranged at present, the horses are taken to the pond to drink, and brought back to the stable to receive their morning allowance of corn. From habit, however, the horses do not require to be led to and from the pond, one of the men only seeing they do not wander or loiter away their time; and while the horses are out of the stable, the rest of the men take the opportunity of removing the dung and soiled litter made during the night into the nearest court-yard, with their shovels, fig. 83, wheel-barrow, fig. 87, and besom.

1412. While the horses are still absent, one of the ploughmen supplies each manger with corn from the corn-chest, where the steward is ready to deliver him the feed appointed for each horse; or every man takes to him his pair of nose-bags, and receives the supply of corn for his own horses before beginning to clean out the stable; or the steward himself puts the corn into the mangers while the men are employed in cleaning the stable. This last plan, if the steward is provided with a light box beside the corn-measure, to carry two feeds at a time, saves most time, which, in a short winter's morning, is of some consequence. On the return of the horses to the stable from the water, they find their mangers plenished with corn—

and it is scarcely worth while binding them with the stall-collars, if the men remain in the stable, and go to work whenever the horses have finished their corn; but this seems the best time for the men to take their breakfast, and which married men usually do—and in quitting the stable, they put the stall-collars on the horses, and leave them in quietness to eat their corn. It is not an unusual practice to curry and wisp the horses, and to put the harness on them while engaged with their corn; but this should never be allowed. Let the horses eat their food in peace, and many of them, from sanguine temperament or greed, cannot divest themselves of the feeling that they are about to be taken from their corn when handled during the time of feeding. The harness can be quickly enough put on after the feed is eaten, as well as the curry-comb and brush used, and the mane and tail combed. An allowance of a little time between eating their corn and going to work is of advantage to the horses, as work, especially when severe, undertaken with a distended stomach, is apt to bring on an attack of *batts* or colic.

1413. Men and horses continue at work until 12 noon, when they come home—the horses to get a drink of water and a feed of corn, and the men their dinner. Some keep the harness on the horses during this short interval, but it should be taken off, to allow both horses and harness to cool—and at any rate the horses will be much more comfortable without it—and it can be taken off and put on again in a few seconds, and the oftener the men are exercised in this way they will become the more expert in putting it on and taking it off.

1414. When the work is in a distant field, rather than come home between yokings, it is the practice of some farmers to feed the horses in the field out of the nose-bags, and the men to take their dinners with them, or be carried to them in the field by their own people. This plan may do for a day or two in good weather, on a particular occasion; but it is by no means a good one for the horses, as no mode gives them a chill more readily than to cause them to stand on a head-ridge for even half an hour in a winter day, after working some hours. A smart walk home can do them no harm; and if time really presses for the work to be done, let the horses remain a shorter time in the stable. The men themselves will be infinitely more comfortable to have dinner at home.

1415. A practice exists in England, connected with this subject, which I think highly objectionable—that of doing a day's work in one yoking. For a certain time, horses, like men, will work with spirit; but if the work endures beyond that time, they not only lose strength, but spirit, and in the latter part of the yoking work in a careless manner. Horses kept for 7 or 8 hours at work must be injured in their constitution, or execute work in the latter part of the yoking badly, or receive extraordinary feeding, any of which consequences is symptomatic of bad management. Common sense tells a man that it is much better for a horse to be worked a few hours smartly, and have his hunger satisfied before feeling fatigue, when he will again be able to work with spirit, than to be worked the entire number of hours of the day without feeding. I see no possible objection to horses receiving a little rest and food in the middle of a long day's work, but I perceive many and serious ones to their working all day long without rest and food.

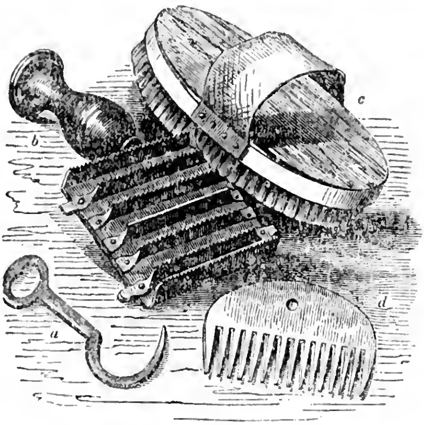
1416. The men and horses come home at mid-day, the usual dinner hour of agricultural labourers, and the first thing done is to give the horses a drink at the pond on the way to the stable, and no washing of legs should be allowed. From the water the horses proceed to the stable, where the harness is taken off; and as the men have nothing else to do, every one gets the corn for his horses from the steward, at the corn-chest, in nose-bags or a small box. Of these two modes of carrying horse corn in the stable, I prefer the trough, as being most easily filled and emptied. The horses are bound up, the stable door shut, and the men go to their dinner, which should be ready for them. After dinner they return to the stable, when the horses will have finished their feed, and a small quantity of fresh straw—for at this time farm-horses get no hay—will be well relished. The men have a few minutes to spare until 1 P.M., when they should wisp down the horses, put on the harness, comb out the tails and manes, and be ready to put on the bridles the moment 1 o'clock strikes, which is announced by the steward.

1417. The afternoon yoking is short, not lasting longer than sunset, which at this season is before 4 P.M., when the horses are brought home. After drinking again at the pond, they are gently passed through it below the knee, to wash off any mud from their legs and feet, which they can hardly escape collecting in winter. In thus washing the horses, the men should be prohibited wetting them above the knees, which they are ready to do when mud reaches the thighs and belly; and to render the prohibition effectual, the horse-pond should not be deeper than to take a horse to the knee. In wetting the belly at this season, there is danger of contracting inflammation of the bowels or colic; and to treat mares in foal in such a way is highly imprudent. If the feet and shanks are cleared of mud, it is all that is requisite for washing in winter. On the horses entering the stable, and having their harness taken off, they should be well strapped down by the men with a wisp of straw. Usually two wisps are used, one in each hand; but the work is better done with one, shifting the hand as occasion requires. A couple of wisps may be used to rub down the legs and clean the pasterns, rendering them as dry as a moderate length of time will admit. The work usually done at this time in the stable is nearly in the dark, and farmers either think there is no occasion for light in a stable at this hour, or grudge the expense; but either excuse is no justification for doing any work in the stable in the dark. In fact the steward ought to have a light ready when the horses enter the stable, and then every thing would be seen to be done in a more satisfactory manner than they generally are.

1418. After the horses are rubbed down, the men go to the straw-barn, and bundle each 4 windlings of fodder-straw, one to be given to each horse just now, and the other two to be put across the small fillets *p*, fig. 105, in the stable, when the stable is fitted up as in this figure; but if constructed as in fig 106, the windlings may remain in the straw-barn till wanted. This preparation is made for the same reason that the cattle-man stowed away his windlings for the cows in the byre—that the straw-barn may not be entered with a light; but the steward may enter it safely with such a lantern as fig 89, to let the men see to get the straw required just now, both for fodder and litter The stable has been without litter all day, since its cleansing out in the morning, and the horses have stood on the stones at mid-day. This is a good plan for purifying the stable during the day, and is not so much attended to as it deserves. Sufficient litter-straw is now brought in by the men from the straw-barn, and shaken up to make the stalls comfortable for the horses to lie down. Leaving the horses with their fodder, and shutting the stable doors, the men retire to their homes, to whatever occupation they please, until 8 P.M., the hour at which horses receive their suppers.

1419. When 8 P.M. arrives, the steward, provided with light in the lantern, summons the men to the stable to give the horses a grooming for the night, and their suppers. The sound of a horn, or ringing of a bell, are the usual calls on the occasion, which the men are ready to obey. I may remark, in passing, that the sound of a horn is pleasing to the ear in a calm winter night—recalling to my mind the goatherd's horn in Switzerland, pouring out its mellow and impressive strains at sunset—the time for gathering the flock and herd together from the mountain sides to their folds in the neighbouring village. Lights are placed at convenient distances in the stable, to let the men see to groom the horses. The grooming consists first in currying the horse with the curry-comb *b*, fig. 109, to free him of the dirt adhering to his skin, and which, being now dry, is easily removed. A wisping of straw removes the roughest of the dirt loosened by the curry-comb. The legs ought to be thoroughly wisped—not only to make them clean, but dry of any moisture that may have been left in the evening; and at this time the feet should be picked clear, by the foot-picker *a*, of any dirt adhering between the shoe and the foot. The brush *c* is then used, to remove the remaining and finer portions of dust from the hair, and it is cleared from the brush by a few rasps along the curry-comb. The wisping and brushing, if done with some force and dexterity, with a combing of the tail and mane with the comb *d*,

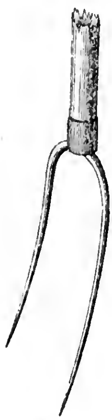
Fig. 109.



THE CURRY-COMB, BRUSH, FOOT-PICKER, AND MANE-COMB.

should render the horse pretty clean; but there are more ways than one of grooming a horse, as may be witnessed by the skimming and careless way in which some ploughmen do it. It is true that the rough coat of a farm-horse in winter is not easily cleaned, and especially in a work-stable where much dust floats about and no horse-clothes are in use; but, rough as it is, it should be *clean* if not *sleek;* and it is the duty of the steward to ascertain whether the grooming has been efficiently done. A slap of the hand upon the horse will soon let you know the existence of the loose dust in the hair. Attendance at this time will give you an insight into the manner in which farm-horses ought to be cleaned and generally treated in the stable.

Fig. 110.



THE COMMON STRAW FORK.

1420. The straw of the bedding is then shaken up with a fork, such as in fig. 110. This figure has rather longer prongs, and too sharp for a *stable fork*, which is most handy for shaking up straw when about 5 feet in length, and least dangerous of injuring the legs of the horses by puncture when in a blunted state. The united prongs terminate at their upper end in a sort of spike or tine, as seen in fig. 111, which is a steel pronged fork of the form used in Lincolnshire, and is an excellent instrument for working amongst straw, driven into a hooped ash shaft. This mode of mounting a fork is much better than with socket and nail, which are apt to become loose and catch the straw.

Fig. 111.

THE LINCOLNSHIRE STEEL STRAW FORK.

1421. The horses then get their feed of oats, after which the lights are removed and the stable doors barred and locked by the steward, who is custodier of the key. In some stables a bed is provided for a lad, that he may be present to relieve any accident or illness that may befall any of the horses; but, where the stalls are properly constructed, there is little chance of any horse strangling himself with the collar, or of any becoming sick where a proper ventilation is established.

1422. In winter it is customary to give farm-horses a mash, once at least, and sometimes thrice a-week. The mash consists of steamed potatoes or boiled turnips, boiled barley, oats or beans, mixed sometimes with bran, and seasoned with salt. The articles are prepared in the stable boiler-house, Plate II., in the afternoon, by the cattle-man, a field-worker, or other person appointed to do it, and put into tubs, in which it is carried to the stable by the men, and dealt out with a shovel, for supper at night, in the troughs used to carry the corn to the horses. It is warm enough when the hand can bear the heat. The quantity of corn put into the boiler is as much as when given raw, and in its preparation swells out to a considerable bulk. The horses are exceedingly fond of mash, and, when the night arrives for its distribution, show unequivocal symptoms of impatience to receive it.

1423. The quantity of raw oats given to farm-horses, when on full feed, is 3 lippies a-day, by measure, and not by weight; but taking horse-corn at almost the greatest weight of 40 lb. per bushel, each feed will weigh $2\frac{3}{4}$ lbs., the daily allowance amounting to $11\frac{1}{4}$ lbs.; but the lippy measure, when horse-corn is dealt out, is most frequently not striked, but heaped, or at least hand-waved, so that the full allowance will weigh even more than this. As horses work only 7 or 8 hours a-day in winter, their feeding is lessened to perhaps 2 full feeds a-day or $7\frac{1}{2}$ lbs., divided into three portions—namely, a full feed in the morning, $\frac{1}{2}$ a feed at mid-day, and $\frac{1}{2}$ a feed at night; and on the nights the mash is given, the evening $\frac{1}{2}$-feed of raw oats is not given. Some small farmers withdraw the corn altogether from their horses in the depth of winter, giving them mashes of some sort instead; whilst others only give them one feed a-day, divided at morning and noon, and a mash at night, or raw turnips or potatoes at night. One of the sorts of mash alluded to consists of barley, or oat or wheat chaff, steeped for some hours in cold water in a large cistern, made for the purpose, and a little light barley or oats sometimes put in, to give the appearance of corn. But a greater deception than such a mess, in lieu of corn, cannot be practised upon poor horses,—for what support can be derived from chaff steeped in cold water? As well might the mess be mixed up at once in the manger. No doubt horses eat it, but only from hunger; and when obliged to live upon it, exhibit thin ribs, pot bellies, and long hair—characteristics which bespeak poverty of condition. A neighbour farmer to myself, faithfully as the winter came round, *fed* his horses, as he phrased it, upon this *steep*, and the consequence was, that they went like snails at their work; and when returning home from delivering a load of corn at the market-town, with even the support of a half-feed of corn, one leg was like to knock over another. A farm-steward recommended this steep to me, as effecting a great saving in corn, and showed me a fine set of cisterns, made of pavement, which he had advised his master, a landed proprietor, to erect for the purpose of making it. Instead of eulogising his fine cisterns, I proposed to do any number of days' work of any sort he pleased with my horses against his, on their respective modes of feeding, and it would then be seen which was best able to support the horses in working condition. He declined the trial, as he had frequent opportunities of seeing my horses pass his way with single carts, stepping out at 4 miles an hour, with a load out and home. No doubt the steep is economical, in as far as saving in corn is concerned; but the saving is effected in substituting bad food for good, and at the expense of the horses' condition. One season, as a mash, I tried steamed potatoes, with salt alone, of which the horses were excessively fond, and received three times a-week, and on which they became sleek in the skin, and fat, notwithstanding much heavy work; but in spring, when the long days' field-work was resumed, they were all affected by shortness of wind. Should cooked potatoes necessarily have this effect upon horses? I may mention that oats and barley, and every other species of grain, when desired to be cooked, must at least be macerated, and to do this effectually *warm* water must be used, so that cold water cannot effectually draw out the nourishing portion of grain.

1424. The price of a curry-comb ranges from 8d. to 1s. 6d. a-piece: brush, 3s. 6d.: mane-comb, 6d.: foot-picker, 1s., and one to fold for the pocket, 1s. 6d. Shears to trim the mane and tail, 5d. to 1s. 4d. Plain nose-bags, 1s. 6d., with leather bottoms, 7s. each.

1425. I have often thought that the usually careless manner of placing the lights in the stable in the evening is highly dangerous to the safety of the building; and yet, in the most crowded and dirty stables, no accidents of fire almost ever happen. Sometimes the candle is stuck against a wall by a bit of its own melted grease; at other times, it hangs by a string from the roof in an open lantern, set apparently on purpose to catch straws. A good stable lantern is still a desideratum; and it should hold a candle, and not an oil-lamp, as being the most cleanly mode of carrying about light; and if the candle could be made to require no snuffing, it would be perfect. A tin-lantern, with a horn glass, is what is commonly in use to carry the candle in the air; but when it becomes blackened with smoke in the inside, it is of little use to give light outside. The globe lantern of glass, made very strong for use on board of ship, has an oil lamp in it, and is, perhaps, the best yet contrived. It has one invaluable property, that of perfect safety. It is fig. 89.

1426. From the stable the steward takes the lantern, and, accompanied by a few of the men, or by all—and of necessity by the cattle-man—inspects all the courts and hammels to see if the cattle are well; and if it be moonlight, and any of the cattle on foot, apparently desirous of more food, gives them a few turnips. The byres in which cattle are feeding are also visited, and the fresh windlings of straw, laid up in reserve by the cattle-man, are now given them, any dung in the stalls drawn into the gutter, and the bedding shaken up with a fork. The cows, both the farmer's and servants', are visited and treated in like manner. The bulls, heifers in calf, and young horses, all are visited at this time, to satisfy the mind, before retiring to rest, that every creature is well and in safety.

1427. This is the usual routine of the treatment of farm-horses in winter, and, when followed with a discernment of the state of the weather, is capable of keeping them in health and condition. The horses are themselves the better of being out every day; but the kind of work they should do daily must be determined by the state of the weather and the soil. In wet, frosty, or snowy weather, the soil cannot be touched; and the thrashing and carrying of corn to market are then conducted to advantage. In frost, the dung from the courts may be taken out to the fields in which it is proposed to make dunghills. When heavy snow falls, nothing can be done out of doors with horses, except thrashing corn, when the machine is impelled by horse-power. In very heavy rain the horses should not be exposed to it, as every thing about them, as well as the men, become soaked; and before they become again in a comfortable state, the germs of future disease may be engendered. When it is fair above, however cold the air or wet the soil, one of the out-door works mentioned above should be done by the horses; and it is better for them to work only one yoking a-day than to stand idle in the stable. Work-horses soon show symptoms of impatience when confined in the stable even for a day—on Sundays, for example; and when the confinement is much prolonged, they even become troublesome. When such occasions happen, as in continued snow-storms, the horses should be ridden out for some time every day, and groomed as carefully as when at work. Exercise is necessary to prevent thickening of the heels, a shot of grease, or a common cold. Fat horses, when unaccustomed to exercise, are liable to molten grease. Such weather affords a favourable opportunity for cleaning harness, the bushes of cart-wheels, the implement-house, or any neglected place in the steading.

1428. It is advisable for a farmer to breed his own horses; and, on a farm which employs 6 pairs, two mares might easily bear foals every year, and perform their share of the work at the same time. without injury to themselves. The advantage of breeding working stock at home is, that, having been born and brought up upon the ground, they not only become naturalised to the products of its particular soil, and thrive the better upon them, but also become familiarised with every person and field upon it, and are broke into work without trouble or risk. The two mares should work together, and be driven by a steady ploughman; and their work should be confined to ploughing in winter and spring, when they are big with young, for the shaking in the shafts of a cart, or going round in the horse-course, is nothing in their favour. Their driver should plough with them, when ever that operation can be performed; and when it cannot, he should assist the other men at their carts with manual labour.

1429. There is a good arrangement as regards the horses adopted by some farmers, as well as being adapted to married ploughmen of different strengths and ages, which is, the keeping a pair or two of the horses always at home, ploughing and doing other works at home, and never bearing cart-loads upon the high-way. Old horses, mares in foal, and ploughmen advancing in life, are kept at home; and the others, consisting of the youngest of the horses, and the most active of the men, are appointed to drive all the loads to and from the farm. This subdivision of labour has the advantage of causing the sorts of work best adapted for the capacities of the men to be executed most perfectly.

1430. Supposing, then, that one or two mares bear a foal every year, these, with the year-olds and two-year-olds, should be accommodated in the hammels N, Plates I. and II., according to age—where there are more than one of the same age, the older being apt to knock the younger about; but where one only of every age is brought up, they may be placed together for the sake of companionship, and horses, being social animals, learn to accommodate themselves to one another's tempers. Where blood foals are bred as well as draught, they should have separate hammels, the latter being rough and overbearing, though the bloods generally contrive in the end to obtain the mastery. Young horses never receive any grooming, and are even seldom handled; but they should be accustomed to be led in the halter from the period they leave their mothers.

1431. The food usually given to young horses in winter is oat-straw for fodder, and a few oats; and where they are wintered among the young cattle in a large court, they have only the chance of picking up a little corn from the corn-barn, or the refuse of hay from the litter of the work-horse stable in spring—when they seldom get corn. The fact is, young horses are unjustly dealt with; they are too much stinted of nourishing food, and the consequences are smallness of bone, which deprives them of the requisite strength for their work, and dulness of spirits which renders their work a burden to them. I speak of what I have seen of the way in which a large proportion of the farm-horses of this country are brought up when young. Their treatment seems to be derived from the opinion that little nourishing meat should be given to young horses. Instead of this, they should receive a stated allowance of corn,—and if bruised, so much the better,—according to their ages; and when a mash is given to the work-horses, the young ones should always have a share. For the purpose of receiving corn and mash, mangers should be put up in the inside of each hammel, apart from each other. Attempts at domineering will be made by the artful over the simple colt or filly; but proper correction administered at times, and justice done to all on every occasion, will put an end to overbearing conduct. The steward cannot be better employed than in giving corn to the young horses; and the cattle-man should attend to their fodder and litter: and were the mash for the horses prepared before daylight departs, the messes could be given to the young horses immediately after the men leave the stable in the twilight. Should a mash be deemed too expensive for young horses, they should get Swedish turnips or carrots every day—moist food being as requisite for them as dry fodder and corn.

1432. The names commonly given to the different states of the horse are these:—The new-born one is called a *foal*, the male being a *colt foal*, and the female a *filly foal*. After being weaned, the foals are called simply *colt* or *filly*, according to the sex, which the colt retains until broken in for work, when he is a *horse* or *gelding*, which he retains all his life; and the filly is then changed into *mare*. When the colt is not castrated he is an *entire colt;* which name he retains until he serves mares, when he is a *stallion* or *entire horse;* when castrated he is a *gelding;* and it is in this state that he is chiefly worked. A mare, when served, is said to be *covered by* or *stinted to* a particular stallion; and after she has borne a foal she is a *brood mare*, until she ceases to bear, when she is a *barren mare* or *eill mare;* and when dry of milk, she is *yeld*. A mare, while big with young, is *in foal*. Old stallions are never castrated.

1433. There are various ways of employing ploughmen in winter, when the horses happen to be laid idle from the state of the weather. Some farmers always employ them to dress the corn for the market, with a view to economy. Ploughmen may certainly be employed in thrashing corn with the mill, when not engaged with their horses; but to lay horses idle for the sake of employing their drivers at barn-work, is poor economy. Men generally cannot riddle corn well, and in every other respect are too rough in their mode of work for the nicer work of the barn. In deep snow, when all the roads of the farm are blown up, the men may be usefully employed in cutting open roads to the most frequented place for the time, such as to the field of turnips, to the one where the sheep are feeding on turnips, to that in which it is proposed to make a dunghill. Their services of this sort may even be required on the public highway, to the extent it passes through the farm, when it is determined to cut open the road for the public convenience. In the severe snow-storm of 1823 this had to be done oftener than once; and unless the farm-servants had rendered assistance upon that occasion, the opening of the roads would have cost more money, and taken a longer time to be opened, than they did. In that state of the weather, the men are usefully employed in assisting the shepherd to open channels in the snow, among the stripped turnips, to allow the sheep to get at them, and in carrying hay to the ewes. In heavy falls of rain, and sudden breaking up of snow-storms, rivulets and ditches often become more full of water than they can conveniently contain, and are therefore apt to overflow the arable ground on each side, to the injury of new wheat, or souring of the ploughed land, as the case may be. It is the duty of the hedger to attend to the state of the ditches, and see that no injury arises from the water, in its course through the farm; but the exertions of one man, in such an emergency, are quite inadequate to stem the torrent of water. The men, therefore, all turn out, with suitable implements, and assist in removing the obstructions the water may have raised against its own course, and cut gaws, where necessary, for leading off the water from the ploughed soil. Small rivers, on the sudden breaking up of a season of frost, bring down shoals of ice, which, on accumulating at the sharp turns of the river, form dammings there, obstructing the passage of the water, which, only finding a vent over the banks or embankment, destroys the soil on either side. Where such an incident is likely to happen, the men should be prepared with proper instruments, as poles, long forks, sledge-hammers, and mallets, to break and guide the shoals, and prevent their accumulation at any place. A timely preparation of this kind may be the means of averting much damage. Such occupations as I have mentioned, are quite befitting stout men; and if the steward be on the outlook for every casualty which may reasonably happen, and take the lead to avert them, he will feel the satisfaction of having been the means, by the exercise of forethought and judgment, of saving much valuable property to his master.

1434. The horse thrives well on cooked food. He has a single or simple stomach, which must be filled at once with well masticated food, before the gastric juice can act upon it in a proper manner; and should any food which enters it in an insufficiently masticated state, escape beyond the influence of the juice into the bowels, it may decompose there, generate gas, and produce the analogous disease of *hoven* in cattle, namely, flatulent colic or *batts*. To render food in such a state at first as shall save the horse the trouble of mastication, is therefore to do him a good service; and hence cooked food is in a proper state for feeding a horse, and has been proved to be economical. Still, the cooking will be carried to an injurious degree, if it shall, by dint of ease of deglutition, prevent the flow of a sufficient quantity of saliva into the stomach, which is necessary to complete digestion,—"the quantity of which," says Professor Dick, "is almost incredible to those who have not had an opportunity of ascertaining it, but which the following fact will testify. A black horse had received a wound in the parotid duct, which became fistulous. When his jaws were in motion, in the act of eating hay, I had the curiosity to collect in a glass measure the quantity which flowed during 1 minute, by a stop-watch; and it amounted to nearly 2 drachms more than 2 oz. in that time. Now, if we calculate that the parotid gland on the opposite cheek poured into the mouth the same quantity in the same time, and allow that the sub-lingual and sub-maxillary glands on each side combined, pour into the mouth a quantity equal to the two parotids, we then have no less than 8 oz. of saliva passing into the mouth of a horse in 1 minute, for the purpose of softening the food and preparing it for digestion."* Yet it is impossible for any horse to swallow food, in the most favourable state it can be made for swallowing, without moving his jaws to a certain degree, and this insures a certain quantity of saliva entering his stomach.

1435. But more than this, cooked food may be presented in too nutritious a state for the stomach; and there may be, on the other hand, too little nutriment in the food given: For "the digestive organs of the horse, like those of the ox," says Professor Dick, "are very capacious,

* *Quarterly Journal of Agriculture*, vol. iii. p. 1025.

and are evidently intended to take in a large proportion of matter containing a small proportion of nutriment; and if the food upon which they are made to live is of too rich a quality, there is, by the excitement produced, an increase of the peristaltic motion, in order to throw off the superabundant quantity which has been taken into the stomach and bowels. It is necessary to give, therefore, a certain quantity of *bulk, to separate, perhaps, the particles of nutritious matter,* that the bowels may be enabled to act upon it properly. A horse could not live so well on oats, if fed entirely upon them, as when a portion of fodder is given ; with them a certain quantity is required. But this may be carried too far, and the animal may have his bowels *loaded* with too large a quantity of unnutritious food,"—as witness the nature of the *steep* before alluded to (1423) — "and nothing less than such a mass as will render him incapable to perform any active exertion, will be sufficient to afford him even a scanty degree of nourishment. A horse living on straw in a straw-yard becomes pot-bellied. Hence it is, that a proper arrangement in the properties and proportions of his food becomes a matter of important consideration."* These and the preceding remarks comprehend all the rationale of feeding horses, and, if carefully considered, may conduct you to adopt such an appropriate mixture of materials in your possession, as may serve to maintain the strength, good health, and condition of your horses, and to do so economically. Mean time I shall enumerate a few of the attempts that have hitherto been made of making comparative mixtures of food for horses, with the view of ascertaining whether cooked or raw food maintains horses in the best order.

1436. The most careful set of experiments that have yet been recorded in supporting *farm-horses* on *boiled* and *raw* grain, and on raw grain *prepared* and in a *natural* state, was made by Mr James Cowie, Halkerton Mains, Kincardineshire. He subjected no fewer than 12 horses to the experiment, dividing them into 3 sets of 4 each, and keeping each set on a separate fare. The horses were weighed on 1st March, when the experiment began, and their weights varied from 9 cwt. 3 qrs. to 12 cwt. 1 qrs. 4 lbs.; and they were again weighed on 1st May, at the end of the experiment, and their weights varied from 9 cwt. 2 qrs. 23 lbs., to 12 cwt. 1 qr. 14 lbs. Thus the entire weights did not vary much at both the periods, though individual weights did. The ages of the horses ranged from 4 to 12 years. They were fed as follows ;—

First Set.—2 on *cut* barley and beans, mixed, *raw.*
" 2 ... ... *boiled.*
Second Set.—2 on oats and beans, *raw.*
" 2 ... *boiled.*
Third Set.—2 on oats *raw.*
" 2 ... *boiled.*

Each horse got 1 peck = 4 lippies = 4 feeds = about 16 lbs. of grain daily, with oat straw. The weight of the barley was 50 lbs., and of the oats 42 lbs. per bushel. The horses were not put suddenly upon a change of food, for Mr Cowie had been in the practice of giving them daily raw, cut, and boiled grain alternately. The experiment having been conducted at a season of heavy work, it is not surprising that the horses lost some weight upon the whole ; thus their gross weights on 1st March was 130 cwt. 2 qrs. 26 lbs., and on 1st May it had decreased to 124 cwt. 3 qrs. 22 lbs.—a difference of 5 cwt. 3 qrs. 4 lbs. ; but as one horse only lost 5 lbs., another kept his weight, and a third gained 10 lbs.—3 out of the 12 thus proving themselves quite able to stand heavy work—the remaining 9 had to bear almost the entire loss of weight, which varied individually from 1 qr. 23 lbs. to 3 qrs. 12 lbs. The result of the losses and gains stand thus :—

	Cwt. qr. lbs.	Cwt. qr. lbs.	Cwt. qr. lbs.
Total loss of weight of 6 horses on *boiled* grain, ...			3 2 27
Total loss of weight of 6 horses on raw grain, . . .		2 0 15	
Deduct gain by 1 horse, . . .	0 0 10		
... same state of 1 horse, . . .	0 0 0		
		0 0 10	
			2 0 5
Average loss on each horse on *boiled* grain, *nearly*, ...			0 2 14
... *raw*, bruised and unbruised, *nearly*, .			0 1 12

In the course of the experiment it was observed, that one or two of the horses fed on boiled grain perspired more freely at their work than the others, drank less water, and voided softer dung, but with no tendency to purge.

1437. The facts brought out in this experiment were, that the horses fed on *unbruised raw* and on *boiled* grain, gave results so nearly alike, that it seems inexpedient to incur the expense of *cooking* food for horses, as that costs about 1½d. on two feeds for each horse. This is a rather remarkable result, for one should have expected that the *boiled* grain would have had the advantage. *Bruised raw* grain seems the most nourishing, and, in not requiring cooking, the most economical mode of feeding work-horses. For all the horses that had *boiled* and *unbruised raw* grain lost 70 lbs. each—and 6 or 7 per cent of loss in an animal is considerable; while those which had *bruised* grain, though raw, either gained weight or lost none. And as to economy in using bruised grain, *besides the cooking,* it is alleged that boiled whole grain passes through the horse undi-

* *Quarterly Journal of Agriculture,* vol. iii. p. 1031.

gested, as well as raw whole grain, and the quantity which thus escapes is equal to one-sixth of what a horse consumes; whereas, the *bruised* grain undergoes a considerable degree of digestion before passing away. If the loss is a sixth part on a horse which gets 12 lbs. of whole oats daily, a yearly saving may be effected of more than 2 quarters of corn, by giving him 10 lbs. of bruised.

1438. Many economical forms of mixtures have been recommended for farm-horses, and these are among them :—

10 lbs. of chaffed straw, at £1 per ton,	1d.
10 lbs. of oats, at 3s. per bushel, . .	9
16 lbs. of turnips, at 10s. per ton, .	1
Expense of cutting and chaffing, .	0½
Cost of one horse each day,	11½d.
16 lbs. of hay, at 3s. 6d. per cwt., .	6d.
5 lbs. of oats, at 3s. per bushel, .	4½
16 lbs. of turnips, at 10s. per ton, .	1
Cost of one horse each day,	11½d.
28 lbs. of steamed turnips, . .	3½d.
7 lbs. of coals at 1s. per bushel, .	1
Expenses of steaming, . . .	0½
6 lbs. of straw, at £1 per ton, . .	1½
Cost of one horse each day,	6½d.

This last mixture, containing no corn of any kind, is said to "succeed remarkably well—and although the horses perspired considerably while at work, they kept their condition exceedingly well"—and has been adopted by some farmers in the south of England, and by Mr Karkeek, the veterinary surgeon, as having been "highly recommended by several practical farmers."* No doubt horses can live on turnips as well as grass, without corn, and they may be said to work upon them; but I agree with Mr Stewart, when he observes,—"What the owner might call *work* is not known. In this country, grass alone will not produce workable horses;" and the same may more truly be said of turnips and straw. "If food is not given," continues Mr Stewart, "work cannot be taken. Every man who has a horse has it in his power to starve the animal; but that, I should think, can afford little matter for exultation."†

1439. Turnips are frequently given to farm-horses in the evening in lieu of a feed of corn, and even of a hot mash at night; and horses are very fond of Swedish turnips, which, on being washed, are set before them whole, unless some of the men take the trouble of slicing them with their knives; but the best way is to slice them with Wallace's turnip-slicer, fig. 86; and those turnips are also much relished by horses when boiled, along with oats, or barley and beans.

1440. Potatoes are given to horses in a raw state, and they seem to relish them, but not so much as Swedish turnips.

1441. But of food of the root kind, none delights horses so much as the carrot. It is to be regretted that this root can only be cultivated successfully on very light soil, otherwise it would be worth while to raise as many as would support the horses, with corn, all winter. Stewart says, that "for slow-working horses, carrots may supply the place of corn quite well, at least for those employed on the farm."‡ They might become fat enough on 70 lbs. of carrots a-day, but would want stamina without corn. Carrots are easily and successfully grown in the island of Guernsey; but are not given to horses on account of an allegation, that "when on this food their *eyes* are injured."

1442. A writer mentions a similar effect produced by the parsnip at a certain season of the year. "To horses," he says, "parsnips are frequently given, and have the property of making them sleek and fat; but in working they are observed to sweat profusely. If new, and cut sufficiently small, no other ill effect results—except, indeed, at one period of the year, towards the close of February, when the root begins to shoot; if then given, both horses and horned cattle are subject, on this food, to an inflammation in the eye, and epiphora or watery eye—in some subjects, perhaps, producing blindness."§ The boiling of both carrots and parsnips might have the effect of removing this dangerous tendency evinced by those roots when eaten raw.

1443. Horses are very fond of bread; with a piece of bread, and especially oat-cake, a horse will be captured in the field, when a feed of corn will not induce him to be taken. It is common in Holland to see travellers, at a village inn, slice down bread with a knife in a trough for their horse. Upon the principle of economy, M. Longchamp proposed to feed the cavalry of France with a bread composed of ¾ of boiled potatoes and ¼ oatmeal, properly baked in an oven. The usual allowance of oats for a horse, at 10 lbs., costs 13 sous; but 10 lbs. of this bread would only cost 5 sous.

1444. But independent of all succedanea, which may be given to horses at times as a treat, and as a beneficial change of food, there should be a regular feed prepared for farm-horses, and administered every day. I shall give two formulæ which have been found to make good prepared food for farm-horses, and they may be prepared without much trouble, provided the proper apparatus is erected for the purpose. One is the following, which is given in quantities suitable for several periods of the day for one horse:—

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 347.
† Stewart's *Stable Economy*, p. 281. ‡ *Ibid.* p. 193.
§ Quayle's *Agriculture of the Channel Islands*, p. 103.

In the morning.

$3\frac{1}{2}$ lbs. of oat and bean meal	}	$14\frac{1}{2}$ lbs.
11 lbs. of chopped straw		

At mid-day.

3 lbs. of oat and bean meal	}	15
12 lbs. of chopped straw		

At night.

$1\frac{1}{2}$ lbs. of oat and bean meal		
11 lbs. of steamed potatoes	}	$14\frac{1}{2}$
2 lbs of chopped straw		
		44 lbs.

This quantity is quite sufficient for the strongest farm-horses, and less will be consumed by ordinary ones; but that can be regulated according to circumstances, by withdrawing a little meal and straw, still retaining the proportions. The usual allowance of oats, as you have seen, (1423,) is $11\frac{1}{4}$ lbs. a-day, when the grain is of the finest quality; but horses seldom receive the finest oats, and are usually supported on the kind called common oats, which do not weigh heavy. The allowance may be taken at 10 lbs.; and when hay is given them in spring, they eat at least $1\frac{1}{2}$ stone of 22 lbs. = 33 lbs. every day. This mixture contains no hay, and only 8 lbs. of oat and bean meal, and 11 lbs. of steamed potatoes, which cannot be estimated beyond the cost of steaming.* The value of the ordinary and of the prepared food can thus be easily estimated; and it will be found that the prepared is the cheapest, and better for the horses' health, and equally good for condition and spirit. The mixture is made in this way: The meal and chopped straw are mixed together in a tub, a little salt sprinkled over them, the steamed potatoes, or 23 lbs. of Swedish turnips boiled, poured hot into the tub, and then the whole is stirred into a mess with a shovel, let stand to acquire an equal temperature throughout, and to render the meal pulpy with the potatoes.

1445. A formula given by Professor Low consists of chopped straw, chopped hay, bruised or coarsely ground grain, and steamed potatoes by weight, in equal parts, with 2 oz. of salt; and of this from 30 lbs. to 35 lbs., or $32\frac{1}{2}$ lbs. on an average, is given to a horse every day.† This mixture, including hay, is more expensive than the above; and I am doubtful that 35 lbs. of it will satisfy a farm-horse on active work in spring, when he can eat 33 lbs. of unchopped hay a-day, besides corn.

1446. It appears surprising that preparing food for farm-horses should only have been recently practised; but the practice of the turf and the road, of maintaining horses on large quantities of dry oats and rye-grass hay, had doubtless a powerful influence in retaining it on farms. But now that a more natural treatment is adopted for horses on fast work, farmers may easily be persuaded that their horses, on slow work, would derive greater benefit from prepared food. How prevalent was the notion at one time that horses could not be expected to do work at all, unless there was *hard meat* in them! "This is a very silly and erroneous idea, if we inquire into it," Professor Dick truly observes; "for whatever may be the consistency of the food when taken into the stomach, it must, before the body can possibly derive any substantial support or benefit from it, be converted into *chyme*—a pultacious mass; and this, as it passes onward from the stomach into the intestinal canal, is rendered still more fluid by the admixture of the secretions from the stomach, the liver, and the pancreas, when it becomes of a milky appearance, and is called *chyle*. It is then taken into the system by the lacteals, and in this *fluid*, this *soft* state—*and in this state only*—mixes with the blood, and passes through the circulating vessels for the nourishment of the system."‡ Actuated by rational principles, Mr John Croall, the enterprising coach-proprietor in Edinburgh, supports his coach-horses on 8 lbs. of chopped hay, and 16 lbs. of bruised oats; and the late Captain Cheyne found his post-horses work well on the following mixture, in the proportions given to each horse every day; and this constitutes the second formula I referred to above:—

In the day	{	8 lbs. of bruised oats.
		3 lbs. of bruised beans.
		4 lbs. of chopped straw.
		15 lbs.
At night	{	22 lbs. of steamed potatoes.
		$1\frac{1}{2}$ lb. of fine barley dust.
		2 lbs. of chopped straw.
		2 oz. of salt.
		$25\frac{1}{2}$ lbs. In all $37\frac{1}{2}$ lbs.

Estimating the barley-dust at 10d. per stone; chopped straw, 6d. per stone; potatoes, steamed, at 7s. 6d. per cwt.; and the oats and beans at ordinary prices, the cost of supper was 6d., and for daily food, 1s. with cooking—in all 1s. 6d. a horse each day.§ 46 lbs. of Swedish turnips boiled would afford equal nourishment to the 22 lbs. of steamed potatoes.

1447. The late Mr James Carmichael, Raploch Farm, Stirling, while remarking on some of the inflammatory complaints which farm-horses are most subject to from their treatment, contrasts that of the harness-horse as being more favourable to health. The harness horse "is chiefly fed on corn and hay, and is regularly supplied at intervals of three or four hours at most, according to his work or stages; while the farm-horse has his consecutive yokings, extending to 10 or 12 hours a-day—often more, with but little intermission for baiting or rest—has less corn, and in general subsists nearly two-thirds of the year on coarser fodder, (oat or bean straw,) which fills the stomach without affording much real nourishment. Let it not however be said," he observes, "that the fresh straw of the common

* *Quarterly Journal of Agriculture*, vol. iv. p. 383.
† Low's *Elements of Practical Agriculture*, p. 497.
‡ *Quarterly Journal of Agriculture*, vol. iii. p. 1033.
§ *Ibid.* p. 1029.

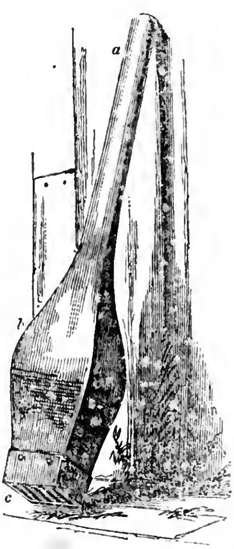
crops of the farm, together with the ordinary feeds and mashes duly served, are insufficient to maintain the horses in proper condition, under ordinary circumstances, without the aid of much or any hay. Nothing is so easy and obvious than to prepare the food of horses in a proper manner, although it certainly requires some care, activity, and arrangement, on the part of both master and servant. If, for example, in commencing with the fodder of the new crop, and until the system of steaming becomes more general—if the new straw were mixed with some sweet dry straw of the previous season, or sprinkled with a few handfuls of salt, as it comes from the thrashing floor, it would greatly promote the health of the horses, as well as of the other stock; and provident farmers always reserve one or two stacks of corn or pulse for the purpose of being so mixed, or used alone, until the straw of the new crop becomes seasoned, by a few weeks in the stack—as pease or bean straw, of beans especially, is very flatulent if taken new or in a soft state, but excellent fodder thereafter, and is much relished by horses accustomed to it. And when the leaves, pods, and chopped stems, or chaff of beans, and the small corn from the winnowing-machine are mixed and boiled or steamed together, with some turnips or potatoes, seasoned with salt, and given lukewarm in lieu of oats, to jaded horses as they return from work in the evening, the benefits are apparent in their plumper form and glossy coats. It is by means of such mashes, or by combining the corn with the chopped hay, that old and weary horses are enabled to masticate so easily, and lie down more readily to repose; whilst others must stand several hours gnawing their ill-suited ration, or hastily swallow it in a crude state, to stifle the cravings of hunger, and lie down to die of colic. Carrots and Swedish turnips, well cleaned and dried, may safely be given in an unprepared state when the horse is cool, and not attenuated with hard work; and the second crop of clover, if early made into hay, and slightly salted, with or without a mixture of old hay or straw, might be made greatly more available for all kinds of stock, instead of remaining inert until late in the season, bleaching under every change of weather, and then given to the horses in a half-rotted green state."*

1448. Mr Marshall, Holme Lodge, Bedale, supports his draught-horses on a mixture of bruised linseed and ground oats, in the proportions specified (1354) when speaking of the fattening of cattle on the same mixture. "The draught-horses," observes Mr Marshall, "had their allowance of prepared food on coming from work. When at constant work, and long days, each horse was supplied with about 5 lbs. of ground oats or split beans, divided into two portions, and given morning and evening, in addition to the 5 lbs. contained in the prepared food. During the three winter and other months in the year that my horses have had this provender, they have improved in their condition, have been free from disease, and capable of performing any work that horses, kept for agricultural purposes, could reasonably be required to do.†

1449. Mr Warnes says, "Were horses, both in town and country, fed on linseed," using little water and plenty of linseed-meal, "one half at least of the corn now consumed in stables would then find its way to the dwellings of the poor In some cases three parts of the oats, in others the whole, might be superseded by linseed ; and expense, at the same time, be considerably reduced. Linseed-meal, sprinkled in small quantities upon grains hot from the brewery and intimately incorporated with a rammer, is excellent food, when mixed with chaff, for horses employed in slow work. Nor will the compound turn sour if properly consolidated."‡ I have heard of no instance in Scotland of farm-horses being fed on this compound of linseed.

1450. That horses will thrive on bruised *whins* or *furze*, I had considerable experience in the winter of 1826, to which expedient I was impelled in consequence of the heat of that summer having burned up the straw of all sorts of grain on light soil. Old whins, growing in a fir plantation, supplied young shoots from 1 foot to 3 feet in length, which were cut by a field-worker with a hook, and led to the steading, where it was bruised with a rammer, fig. 112, having a shank *a*, 3 feet 8 inches in length, a bulged out part *b*, to give the instrument weight, and shod with an iron cutter *c*, 4 inches square and 3 inches deep, having its lower edges sharpened, and furnished with 3 parallel cutters, riveted to it by their ends. Every man bruised, with this implement, as much furze in the morning, on a stone floor, in 20 minutes, as served his pair of horses for the day. The horses relished the whins better than hay, and became remarkably fine in condition and coat. Machines, to bruise or beat, have been invented for the preparation of whins; but the simple rammer represented above, and used by hand, is better than any other for bruising young whins ; and no large

Fig. 112.



THE WHIN-BRUISER.

* *Transactions of the Highland and Agricultural Society* for March 1848, p. 220-1.
† Marshall *On Feeding Stock with Prepared Food*, p. 5.
‡ Warnes *On the Cultivation of Flax*, 2d edition, p. 317.

quantity of whins at any age should be bruised at once, else the mass will heat, and ferment, and become unpalatable food. But when the older sprays of whins are used, one of the more powerful machines is required to bruise them into a fit state to be eaten by horses. I have seen an old cart-wheel, placed on its ring, and made to revolve in a circular trough; but better is an old mill-stone shipped by the hole through its centre, upon a 12-feet horizontal axle of wood, attached by one end to a swivel on the top of a stout post, driven into the ground, round which the stone revolves on a paved circular bed, 8 feet in diameter; and a horse is yoked with a swing-tree at the other end of the axle, to draw the stone round on its edge in the trough, into which the fresh whins are thrown, and, when bruised, taken out ready for use; but young whins are at all times much preferable to old ones for food.

1451. In the southern parts of Germany, in Italy, and in most parts of the United States of America, the horses in winter are fed on *Indian corn*, instead of any other species of grain, and it maintains them in fine condition. This grain becomes as hard as our beans, and horses would find as great, and perhaps greater difficulty in breaking it, were it not steeped in water for a number of hours before it is used, when it is easily masticated.

1452. Machines for cutting straw and hay have already been given in figs. 91 and 92, as also those for bruising linseed and corn in figs. 97 and 98, while treating on the feeding of cattle.

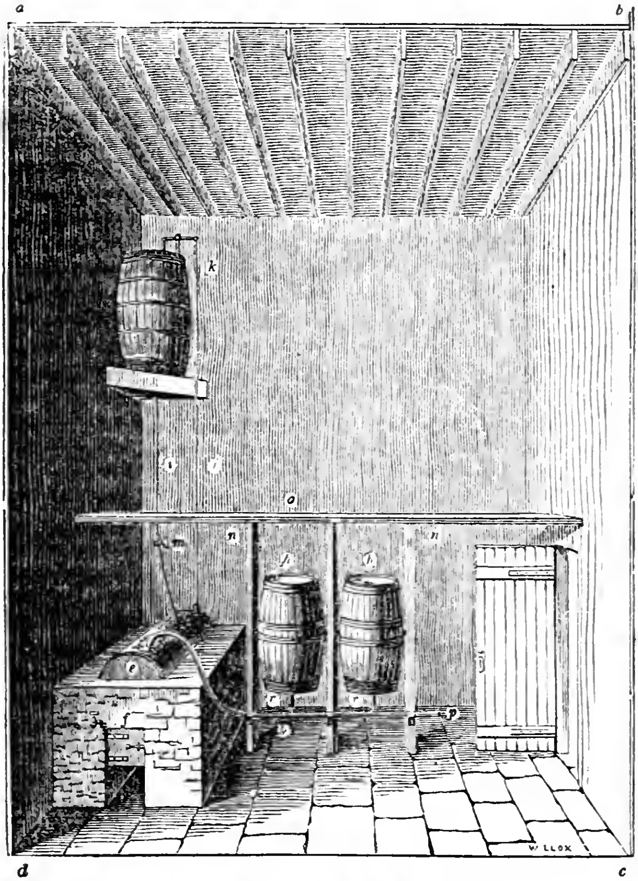
1453. As the maintenance of horses is a serious expense to farmers, any treatment that proffers a probable reduction of the cost of their keep, while the animals are sustained in health and condition, deserves attention and even a trial. With this view I relate a method of feeding horses quite in the power of any farmer to follow. It is that practised by Mr Trotter near Darlington, which is this:—"I have paid some attention to the subject of keeping draught-horses during winter for some years past, but for the last three years I have adopted quite a different mode to what I previously followed. My method formerly was, to allow my draught-horses each 2 bushels of oats per week, together with 1 bushel of beans, and as much hay as they could eat, generally clover-hay; but for the last three winters I have fed them almost entirely on cut oat-sheaf, cut into half-inch chaff, which to me has been a very great saving. In an oat crop of about 40 stooks per acre, which might yield near 60 bushels, the feed of a draught-horse averages 2 sheaves per day, or 14 sheaves per week, which would be about 1 bushel and 3 pecks of corn per week, if it had been thrashed out, which is a saving of 1 peck of oats per week each horse, from what I formerly gave them; besides, I save the bushel of bran per week, and the clover-hay, which latter was a very considerable item; for draught-horses, when they get three feeds of clean oats in a day, when at work they will eat a great quantity of clover-hay, besides. Now, when I first changed my mode of feeding from corn and hay to cut sheaf, the horses improved in condition wonderfully, thus showing that it suits them well. In very busy seasons, when they are very hard worked, I allow them half a peck of oats at dinner-time, besides the cut sheaf. Last winter I had only 18 acres of oats; these kept 12 draught-horses, besides 4 young horses occasionally. This quantity of oats would not have served through the year, had I not pursued this system of feeding. The mode I have adopted of preparing the cut sheaf is this:—I have my straw-cutter to work from the horse-wheel of my thrashing-machine, and I generally have as much cut in one day as will serve 12 draught-horses for nearly a month. One man attends to and feeds the cutter with the oat sheaves, whilst another man carries the cut sheaf into the granary ready for use, when it is taken to the stable in bags as required."

1454. *Cooking apparatus.*—The means employed for cooking food for horses and cattle are either boiling or steaming. In the first, an open vessel is employed, in which the roots or other substances are placed with a sufficient quantity of water. In the second, either a partially closed vessel is employed, or a perfectly closed one, in which the steam is generated, and conveyed in pipes to a partially closed one.

1455. Steaming in a separate vessel has been followed in a variety of forms; but these may be ranked under two distinct kinds. The first is an open vessel, a boiler, generally of cast-iron, having a channel or groove of 1 inch wide and 2 inches deep, formed round its brim. The vessel is placed over a furnace properly constructed, and is partly filled with water. The groove is also filled with water. A sheet-iron cylindrical pan, of 3 or 4 feet in depth, and of a diameter suited to pass into the groove of the water-vessel, (which is generally about 3 feet diameter,) is also provided. The pan has a perforated bottom, to admit steam freely from the lower vessel. It is also furnished with an iron bow, by which it can be suspended, and by which it can be conveniently tilted while suspended. This is the steaming pan; and for the purpose of moving it to and from the boiler, a crane, mounted with wheel and pinion, and a chain, completes the apparatus. To put this in operation, the pan is filled with the substances to be steamed, and covered over either with a deal cover or with old canvass bags. It is then placed upon the boiler by means of the crane, and the fire is pretty strongly urged till the water in the boiler gives off its steam, which, passing up through the bottom of the pan, and acting upon the contents, produces in a few hours all the results of boiling. The water in the groove of the boiler serves as a sealing, to prevent the escape of steam without passing through the pan. But notwithstanding this, it is evident that the steam can hardly ever reach the temperature of 212°; and hence, this apparatus is always found to be very tardy in its effects. When the contents of the pan have been found sufficiently done, the whole is removed from the boiler by means of the crane, and tilted into a large trough to be thoroughly mixed, and from thence served out to the stock. A general complaint has been urged against this construction of apparatus, arising from the slowness of the process of cooking by it, and consequent expense of fuel. Boilers of the form here described are not well calculated to absorb the maximum of caloric that may be afforded by a given quantity of fuel, neither is the apparatus generally the best adaptation for the application of steam to the substances upon which the steam has to act. Such boilers, as already observed, can never produce steam of a higher temperature than 212°. If they did, the shallow water-luting, formed by the marginal groove, would be at once thrown out by the steam-pressure ; for it is well known, that the addition of 1° to the temperature of the steam increases its elasticity equal to the resistance of a column of water about 7 inches high. A groove, therefore, of 7 inches in depth would be required to resist the pressure which would even then be only one-fifth lb. of pressure on the square inch. Under such circumstances the temperature in the steaming-pan will always be under 212° : hence the tedious nature of the process by using this apparatus.

1456. The apparatus which deserves the pre-

Fig. 113.



THE CLOSED-BOILER STEAMING APPARATUS.

cedence of the above is represented in fig. 113. The principle of its construction is that of a closed boiler, in which the steam is produced under a small pressure of 3 to 4 lbs. on the inch. It is then delivered through a pipe to one or more separate vessels containing the substances that are to be cooked ; and these vessels are so arranged as to be readily engaged or disengaged with the conducting steam-pipe. The outline *a b c d* of the figure represents a section of the steaming-house, with the apparatus in due order of arrangement, and of the extent that may be capable of supplying an establishment of from 10 to 16 horses. The boiler *e* is of a cylindrical form, 20 inches in diameter and 4 feet in length. It is set on brick-work *f*, over a furnace of 14 inches in width, with fire-grate and furnace-door. The brick building requires to be 6 feet 6 inches

PLATE VI.

John Shiels A.R.S.A. — Thos Landseer

SHORT-HORN COWS.

THE PROPERTY OF HIS GRACE THE DUKE OF B[illegible] in length, 4 feet 6 inches in breadth, and the height about 3 feet 6 inches. The furnace is built with a circulating flue, passing first to the further end of the boiler, then turning to right or left, according as the chimney may be situated, returns to the front of the boiler, and terminates in the chimney on the side opposite to the first turning. The flues should not be less in width at the upper part than one-fourth the diameter of the boiler; and their height will be about one-third the diameter. The steam-pipe is attached to the boiler at its crown, takes a swan-neck bend downwards to within 12 inches of the floor at *g*, and terminates at *p*; it is furnished with as many branch nozzles as there are intended to be steaming-vessels. The steam-pipe may be either cast-iron or lead, and 2 inches diameter in the bore. The receptacles or steaming-vessels *h h* are usually casks of from 50 to 100 gallons contents. They are mounted with 2 iron gudgeons or pivots, placed a little above mid-height; they are, besides, furnished with a *false* bottom, supported about 3 inches above the true one; the former being perforated with a plentiful number of holes, to pass the steam which is introduced between the two bottoms. The connexion between the steam-pipe and the receptacle may be either by a stop-cock and coupling-screw—which is the most perfect connexion—or it may be by the simple insertion of the one nozzle within the other, in the form of a spigot and faucet. In this latter case, the nozzle that leads from the steam-pipe is stopped with a wooden plug, when the receptacle is disengaged. Besides the steam-pipe, the boiler is furnished with a pipe *i*, placed in connexion with a cistern of water *k*, the pipe entering into it by the bottom, and its orifice closed by a valve opening upward, the lower extremity of the pipe passing within the boiler to within 3 inches of its bottom. A slender rod *l* passes also into the boiler through a small stuffing-box; and to its lower end, within the boiler, is appended a float, which rests upon the surface of the water within the boiler. The upper end of this rod is jointed to a small lever, which has its fulcrum supported on the edge of the cistern a little above *k*; the opposite end of the lever being jointed to a similar but shorter rod, rising from the valve in the bottom of the cistern. This forms the feeding apparatus of the boiler, and is so adjusted by weights, that when the water in the boiler is at a proper height, the float is buoyed up so as to shut the valve in the cistern, preventing any further supply of water to pass into the boiler, until, by evaporation, the surface of the water has fallen so far as to leave the float unsupported, to such extent as to form a counterpoise to the valve, which will then open, and admit water to descend into the boiler, until it has again elevated the float to that extent that will shut the valve in the cistern. By this arrangement, it will be perceived that the water in the boiler will be kept nearly at a uniform height; but to accomplish all this, the cistern must be placed at a certain fixed height above the water in the boiler, and this height is regulated by the laws which govern the expansive power of steam. This law, without going into its mathematical details, may be stated in round numbers as follows:—That the height of the surface of the water in the cistern must be raised above the surface of that in the boiler, 3 feet for every pound-weight of pressure that the steam will exert on a square inch of surface in the boiler. Thus, if it is estimated to work with steam of 1 lb. on the inch, the cistern must be raised 3 feet; if 2 inches, 6 feet; 3 inches, 9 feet; and so on. If the steam is by any chance raised higher than the height of the cistern provides for, the whole of the water in the boiler may be forced up through the pipe into the cistern, or until the lower orifice of the pipe, within the boiler, is exposed to the steam, which will then also be ejected through the pipe; and the boiler may be left dry. Such an accident, however, cannot occur to the extent here described, if the feeding apparatus is in proper working order; and its occurrence to any extent is sufficiently guarded against by a safety-valve.

1457. The safety-valve of the steam-boiler is usually a conical metal valve, and always opening outward; it ought always to be of a diameter large in proportion to the size of boiler and steam-pipe, so as to insure the free egress of any rapid generation of steam. For a boiler of the size under consideration it should be 2 inches in diameter on its under surface—that being the surface acted upon—this gives an area of fully 3 square inches; and if loaded directly, or without the intervention of a lever, for steam of a pressure of 1 lb. on the inch, it will require 3 lbs.; if 2 lbs. on the inch, 6 lbs.; if 3 lbs. on the inch, 9 lbs., and so on. With these adjustments, the steam, should it rise above the proposed pressure, will, instead of forcing the water through the feed-pipe, raise the safety-valve, and escape into the atmosphere until the pressure is reduced to the intended equilibrium.

1458. Another precautionary measure in the use of the steam-boiler is the gauge-cock, of which there are usually two, but sometimes one, a two-way cock; they are the common stop-cock, with a lengthened tail passing downward, the one having its tail terminating about 1½ inch below the proper water-level in the boiler, the other terminating 1½ inch above that level, which allows a range of 3 inches for the surface of the water to rise or fall. The first, or water-cock, when opened, will throw out water by the pressure of the steam upon its surface, until the surface has sunk 1½ inch below its *proper* level, when steam will be discharged, thus indicating the water in the boiler to be too low, and that measures should be taken to increase the supply. When the second, or steam-cock is opened, it will always discharge steam alone, unless the water shall have risen so high as to come above its orifice, in which case the cock will discharge *water*, indicating a too large supply of water to the boiler, and that it should be reduced; for this purpose the feed-pipe *i* is provided with a stop-cock *m*, whereby the admission of water can be entirely prevented at the pleasure of the attendant.

1459. The foregoing description refers to a steaming apparatus of the best description, and implies that the water-cistern can be supplied either from a fountain-head, or that water can be pumped up to the cistern. But there may be cases where neither of these are easily attainable. Under such circumstances the feed-pipe may rise to the height of 4 or 4½ feet, and be surmounted by a funnel, and under it a stop-cock. In this case, also, a float with a wire stem, rising through a stuffing-box on the top of the boiler, must be employed—the stem may rise a few inches above the stuffing-box, in front of a graduated scale—having the zero in its middle point. When the water is at the proper height in the boiler, the top of the stem should point at zero, and any rise or fail in the water will be indicated, accordingly, by the position of the stem. To supply a boiler mounted after this fashion, the first thing to be attended to, before setting the fire, is to fill up the boiler, through the funnel, to the proper level, which will be indicated by the float pointing to zero; but it should be raised, in this case, two or three inches higher. In this stage the gauge-cocks are non-effective; but when the steam has been got up, they, as well as the float, must be consulted frequently; and should the water, by evaporation, fall so low as 3 inches below zero, a supply must be introduced through the funnel. To effect a supply, in these circumstances, the steam must be allowed to fall rather low; and the funnel being filled, and the stop-cock opened, the water in the former will sink down through the tube, provided the steam be sufficiently low to admit its entrance; but the first portion of water that can be thus thrown in will go far to effect this, by sinking the temperature. The sinking of the temperature by the addition of a large quantity of cold water, is the objection to this mode of feeding; but this is obviated to some extent from the circumstance that, unless the steaming receptacles are large or numerous, the first charge of water will generally serve to cook the mess, when a fresh charge can be put in for the next.

1460. In using this steaming apparatus, it has been noticed that the casks are furnished with gudgeons, which play in the posts *n n*; these are kept in position by the collar-beam *o* to which they are attached—the casks being at liberty to be tilted upon these gudgeons. They are charged when in the upright position, and the connexion being formed with the steam-pipe, as described, they are covered at top with a close lid or a thick cloth, and the process goes on. When the substances are sufficiently cooked, the couplings *r r* are disengaged, the upper part of the cask is swung forward, and their contents discharged into a trough, which is brought in front of them for that purpose.

1461. The connexions with the steam-pipe are sometimes, for cheapness, formed by a *sliding tube* of copper or brass, about 4 inches in length, which, after the nozzle of the cask and that projecting from the steam-pipe are brought directly opposite to each other, is slid over the junction, and as a moderate degree of tightness only is requisite in such joints, a strip of sacking wrapped round the ends of the slider is found sufficient. On breaking the connexion, and opening the exit nozzles, the steam will of course flow out, but this is checked by a wooden plug, or even a potato or slice of turnip, thrust into the orifice, may be sufficient. It is advisable, however, that a main stop-cock should be placed in the steam-pipe any where between the boiler and the first receptacle.

1462. The most perfect mode of connexion between the steam-pipe and the receptacles is a *stop-cock and coupling-screw*. These should be of 1½ inch bore: they are more certain in their effect, and more convenient in their application, though attended with more expense in the first cost of the apparatus. In this case no main-cock is required. The extremity of the steam-pipe should, in all cases, be closed by a small stop-cock, for the purpose of draining off any water that may collect in the pipe from condensation. A precaution to the same effect is requisite, in the bottom of each cask, to draw off the water that condenses abundantly in it; or a few small perforations in the bottom will effect the purpose.

1463. It must be remarked, in regard to steaming, that where grain of any kind is given in food in a cooked state, that dry grain cannot be cooked, or at least boiled to softness in dry steam, the only effect produced being a species of parching; and if steam of high temperature is employed, the parching is increased nearly to carbonisation. If it is wished, therefore, to boil grain by steam, it must be done by one of the two following methods. The grain must either be soaked in water for a few hours, and then exposed to the direct action of the steam in the receptacle—or it may be put into the receptacle with as much water as will cover it—and then, by attaching the receptacle to the steam-pipe by the coupling stop-cock, or in the absence of stop-cocks, by passing a bent leaden pipe from the steam-pipe over the upper edge of the receptacle, and descending again inside—to the space between the false and the true bottoms—the steam discharged thus, by either method, will shortly raise the temperature of the water to the boiling point, and produce the desired effect.*

1464. The time required to prepare food in this way varies considerably, according to the state of the apparatus, and the principle of its construction. With the apparatus just described, potatoes can be steamed in casks of from 32 to 50 gallons contents, in 30 to 45 minutes. In casks extending to 80 gallons, an hour or more may be required. Turnips require considerably longer time to become fully ready, especially if subjected to the process in thick masses: the time may be stated at double that of potatoes. When the apparatus is ill constructed, the time, in some cases, required to cook turnips, extends to 5 hours. And, with reference to the appa-

* *Quarterly Journal of Agriculture*, vol. vi. p. 33.

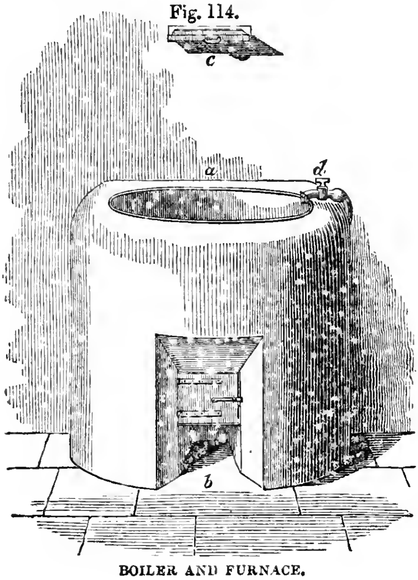
ratus first described, (1455,) the time is seldom under 5 hours.

1465. The prices of steaming apparatus vary according to quality and extent; but, on an average, the open boiler and pan apparatus, including a power-crane, will range from £7 to £10; and of the other, fig. 113, the price ranges from £8 to £16. The expense of building the furnace, and supplying mixing troughs, will add about £2, 10s. to each.

1466. Experience is every day discovering the trouble and inconvenience felt in the use of a steaming apparatus of the perfect construction even of the one just described, and far more of others of less ingenious construction; and the consequence is, that many are abandoning the steaming process altogether, and returning to the once contemned open boiler. It is quite possible that more fuel is required in the boiler than in the steaming apparatus to produce the same effects; but the former is so simple in its use, so ready at all times, so free from danger and accident, and so efficient in its results, that it will ultimately be the only apparatus in a farm that will be used to prepare food for either cattle or horses. I have had opportunities of witnessing the use of both apparatus in extensive farms where food is constantly prepared, and has been for many years past; and my conviction is now entirely in favour of the boiler. And now that potatoes, which are best cooked by steaming, cannot now be depended on as a crop, and may, in future, bear a high price—and, on the contrary, as turnips are best cooked by boiling, and whose culture is extending every year—the boiler promises to become the more useful apparatus of the two.

1467. Fig. 114 represents a common large boiler, fitted up in the best manner, where *a* is the cast-iron boiler, from 3½ to 4 feet diameter across the top; *b* the furnace-grate for containing the fire, with its door; and *c* the damper, in the flue for regulating the draught upon the fire. Its use is so well known to country people that nothing need be said on it here.

Fig. 114.



BOILER AND FURNACE.

1468. But the boiler is not always properly built upon its seat in the furnace. It is furnished with two or three studs or ears, projecting from under the flange around its mouth, by which it may easily be suspended. A not unfrequent, but improper way of setting the boiler upon the furnace, is to cause the edge of its bottom to rest upon the building from both sides of the furnace-door to the back part of the building, where the flue is formed in connexion with the chimney. The effect of this mode of setting is to cause the entire force of the fire in the furnace to strike against the bottom only of the boiler, and the greatest force will affect that part of the bottom which is nearest the furnace-door—the heat from whence must cook the entire contents of the boiler, and where at times the bottom must be so greatly heated—as when the contents of the boiler are removed immediately after they are sufficiently cooked, and cold water is poured into the boiler, in preparation for the cooking of another mess—that the bottom of the boiler is either cracked by the sudden cooling of the water, or is honey-combed by the fire, when the liquid in the boiler oozes gradually through the corroded metal into the fire.

1469. Now, the proper way of setting a boiler is this:—When the building has proceeded so far as to have formed the ash-pit, and received the grate and dumb plate and furnace-door, to the height of the latter, let a circular basin be built of the form of and a few inches larger than the boiler, to contain the boiler itself; and let it be so contracted, as it comes nearer to its height, as to suspend the entire boiler within the basin by its ears; and let a flue be built from behind, or at one side of the basin, as the case may be, into the chimney. The advantage of this mode of setting is, that the heat of the fire is not confined to one part of the boiler, but is diffused over the whole of its under surface; and though the heat may not be so great at any one part, it cooks the contents more equally, and preserves the boiler from overheating and injury.

1470. In any case a damper is a requisite part of a boiler and furnace, to regulate the draught through the fire, according to the state of the air. It is to be regretted that this regulator is little attended to after the first time it has been adjusted; and the consequence is, when the fire does not burn so briskly as desired, more coals or wood are put into the furnace; and when it burns too fiercely, it is regarded as a happy incident, instead of the draught of air being regulated by means of the damper, according to the circumstances of the case.

1471. The horse is an intelligent animal, and seems to delight in the society of man. It is remarked by those who have much to do with blood-horses, that, when at liberty, and seeing two or more people standing conversing together, they will approach, and seem, as it were, to wish to listen to the conversation. The farm-horse will not do this; but he is quite obedient to call, and distinguishes his name readily from that of his companions and will not stir when desired to stand until *his own name* is pronounced. He discriminates between the various sorts of work he is put to, and will apply his strength and skill in the best way to effect his purpose, whether in the thrashing-mill, the cart, or the plough. He soon acquires a perfect knowledge of the nature of his work. I have seen a horse walk very steadily towards a feering pole, and halt when he had reached it. He seems also to have an idea of time. I have heard a horse neigh almost daily about 10 minutes before the time of loosening from work in the evening, whether in summer or winter. He is capable of distinguishing the tones of the voice, whether spoken in anger or otherwise, and can even distinguish between musical notes. There was a work-horse of my own, even when at his corn, would desist eating, and listen attentively, with pricked and moving ears and steady eyes, the instant he heard the note of low G sounded, and would continue to listen as long as it was sustained; and another was similarly affected by a particular high note. The recognition of the sound of the bugle by a trooper, and the excitement occasioned in the hunter when the pack give tongue, are familiar instances of the extraordinary power of particular sounds on horses, in recalling old associations to their memory. The horse's memory is very tenacious, as is evinced in the recognition of a regarded stable after a lengthened absence.

1472. As to the names of farm-horses, I may mention that they should be *short and emphatic*, not exceeding two syllables in length, for longer words are difficult of ready pronunciation, and inconvenient to utter when quick or sharp action is required of the horse; and are almost always corrupted into short ones. For geldings, Tom, Brisk, Jolly, Tinker, Dragon, Dobbin; for mares, Peg, Rose, Jess, Molly, Beauty, Mettle, seem good names; and as to those of stallions, they should be indicative of more importance, as Lofty, Farmer, Plough-boy, Matchem, Diamond, Blaze, Sampson, Champion—which last is the name of the black stallion pictured in Plate IV.—are all names which have distinguished prize draught stallions.

1473. *Diseases of Horses.*—In respect to the diseases of the horse, if we were to regard in a serious light the list of frightful maladies incident to this animal, which every work on veterinary science contains, the farmer would never purchase a horse; but, fortunately for him, his horses are exempt from the largest proportion of those maladies, which chiefly relate to the foot and leg. Nevertheless, many serious and fatal disorders do overtake farm-horses in their usual work, with the symptoms of which you should be so far acquainted as to recognise the nature of the disease; and as you should be able to perform some of the simpler operations to assist the animal in serious cases, until the arrival of the veterinary surgeon, a short account of these may prove useful. One or more simple remedies, when timely exercised, may have the effect of quickly removing the symptoms of less serious complaints. They consist of bleeding, giving physic and drenches, applying fomentations, poultices, injections, and the like.

1474. *Bleeding.*—"In the horse and cattle, sheep and dog, bleeding, from its greater facility and rapidity," says Professor Dick, "is best performed in the jugular or neck vein, though it may also be satisfactorily performed in the *plate* and *saphena* veins, the former coming from the inside of the arm, and running up directly in front of it to the jugular; the latter, or thigh-vein, running across the inside of that limb. Either the fleam or lancet may be used. When blood is to be drawn, the animal is blindfolded on the side to be operated upon, and the head held to the other side; the hair is smoothed along the course of the vein by the moistened finger, the point selected being about 2 inches below the angle of the jaw. The progress of the blood toward the heart is to be obstructed, and the vein thus made sufficiently permanent and tense. A large-bladed fleam, and a good sized-lancet, are preferable, as the benefit of the operation is much increased by the rapidity with which the blood is drawn. From 8 to 10 pints imperial is a moderate bleeding for the horse and ox, regulated in some degree by the size. From 12 to 16, or even 20 pints, is a large one; and sometimes, in skilful hands, it is expedient to bleed till fainting is induced, and the animal drops down under the operation. The vessel in which the blood is received should be such that the quantity can be readily ascertained. When this is sufficient, the edges of the wound are to be brought *accurately together*, and kept so, by a *small sharp pin* being passed through them, and retained by a little tow. It is of importance, in closing the wound, to see it *quite close*, and that *no hairs or other foreign bodies* interpose. For a time the head should be tied up, and care taken that the horse does not injure the part."

1475. The dangers arising from carelessness in blood-letting are not numerous; and "the first of which, though it may alarm the inexperienced, is very trifling. It is a globular swelling, *thrombus*, sometimes as large as the fist, arising immediately around the new-made incision. The filtrating of the blood from the vein into the cellular membrane, which is the cause of the disease, is rarely very copious. Gentle pressure may be used at first, and should be maintained with a well-applied sponge and bandage, kept cool with cold lotion. Occasionally there is *inflammation of the jugular* from bleeding. . . . The cause is usually referred to the use of a foul fleam, or from allowing hairs to interfere with the accurate adjustment of the edges of the wound. The first appearance indicative of the disease is a separation of the cut edges of the integuments, which become red and somewhat inverted. Suppuration soon follows, and the surrounding skin appears tumefied, tight, and hard, and the vein itself, above the orifice, feels like a hard cord. After this the swelling of the neck increases, accompanied with extreme tenderness, and now there is constitutional irritation, with tendency to inflammatory fever. . . . In the first stage we must try to relieve by evaporating lotions or by fomentation. If these fail, and as soon as the disease begins to spread in the vein, the appropriate remedy is to touch the spot with the actual cautery, simply to sear the lips of the wound, and apply a blister over it, which may be repeated. Purgatives in full doses must be administered, and the neck, as much as possible, kept steady and upright."

1476. *Blistering.*—"Blistering plasters are never applied to horses. An ointment is always used, of which rather more than half is well rubbed into the part to be blistered, while the remainder is thinly and equally spread over the part that has been rubbed. When there is any danger of the ointment running, and acting upon places that should not be blistered, they must be covered with a stiff ointment made of hog's lard and bees'-wax, or kept wet with a little water. . . . The horse's head must be secured in such a way that he cannot reach the blister with his teeth. . . . . When the blister has become quite dry, the head may be freed. Sometimes it remains itchy, and the horse rubs it; in that case he must be tied up again. . . . . When the blister is quite dry, put some sweet-oil on it, and repeat it every second day. Give time and no work, otherwise the horse may be blemished by the process."

1477. *Physicking.*—"Physicking, which in stable language is the term used for purging, is employed for improving the condition when in indifferent health, and is a remedy for disease. The medicines chiefly used are, for *horses*, Barbadoes aloes, dose from 3 to 9 drachms; croton *bean*, from 1 scruple to ½ drachm, or *cake*, from ½ drachm to 1 drachm, to which may occasionally be added calomel, from 1 to 1½ drachm. For *cattle*, aloes, in doses somewhat larger than for the horse; Epsom salts, or common salt, dose from 1 lb. to 1½ lb., with some stimulus, as ginger, anise, or carraway-seed; also linseed-oil, dose 1 lb., and croton oil, 15 to 20 drops, or the bean or cake, the same as in the horse. For *dogs*, jalap, dose 1 drachm, combined with 2 grains of calomel; croton oil, dose 2 drops; bean, 5 grains; and syrup of buckthorn, dose 1 oz.

1478. "These, it will be observed, are average doses for full-grown animals; in the young and small they may be less, in the large they may require to be greater; but much injury has often been done by too large doses too frequently repeated. To the *horse*, physic is usually administered in the form of a bolus or *ball;* to *cattle* by drinking or *drenching*, though for both either way may be employed. A ball is conveniently made of linseed-meal, molasses, and the active ingredient, whether purgative, diuretic, or cordial; it should be softish, and about the size of a pullet's egg. In administering it, the operator stands before the horse, which is generally unbound, and turned with its head out of the stall, with a halter on it. An assistant stands on the left side, to steady the horse's head, and keep it from rising too high; sometimes he holds the mouth, and grooms generally need such aid. The operator seizes the horse's tongue in his left hand, draws it a little out and to one side, and places his little finger fast upon the under jaw; with his right hand he carries the ball smartly along the roof of the mouth, and leaves it at the root of the tongue; the mouth is closed, and the head is held, till the ball is seen descending the gullet on the left side. When loath to swallow, a little water may be offered, and it will carry the ball before it. A hot, troublesome horse should be sent at once to a veterinary surgeon. Instruments should, if possible, be avoided, and adding croton farina to the mash often answers the purpose."

1479. "The horse must undergo *preparation for physic*, which is done by gently relaxing the bowels. During the day previous, his food should be restricted to bran mashes—a quarter peck being sufficient for a feed—and this with his drink, should be given warm; corn should be withheld, and hay restricted. He may have walking and trotting exercise morning and evening. The physic is given on an empty stomach early in the morning; immediately after, a bran mash is given; that over, the horse goes to exercise for perhaps an hour, and is watered when he returns. The water should be as warm as he will take it; and he should take as much as he pleases throughout the day; bran mash should be given as often as corn usually is, and better warm than cold; if both are refused, bran may be tried, but no corn, and but little hay. Sometimes gentle exercise may be given in the afternoon, and also next day. The physic usually begins to operate next morning, though it rarely takes effect in 12 hours, frequently not for 30. When the physic begins to operate, the horse should stand in the stable till it *sets*, which may be in 12 hours."* The stable should be well littered behind the stall, to receive the discharge.

1480. *Drenches* should be given with caution either to horse or ox; "that no unnecessary force be used, that they be never given by the nostrils, and especially that, if the slightest irritation is occasioned in the windpipe, the animal shall immediately be set at liberty, that, by coughing, he may free himself of the offending matter."

1481. "Many practitioners and horse proprietors," says Mr Youatt, "have a great objection to the administration of medicines in the form of drinks. . . . There are some medicines, however, which must be given in the form of drink, as in colic. . . . An ox horn, the larger end being cut slantingly, is the usual and

* Dick's *Manual of Veterinary Science*, p. 8.

best instrument for administering drinks. The noose of a halter is introduced into the mouth, and then, by means of a stable-fork, the head is elevated by an assistant considerably higher than for the delivery of a ball. The surgeon stands on a pail on the offside of the horse, and draws out the tongue with the left hand. He then, with the right hand, introduces the horn gently into the mouth and over the tongue, and by a dexterous turn of the horn, empties the whole of the drink—not more than about 6 oz.—into the back part of the mouth. The horn is now quickly withdrawn, and the tongue loosened, and the greater portion of the fluid will be swallowed. A portion of it, however, will often be obstinately held in the mouth for a long time, and the head must be kept up until the whole is got rid of, which a quick, but not violent, slap on the muzzle will generally compel the horse to do. The art of giving a drink consists in not putting too much in the horn at once; introducing the horn far enough into the mouth; and quickly turning and withdrawing it without bruising or wounding the mouth, the tongue being loosened at the same moment. A bottle is a disgraceful instrument to use, except it be a flat pint bottle, with a long and thick neck."* The nearside horn has the most handy twist for administering a drink with the right hand.

1482. *Fomentations.*—" Clean water is the best fomentation. It should be as hot as the hand can bear it, yet not hot enough to pain the animal. In fomenting the horse, the groom has rarely enough water, and he does not continue the bathing long enough to do any good. If the leg is to be fomented, get a pailful of water as hot as the hand can bear it; put the horse's foot into it, and, with a large sponge, lave the water well above the affected part, and keep it constantly running down the whole limb. Foment for half an hour, and keep the water hot by adding more."

1483. *Poultices.*—"Poultices should be formed of those materials which best maintain heat and moisture, and they should be applied as warm as possible, and can be safely borne. They are usually made of bran mash, turnips, or oatmeal porridge. Linseed meal alone makes the best of poultices, and some of it should always be added to the other ingredients. Wet bandages act as poultices."

1484. *Lotions.*—" Of *cooling* lotions, cold water is the menstruum. It may be made colder by the introduction of a little salt or ice. Sal-ammoniac and vinegar may be added for the same purpose. The object is to reduce heat, and promote evaporation. The addition of a little spirits is made with the same object."

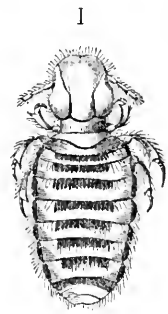
1485. *The Pulse.*—" Of the *horse*, the natural pulse is from 35 to 45 beats in the minute; under fever, it rises to 80, 90, and 100. The most convenient spot to examine it is at the edge of the lower jaw, a little before the angle, where the maxillary comes from the neck to be distributed over the face. The pulse is one of the most important indications in all serious disorders."

1486. *Injections.*—" Injections, though easily administered by means of the old ox-bladder and pipe, are still more conveniently given with a syringe. For laxative clysters for the horse or cow, from 1 gallon to 12 pints imperial of warm water or gruel, at the temperature of 96° Fahr., with a couple of handfuls of salt or 2 oz. of soft soap, prove most useful. Stronger ones may be obtained by adding a few ounces of aloes to the mixture. In cases of diarrhœa or over-purging, the injection should consist of a few pints of warm gruel, to which is added 1 oz. of catechu electuary, or from ½ drachm to 1 drachm of powdered opium. The only art in administering a clyster,—where, however, there is often bungling, and even injury, by wounding the rectum,—is *to avoid frightening the animal*, anointing the pipe well, and *gently* insinuating it *before the fluid is forced up*."

1487. " In general, bran mashes, carrots, green meat, and hay, form the sick horse's diet; gruel and tepid water his drink."† Of the diseases themselves, I shall only notice those at present which usually affect *farm*-horses in winter.

1488. *Horse-louse* (*Trichodectes Equi.*)—The horse is infested by a louse as well as the ox, and which is represented in fig. 115. It will be found referred to by the older writers on natural history, under the name of *Pediculus Equi*. Colour of the head and thorax bright chestnut, the former very large and somewhat square, the surface with a longitudinal black line towards each side, forming an angle near the middle; antennæ with the third joint longest; abdomen pale, tawny yellow, with fine pubescence, the first eight segments having a dusky transverse band on the upper half, the lateral margins also with a dusky band; legs pale chestnut; length 1 line. Common in the tail-head and neck of the horse, especially when fresh from pasture in autumn. Found also on the ass. A little oil will destroy this animal when it first appears; but if allowed to establish itself for some time, mercurial ointment will be necessary, but in small quantities at a time.

Fig. 115.



THE HORSE-LOUSE, TRICHODECTES EQUI.

1489. Besides being infested by this species, the ass has a louse peculiar to itself, the *Hæmatopinus Asini*; of a rusty red; abdomen whitish, tinged with yellow, and having a row of dark horny excrescences on each side; head long, with

* Youatt *On the Horse*, p. 507, edition of 1843.

† Dick's *Manual of Veterinary Science*, p. 9.

a deep sinuosity behind the antennæ; length 1 to $1\frac{3}{4}$ line. It frequents the mane and neck, and is common.*

1490. *Batts.*—One of the most common complaints amongst farm-horses is the flatulent colic, gripes, or batts. It arises from indigestion, which again is occasioned by various causes, such as hard work immediately after feeding, drinking water largely after a feed of corn, bad state of the food, fast eating, and, in consequence, a paucity of saliva, an overloaded stomach, a sudden change of food from soft to hard and dry, and more likely to occur after eating turnips, potatoes, carrots, and grass, than hay and oats, and after pease than barley. The indigestion arises in two forms; the food either undergoing no change, or running rapidly to fermentation. In the former case *acute foot-founder* is apt to arise, and its treatment is purgatives, drenches, and injections. In the latter case, the symptoms are most alarming—the horse falls down, rolls over, starts up, paws the ground with his forefoot, strikes his belly with the hind-foot, perspiration runs down, and agony appears extreme. Relief may be obtained from this dose :—Linseed oil, raw, 1 lb. ; oil of turpentine from 2 to 3 oz. ; laudanum from 1 to 2 oz., or hartshorn from ½ to 1 oz. The following tincture may be kept in readiness : In 2 lbs. of whisky digest for 8 days 3 oz. of ginger, 3 oz. of cloves, and then add 4 oz. of sweet spirits of nitre. Half a pint imperial of this tincture is a dose, in a quart of warm water. The abdomen should be rubbed, the horse walked slowly about, and supplied with a good bed, and with room to roll about. If there is no relief in half an hour, a second dose may be given, and, ere long, if still required, a third. Farm-horses that have keen appetites and devour their food greedily, and when they have been long in the yoke, are most apt to this disease.

1491. *Inflammation of the bowels.*—The symptoms of the batts are very similar at first to those of inflammation of the bowels, and, if mistaken, serious consequences may arise, as the treatment of the two complaints is very different. The symptoms may be distinguished thus : In batts, the pulse remains nearly unaltered, whereas in inflammation it is quickened; all the extremities, the ears, and feet, feel cold in batts, hot in inflammation. Whenever inflammation is apprehended, blood may be taken; in batts this is not necessary; but, under such an apprehension, the assistance of the veterinary surgeon should be obtained as speedily as possible. I have cured many horses of the batts by administering stimulating drinks with a handy cow's horn. I remember of one horse being seized with inflammation of the bowels, on its arrival home from delivering corn at the market town ; and though the usual remedies of bleeding and blistering were resorted to, they proved ineffectual—no doubt from being disproportioned to the exigencies of the case—and the horse sunk in five days in excruciating agony. There was no veterinary surgeon in the district at that time, which was many years ago. Now, however, thanks to the Veterinary College of Edinburgh, through the really practically useful tuition of its indefatigable principal, Professor Dick, there is not a populous district of the country in which a skilful veterinarian is not settled. To the surgeon, therefore, in a serious case such as this—and, indeed, in all cases of extensive *inflammation*, and especially in the interior of the body —recourse should immediately be had. I say *immediately*, for it is but fair to give the surgeon the *chance* of treating the case correctly from its commencement, and not to impose upon him the task of amending your previous bungling. Inflammation of the *lungs*, as well as inflammation of the *kidneys*—both of which the farm-horse is subject to—should always be treated by the veterinarian; but, fortunately, these formidable maladies may, almost with certainty, be evaded with well-timed working, discrimination of work according to the state of the weather, and by good food, supplied with regularity, and proper quantity.

1492. *Common colds* frequently occur among farm-horses at the commencement of winter, and when not entirely unheeded, but treated with due care, seldom leave serious effects. "A cold requires nothing more but confinement in a moderately warm stable for a few days, with clothing, bran mashes instead of corn, and a little laxative and diuretic medicine." The evil lies not so much in the complaint as in its ordinary treatment ; it is seldom thought seriously of by farmers—"It is *only* a cold," is the usual remark—and, in consequence, the horse goes out every day, feels fatigued, gets wet, becomes worse, and then the lungs not unfrequently become affected, or a chronic discharge is established from one of the nostrils. One season 9 horses out of 12 in one stable were affected, one after another, by a *catarrhal epidemic*, which required bleeding, poulticing, or blistering under the jaw, besides the medical remedies mentioned above. These I was obliged to take charge of myself, there being no veterinarian in the district, and all fortunately recovered. The remaining 3 were slightly affected afterwards, and easily brought through ; but had the cases been unheeded from the first, very serious loss might have been incurred by death.

1493. *Grease.*—"The well-known and unsightly disease called grease," says Professor Dick, "is a morbid secretion of the cutaneous pores of of the heels and neighbouring parts, of a peculiar greasy offensive matter, attended with irritation and increased vascular action. It is most frequently seen in coach and cart horses, but often also in young colts which are badly cared for ; and it is most common in the hind-feet, but occurs in all. Its main cause seems to be sudden changes in the condition of the foot from dry to wet, and from heat to cold, greatly augmented, of course, by evaporation." Hence the evil effects of washing the legs at night without thoroughly drying them afterwards. "The first appearance of grease," continues the Professor, "is a dry state of the heels, with heat and itchi-

* Denny's *Monographia Anoplurorum Britanniæ.*

ness. Swelling succeeds, with a tendency to lameness; the discharge augments in quantity, the hair begins to fall off. . . . In the early stage the parts should be washed with soap and water, and a solution of sugar of lead and sulphate of zinc applied; this may not be chemically scientific, but we have found it superior to any thing else. Even in old and aggravated cases it is very efficacious. . . . If the horse be strong and full of flesh, laxatives should be given, followed by diuretics; if weak, tonics may be added to these last. The feeding, too, must be varied with the condition:—green meat and carrots should be given, and mashes frequently, as a substitute for corn. During convalescence, exercise should be given, and bandages and pressure hasten the cure." I have no hesitation in saying that it is a disgrace for any steward, and in the want of such a functionary, it is so in the farmer himself, to allow his horses to become greasy.

1494. There is a complaint called a *shot of grease*, arising from a different cause from the common grease. "In the horse, plethora," says Professor Dick, "creates a strong disposition to inflammation of the eyes, feet, and lungs, and sometimes to an eruption which is called *surfeit*, or the *nettle-rush*. The hair falls off in patches, and the skin is raw and pimpled. There is also a tendency to *grease*, and to what has been designated a *weed* or *shot of grease* in the heavy draught-horse. One of the legs, generally a hind one, suddenly swells; the animal becomes lame; there is pain in the inside of the thigh; increased upon pressure; and fever supervenes. . . . We have seen it occur chiefly during continued rest after hard work and exposure to weather, in animals which were highly fed. The best treatment is large blood-letting, scarifying the limb, fomenting, and applying hay, straw, or flannel bandages, with purgatives and diuretics. The pressure of a bandage will expedite the reduction of the part to its natural dimensions.

1495. *Stomach staggers.*—"The most prominent symptoms of this disease are the horse's hanging his head, or resting it on the manger, appearing drowsy, and refusing food; the mouth and eyes being tinged with a yellowish colour; there is twitching of the muscles of the chest, and the fore-legs appear suddenly to give way, though the horse seldom falls. Inflammation of lungs or bowels, or lock-jaw, may supervene. Its cause is long fasting and over-work; but the quality of the food acts as a cause. Its treatment is relieving the stomach and bowels with searching laxatives, such as croton, also aloes and calomel, with ginger. Clysters should also be given, and afterwards cordials. Blood-letting from the jugular vein will be attended with advantage. Finally, steady exercise and careful feeding will prevent a recurrence of the disorder." * I had a year-old draught colt that was affected with this disease. He was a foul-feeding animal, delighting to eat the moistened litter from the stable and byre. He was bled and physicked by a veterinarian, who had established himself in the neighbourhood, and the front of his head blistered. He quite recovered, and having been removed from the temptation of foul-feeding, he was never again similarly affected.

1496. The practice of keeping *he-goats* in the stables of inns, and of those persons who have extensive studs, is supposed, by the common people, to act as a *charm* against the mad staggers; but, as Marshall judiciously observes, the practice may be explained on physiological principles. "The staggers are a nervous disorder," he remarks; "and as odours, in many cases, operate beneficially on the human nerves, so may the strong scent of the goat have a similar effect on those of the horse. The subject," he adds, "is worthy of inquiry." † And he gives a striking instance of the good effects of the practice.

1497. *Thrush.*—I have said that the feet of the farm-horse are not liable to so many diseases as those of horses subjected to high speed on hard roads. Farm-horses, however, are liable to *thrush* and *corns* in the feet. The former is situate at the hind part of the cleft of the frog, originating principally from continued application of moisture and dirt; and hence it may be most expected to be seen in dirty stables, of which there are not a few in the country. After being thoroughly cleaned out, the hollow may be filled with calomel, which generally cures; or with pledgets of tow dipped in warm tar, or spirit of tar, applied at night, and retained during the day. The general health of the horse should be attended to.

1498. Corns arise from undue pressure of the shoes upon the sole.

1499. *Broken wind.* — Besides natural complaints, farm-horses are liable, in the execution of their work, to accidents which may produce serious complaints. Thus over-work, in a peculiar state of condition, may produce *broken wind*, which is the common phrase given to all disorganised affections of the lungs, though the term is defined by veterinarians to be "the rupture of some of the air-cells of the lungs, whereby air-vesicles are produced on the surface, and the expulsion of the air is rendered less direct and easy. It is usually produced by animals being urged to over-exertion when in bad condition, though a horse may become broken-winded in a straw-yard." There are many degrees of broken wind, which receive appellations according to the noise emitted by the horse; and on this account he is called a piper, trumpeter, whistler, wheezer, roarer, high-blower, grunter, with thick wind, and with broken wind. I had two uncommonly good horses affected in the wind by working much in the *traces* of a four-horse plough, which was employed to rip up old turf-walls, intermixed with large stones, and to break up rough ground. Those serious effects arising from that sort of work, gave me the hint to relinquish them, and to betake myself to the spade, which I soon found did the work

* Dick's *Manual of Veterinary Science*, p. 55.
† Marshall's *Rural Economy of Gloucestershire*, vol. ii. p. 34.

much better, and in the end cheaper. The horses got gradually worse under the disease, and at length, being unable to maintain their step with the rest, were disposed of as broken-winded horses.

1500. *Sprains.*—"A sprain, or strain, is violence inflicted, with extension, often rupture and displacement, upon the soft parts of a joint, including cellular membrane, tendons, ligaments, and all other parts forming the articulation. The dislocation or disruption may be complete, or it may be a mere bruise or stress; and innumerable are the shades of difference between these extremes. Effusion of the fluids is an attendant consequence. Parts of vital importance, as in the neck or back, may be implicated, and the accident be immediately fatal, or wholly irremediable; on the contrary, they may be to that extent only that, with time and ease, restoration may be accomplished. They constitute a serious class of cases. The marked symptoms are, pain in the injured parts, and inability of motion sometimes complete. The treatment is at first rest, a regulation of the local action and constitutional disturbance, according to circumstances, by venesection, general and local, the antiphlogistic regimen, fomentation, bandages, and other soothing remedies; and when the sprain is of an older date, counter-irritation, friction, and gentle exercise." Farm-horses are not unfrequently subject to strains, especially in doing work connected with building, draining, and other heavy work; and they are most apt to occur in autumn, when geldings are generally in a weak state. For rough work of this kind, old seasoned horses are best adapted, and such may often be procured for little money at sales of stock.

1501. *Saddle-galls.*—When young horses are first put to work, the parts covered by the saddle and collar are apt to become tender, heated, and then inflamed, and if the inflammation is neglected, the parts may break out into sores. Washing with a strong solution of salt in water, with tincture of myrrh, is a good lotion, while attention should be paid to the packing of both saddle and collar, until they assume the form of the horse intended to wear them. "Tumours, which sometimes result from the pressure of the saddle, go by the name of *warbles*, to which, when they ulcerate, the name of *sitfasts* is applied, from the callous skin which adheres to the centre. Goulard water may be used to disperse the swelling; a digestive ointment will remove the sitfast; and the *sore* should be healed with a solution of sulphate of zinc."

1502. *Crib-biting and wind-sucking.* — These practices are said to increase the tendency to indigestion and colic, and to lower condition, rendering the horses which practise them unsound. "A crib-biter derives his name from seizing the manger, or some other fixture, with his teeth, arching his neck, and sucking in a quantity of air with a peculiar noise. . . . Wind-sucking consists in swallowing air, without fixing the mouth. The horse presses his lip against some hard body, arching his neck, and gathering together his feet." Both vices are said to be prevented by fastening a strap round the neck, studded with one or more sharp points or prickles opposite the lower jaw; but this means will not avail in all cases, for I had a year-old colt which first began crib-biting in the field by seizing the gate or any other object he could find. Being prevented using the gate by a few thorns, he pressed his mouth against any object that would resist him, even against the sides or rumps of his companions, and he then became a regular wind-sucker. A strap of the above form was put on, recommended to me by an artillery officer; but though it remained upon the colt for more than a twelvemonth, night and day, and as tight as even to affect his appearance, he continued to crib-bite or wind-suck in spite of it, even to the laceration of his skin by the iron prickles. Growing largely to the bone, though very thin, he was taken up to work at the early age of two years, solely with the view of seeing if the yoke would drive him from the practice; but it had no such effect. Whenever he came into the stable, he set to with earnestness to bite and suck with the strap on, until he would become puffed up as if to bursting, and preferred sucking wind to eating his corn. At length I was so disgusted with the habit of the brute that I sold him to a carrier, to draw a heavy single cart, and being a powerful animal and good worker, got a fair price for him, though sold as a crib-biter. I may mention that the constant practice of the vice neither retarded his growth nor injured his health.

1503. *Dust-ball.*—Millers' horses are most liable to be affected with this disease. Dust-ball is composed of corn and barley-dust, saved in grinding meal and used as food, and occurs sometimes in the stomach, but more frequently in the intestinal canal. "In an advanced stage, no doubt can remain as to the nature of the disorder. The countenance is haggard, the eye distressed, the back up, the belly distended, the respiration becomes hurried, bowels habitually costive, and sometimes the horse will sit like a dog on his haunches. Relief may frequently be afforded. Strong purgatives and large injections must be given, and under their continued action the offending body is sometimes removed." On using barley-dust as food for horses, it would be well to mix it thoroughly with other prepared ingredients, instead of using it in the dry state.

1504. *Worms.*—Farm-horses are sometimes affected with worms. These are of three kinds: the round worm, *teres*; the thread-worm, *ascaris*; and the tape-worm, *tænia*. "In the horse the tænia is very rare; in the dog exceedingly common. When the horse is underfed, his bowels are full of teres and ascaris; and the appearance of his staring coat, want of flesh, and voracious appetite, betoken it. They occasion gripes and diarrhœa, but the mischief they produce is not great. The principal habitat of the ascaris is the cœcum, although they are sometimes found in countless multitudes in the colon and rectum. Turpentine is a deadly poison to all these worms; but this medicine, so harmless in man, acts most disagreeably in the lower animals. Hence it must not be given to them pure, or in large quantities, but mixed in small proportion with other oils, as linseed, or in a pill; and, with these precautions, it may be found at once safe and efficacious."

1505. *Nebulæ, or specks in the eye.*—Farm-horses are not subject to the more violent diseases of the eye; but being liable to accidents, the effects of inflammation—nebulæ or specks—do sometimes appear. "The former are superficial, the latter dip more deeply into the substance of the part. Directly in the sphere of vision, these of course impede it, and cause obscurity of vision. Even here we must proceed gently. These blemishes are the pure consequences of inflammation, and, this subdued, their tendency is to disappear. Time and nature will do much, and the duty of the practitioner consists in helping forward the salutary process, where necessary, by gently stimulating washes, whilst irritating powders should be avoided."* With these sensible remarks of Professor Dick, I shall conclude what I have to say of the diseases of the farm-horse at this time.

1506. The offals of the horse are not of great value. His *hide* is of most value when free of blemishes. It tans well and forms a good leather, which, on being japanned, is chiefly used for covering carriages. I was informed by a friend who settled in Buenos Ayres as a merchant, that he once bought a lot of horses, containing no fewer than 20,000, for the sake of their hides alone, and that some of them would have fetched good prices in England. They were all captured with the *lasso.* Hides sent from Buenos Ayres have merely been dried in the sun.

1507. "Hair, horn, and wool," says Professor Johnston, "are distinguished from the muscular parts of the animal body by the large proportion —about 5 per cent—of sulphur which they contain. They consist of a substance which, in other respects, closely resembles gluten and gelatin in its chemical composition. When burned, they leave from 1 to 2 per cent of ash. . . . The inorganic matter contained in hair is, generally speaking, the same in kind as that which exists in the muscular fibre and in the bone. It contains the same phosphates of lime and magnesia, the same sulphates and the same chlorides, among which latter common salt is most abundant. The absolute quality of ash or inorganic matter varies, as well as the relative proportions in which the several substances are mixed together in the different solid parts of the body; but the substances themselves of which the inorganic matter is composed are nearly the same, whether they be obtained from the bones, from the muscle, or from the hair."†

1508. "Hair, of all animal products, is the least liable to spontaneous change. It can be dissolved in water only at a temperature somewhat above 230° Fahr. in Papin's digester, but it appears to be partially decomposed by this heat, since some sulphuretted hydrogen is disengaged. By dry distillation, hair gives off several sulphuretted gases, while the residuum contains sulphate of lime, common salt, much silica, and some oxides of iron and manganese. It is a remarkable fact that fair hair affords magnesia instead of these latter two oxides. Horse-hair yields about 12 per cent of the phosphate of lime. Hair also yields a bituminous oil, which is black when the hair is black, and yellowish-red when the hair is red."‡

1509. "Hairs are tubular, their cavities being filled with a fat oil having the same colour with themselves. Hair plunged in chlorine gas is immediately decomposed, and converted into a viscid mass; but when immersed in weak aqueous chlorine it undergoes no change, except in a little bleaching."

1510. "Hair, as an object of manufacture, is of two kinds—the *curly* and the *straight.* The former, which is short, is spun into a cord, and boiled in this state, to give it the tortuous springy form. The long straight hair is woven into cloth for sieves, and also for ornamental purposes, as in the damask hair-cloth of chair bottoms. For this purpose it is dyed of various colours." Horse-hair is also used for fishing-lines, and horse-tails for cavalry caps.

1511. "Button moulds are made of the bones of the horse, ox, and sheep. The shavings, sawdust, and more minute fragments in making these moulds, are used by the manufacturers of cutlery and iron toys, in the operation of case-hardening, so that not the smallest waste takes place."§ The bones of all these animals, when reduced small, make the valuable manure bone-dust, well known to every farmer.

1512. "The bones, like the muscles, consist of a combustible and an incombustible portion; but in the bones the inorganic or incombustible part is by much the greater. . . . The incombustible portion consists, for the most part, of phosphate and carbonate of lime. The relative proportions of these two earthy compounds also vary with the kind of animal, with its age, its condition, its food, and its state of health. To form 100 lbs. of bone, the animal will usually require to incorporate with its own substance about—

35 lbs.	of gelatin.
55	phosphate of lime.
4	carbonate of lime.
3	phosphate of magnesia.
3	of soda, potash, and common salt."‖
100 lbs.	

* Dick's *Manual of Veterinary Science*, p. 104.
† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 1013.
‡ Thomson's *Animal Chemistry*, p. 302.
§ Ure's *Dictionary of the Arts*,—arts. *Hair, Button.*
‖ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 1012.

1513. M'Queen estimated in 1836 the number of horses employed in agriculture, in the whole kingdom, at 1,609,178, and valuing these at £25 each, the amount would be £40,229,450.

1514. If we take his estimate of the annual increase of agricultural horses at 8000, at £25 each, their value is £200,000; and supposing that this number is sufficient to supply the tear and wear occasioned by work, the yearly estimate of the wear and tear may thus be taken at one-twentieth of the entire value, or £2,000,000 a-year. Marshall, and the Agricultural Committee of 1821, estimated the wear and tear of farm-horses at *one-tenth* ; but if the annual increase is correct, as given by M'Queen, this cannot be the proportion, and I should say, from ordinary experience, that it is above the mark.

1515. To test the value of the labour of the farm-horse, M'Queen offers these data—the labour of 1 horse is equal to that of 5 able-bodied men, and as the yearly charge of a man is £29, it follows that the value of the labour of 1,609,178 farm-horses should be yearly of the prodigious sum of £233,330,810.*

1516. Since 1822, farm-horses have been exempted from duty, and brood-mares have always been so. The numbers entered for the duty were 832,726,—Ireland being always exempt.† The duty was 17s. 6d. each, and the sum thus remitted was £728,435 yearly.

1517. By the customs tariff of 1846, horses, mares, geldings, colts, foals, may be imported free.‡

1518. Dealers in horses must procure a license, for which they pay yearly £12, 10s. if out of, and £25 if in London. In 1831, the number of horse-dealers licensed in all parts of the kingdom was 1037.

1519. Slaughterers of horses must also procure a license.§

1520. The stealing of horses is not now a capital crime.

1521. "By cases, it is seen that it is not necessary, by the law of Scotland, that a horse should be warranted sound at the period of sale, as is generally thought, to entitle the buyer to return it, should it prove unfit for the purpose for which it is sold. By the law of England, warrandice is necessary to entitle the buyer to return an unsound horse. By the law of both Scotland and England, the buyer of a subject sold with all faults, has no right to question the sale, when he has not been drawn into it by fraud, (Shaw, Dec. 1594, M. 14229; Baglehole, 3 Camp. 154.) See Lord Eldon's judgment in the latter case. But Mr Bell, in his Commentaries, vol. i. p. 242, says that "when the faults are such as the buyer can only learn from the seller's information, the concealment is fraud."‖

ON THE TREATMENT OF THE FARMERS' SADDLE AND HARNESS HORSE IN WINTER.

1522. I have said (9) that the agricultural pupil should have no horse of his own at first, to tempt him to leave home and neglect his own training; and before he is entitled to one, he should know how to groom it, to be able to correct the groom when he neglects his duty, or performs it in an improper manner. I would advise the pupil himself to undertake the charge of a horse for some time—not merely to superintend its keeping, but to clean it himself, to water and corn it at stated times at morning, noon, and night, and to keep the saddle and bridle in proper order. I groomed a new-broke-in blood filly for four months one winter, and got more insight into its form, temper, management, and wants, than I could have obtained by observation alone in a much longer time. On coming home even at night, from visiting a friend, I made it a point with myself to make the mare comfortable for the night before indulging in my own rest.

1523. Usually a young lad, a groom, is hired by the farmer to take charge of his saddle or harness horse, or of both, to go errands and to the post-office, and otherwise to make himself serviceable in the house. Sometimes the hedger or shepherd acts the part of groom. My shepherd acted as groom, and his art in grooming was so skilful, that many friends would have been glad could their *professed* grooms have turned out the saddle-horse or drag in as good a style. Besides being useful in carrying the farmer to market, or other short distances, a roadster is required to carry him over the farm when it is of large extent, and the work-people require pretty constant superinten-

* M'Queen's *General Statistics of the British Empire*, p. 15 and 37. 1836.
† Porter's *Progress of the Nation*, p. 163. 1847. ‡ *The Customs Act*, 26th June 1846.
§ M'Culloch's *Commercial Dictionary*,—arts. *Horse, Horse-dealers.*
‖ *The Farmer's Lawyer*, p. 142.

dence in the important operations of seed-time and harvest. A harness-horse is useful to a family at all times, and to the farmer himself when he visits his friends; and many farmers now prefer riding to market in a gig or drosky to horseback.

1524. A saddle or harness-horse is treated somewhat differently in the stable from a work-horse. The first thing to be done early in the morning is to shake up the litter nearest the strand with a fork, removing the dung and soiled straw to a court-yard, and sweeping the floor clean. Then give the horse a drink out of the pail, which is constantly kept full of water in the stable. The usual practice is to offer the water *immediately* before giving the corn; but I conceive it more conducive to the health of the horse to slake his thirst a while before giving him corn, to allow the water time to reach its destination, and acquire the temperature of the body. Should the horse have to undertake a longer journey than walking about the farm, the allowance of water should be stinted to 10 gluts; but if he is to be at home, he may drink as much as he pleases.

1525. The grooming is begun by first removing the sheet, and gently going over the whole body with the currycomb, fig. 109, to remove any particles of mud that may possibly have escaped the former night's grooming, and also to raise the scurf from the skin; and then wisping down with straw, to clear off what the currycomb may have raised to the surface. The brush follows, to clear the hair of its scurf, the currycomb being used to clean the brush. Of wisping and brushing, wisping is the more beneficial to the legs, where the hair is short and the tendons and bones are but little covered, because it excites warmth and cleans sufficiently. Both wisping and brushing should be begun at the head and terminated at the other end of the body, along the lie of the hair, which, notwithstanding different swirls, tends from the upper to the lower part of the body. Many a groom rests content with a brushing only; but it does not effectually remove the dust raised to the surface, and a wisping is required to do it. The horse should be turned round in the stall, to have his head, neck, counter, and fore-legs, wisped, which, when done, he is again turned to his former position, to have the body, quarters, and hind-legs, wisped over; and when the whole of this has been accomplished, the horse may be considered clean. All this grooming implies the bestowal of much more labour than most farmers' riding-horses receive. They are usually scuffled over in the morning with the currycomb, and skimmed with the brush, and with a hasty combing of the mane and tail the job is considered finished. The mane and tail ought to be carefully combed out, and wetted over at the time of combing with a half-dry water-brush. The sheet should then be thrown over the horse, and in putting it on, it should be thrown more towards the neck of the horse than where it is intended to remain, and from thence drawn gently *down the hair* with both hands, to its proper position, while standing behind the horse. It is kept in its place by means of the roller, which should be buckled on tightly. The litter is then neatly shaken up with a fork, taking care to raise the straw so far up the travis on each side as to form a cushion for the side of the horse to rest against when he lies down.

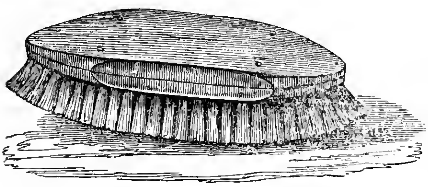
1526. The feed of corn is then given him, and a little hay thrown into the rack; and on the stable-door being shut, he is permitted to enjoy his meal in peace. At mid-day he should have another drink of water from the pail, the dung removed, the litter shaken up, and another portion of oats given him. At 8 o'clock at night the sheet should again be taken off, the currycomb and brush used, and the entire dressing finished again with a wisping. The sheet is then thrown over him as in the morning, the litter shaken up and augmented, water given, and the supper of oats, or a mash, finishes the day's treatment of the saddle-horse.

1527. The wisp for this purpose is best made of Russia mat, first wetted and then beaten to a soft state, and after being dried is rolled up in the form of a wisp, just large enough to fill the hand. This wisp cleanses the surface of the hair most effectually when it is damped with a little water and dried by being beaten against a stone wall.

1528. A wisp of horse-hair cloth makes a horse's skin very clean; but in dry weather it is apt to excite such a degree of electricity in the hair of the horse as to cause it to attract much dust to it.

1529. The treatment just described is most strictly applicable to the horse remaining all day in the stable; but when he is ridden out, a somewhat different procedure is required. When he comes home from a dirty ride, the first thing is to get clear of the mud on the belly and legs. A very common practice is to wade the horse through the pond, as the farm-horses are; but this should not be done, since wading through a pond cannot thoroughly clear the legs of mud *to the skin*, and there still remains the belly to be cleaned by other means than wading. The plan is, in winter, to bring the horse into the stable upon the pavement, and, on taking off the saddle and bridle and putting on a halter, scrape all the mud as clean off the belly and legs as can be done with a blunt knife. With a pailful of lukewarm water wash down *the legs*, outside and inside, with a water-brush, fig. 116, then each foot separately,

Fig. 116.



THE WATER-BRUSH.

picking out the mud with the foot-picker, fig. 105, and washing the mud clean from the belly with the water-brush. A scrape with the back of the knife, after the washing, will bring out all the superfluous water from amongst the hair in the belly, and a stroke down the legs with the hands will clear them of most of the water. On going into the stall the horse should be wisped firmly with straw, rubbing the belly first, and then both sides of each leg until thoroughly dry. It is scarcely possible to dry the belly at once, so it should get another good wisping with dry clean straw after the legs are dry. The head, neck, and body are then thoroughly cleaned with the currycomb, brush, and wisp, as above described. On combing out the mane and tail, putting on the sheet, and bedding plentifully with dry straw, the horse will be placed out of danger, and feel pretty comfortable even for the night; but should he have arrived some time before the evening time for grooming, the currycomb and wisp reapplied then will remove any moisture or dust that may have escaped before.

1530. Considerable apprehension is felt in regard to wetting the abdomen of horses, especially at night—and the apprehension is not ill founded, for if the moisture is allowed to remain, even to a small degree, its quick evaporation ensues from the excited state of the body consequent on exercise, and rapidly reduces the temperature of the skin. The consequence of such a cooling tends to irritate the skin, and bring grease into the legs, and this is the danger attending the wetting of the bellies of farm-horses with *cold* water; but *warm* water cleanses the hair and makes it dry sooner, even on the abdomen, where it is generally much longer than on the legs. Unless, however, as much labour is bestowed as will dry the skin, and which is usually more than may be expected from ordinary country grooms, it is safer for the horse to remain in a somewhat dirty state all night, than to risk the consequences of an attack of grease and inflammation by neglected wet limbs and abdomen. If the requisite labour *shall* be bestowed to render the skin completely dry, less risk is incurred in wetting the belly than the legs, inasmuch as the legs, in proportion to their magnitude, expose a much larger surface for evaporation, and are not so near the source of animal heat as the body.

1531. Clipping the hair close to the body of saddle and harness-horses, has been recommended and practised pretty extensively within the last few years. The effects likely to arise from this operation may be collected from these remarks of a veterinary surgeon:—"If the owner," says he, "cannot suffer a long coat of hair, and will have it shortened, he must never allow the horse to be motionless while he is wet or exposed to a cold blast. He must have a good groom and a good stable. Those who have both, seldom have a horse that requires clipping, but, when clipped, he must not want either. A long coat takes up a deal of moisture, and is difficult to dry; but, whether wet or dry, it affords some defence to the skin, which is laid bare to every breath of air when deprived of its natural covering. Everyone must know from himself whether wet clothing and a wet skin, or no clothing and a wet skin, is the most disagreeable and dangerous. It is true that clipping saves the groom a great deal of labour. He can dry the horse in half the time, and with less than half the exertion which a long coat requires; but it makes his attention and activity more necessary, for the horse is almost sure to catch cold if not dressed immediately. When well clothed with hair he is in less danger, and not so much dependent upon the care of his groom."* These observations contain the whole rationale of clipping, and show it is inapplicable to farm-horses, and, as country grooms are usually qualified, clipping would prove but problematically beneficial to the saddle or harness horse of the farmer.

1532. Saddle-horses receive oats in proportion to the work they have to perform, but the least quantity supposed to keep them in such condition as to enable them to do a day's work at any time, is three half-feeds a-day—one in the morning, another at mid-day, and a third at night. When subjected to *daily* exercise, riding-horses require three feeds a-day, and an extra allowance for extra work, such as a long journey. A mash once a-week, even when on work daily, is requisite; and when comparatively idle, a part of the mash prepared for the work-horses, may be administered with much advantage. I am no advocate of a bran mash to a horse in good health, as it serves only to loosen the bowels without bestowing much nourishment. Boiled barley is better. A riding-horse should have hay, and not straw, in winter; and he will eat from a half to three-quarters of a stone of 22 lbs. daily.

1533. A method of feeding harness-horses is practised by Mr R. G. Durham, Turnham Green, London, on his omnibus horses. They are now partly fed on carrots, instead of wholly on oats as formerly, and the results deserve the attention of the farmer in supporting his own saddle-horse. Mr Durham observes:—"I make bold to offer to the keepers of horses a plan which I have successfully practised for the last three years, to save a large consumption of oats; and, having had the management of upwards of 200 horses belonging to the Hammersmith Conveyance Company, I can confidently state that the plan is not only a great saving in expense, but is in the highest degree conducive to the health, and the development of the capabilities of the horse. In autumn I lay in a sufficient store of either white or red carrots, (white preferred,) to last till the spring, and from every stud of 8 horses I deduct from their daily allowance of oats, (which is 4 bushels, or 152 lbs.,) 1 bushel, or 38 lbs., in place of which I substitute about 72 lbs. of carrots sliced thin, and then mixed with the chaff and oats—thus saving one bushel of oats in every stud per day; a ton of carrots being equal to 4 quarters of oats. Now, taking the number of horses working in the omnibuses round London at 8 per omnibus, and the number of omnibuses at 1400, the saving in the consumption of oats by omnibus horses only would be 1,400 bushels, or 175 quarters, per day. But almost all descriptions of horses do well upon this food. Blaine, in his *Veterinary Art*, says of carrots that 'agricultural horses may be supported on them wholly, when sliced and mixed with chaff; the sweet parsnip has similar properties, and may be used with almost equal success; and the Swedish turnip has proved an excellent food, the sugar predominating in all these to an eminent degree;' and he adds, 'but carrots stand foremost, and hardly too much can be said on their excellent qualities. They appear particularly favourable to condition, as the skin and hair always look well under their use; they are highly nutritious, and so favourable are they to the free exercise of the lungs that horses have been found even to hunt on them, and, in conjunction with a certain portion of corn, would form as good a food as could be devised for our coach and machine horses and our hack-

* Stewart's *Stable Economy*, p. 120.

neys.' And further on he states, 'that in very many cases of horses in fair work, carrots may be wholly substituted for corn, provided the quantity be doubled or trebled—and with additional advantage to the health and condition of the animals.'"

1534. Of *harness* there should be two pairs of girths in use with the saddle, when the horse has much work to do, to allow one pair to be thoroughly cleaned and dried while the other is in use. The best way to clean girths is first to scrape off the mud with a knife, and then to wash them in *cold* water, and hang them up to a fire or bright sun to dry *quickly*. *Warm* water makes them shrink rapidly, and so does long exposure to wet. If there is time, they should be washed the same day they have been dirtied; and if not, on being scraped at night, they should be washed in the following morning, and hung up in the air to dry; and if the air is damp, hang them before the kitchen fire. Girths allowed to dry with the mud on soon become rotten and unsafe.

1535. The stirrup leathers should be taken off and sponged clean of the mud, and dried with a cloth; and the saddle-flaps should also be sponged clean of mud, and the seat sponged with a wrung sponge, and rubbed dry with a cloth.

1536. The stirrup-irons and bit should be washed in water, and rubbed dry with a cloth, immediately after being used. *Fine* sand and water, on a thick woollen rag, clean these irons well, and a dry rub afterwards with a cloth makes them bright. Some smear them with oil on setting them past, to prevent rust; but oil, on evaporation, leaves a resinous residuum to which dust readily and strongly adheres. The curb-chain is best cleaned by washing in clean water, and rubbed dry with a cloth, and made bright by friction between the palms of both hands.

1537. Carriage harness should be sponged clean of mud, kept soft and pliable with fine oil, and, when not japanned, blackened with the best shoe black, Everington's being excellent. There should be no plating or brass ornaments on a farmer's harness; plain iron japanned, or iron covered with leather, forms the neatest, most easily kept, and serviceable mounting. Bright metallic mountings of every kind soon assume the garb of the shabby genteel in the hands of an ordinary rustic groom.

1538. The wheels of a carriage are best cleaned with a worsted mop and water, and made dry with a soft linen cloth, and finished with chamois leather. The body should be washed with a wet sponge, and rubbed dry with chamois leather. In taking off mud from the body of a carriage with a wet sponge, care should be taken to let the loose mud run off of itself with the water from the sponge, and to keep the sponge clean by wringing out, to avoid scratching the varnishing.

1539. On choosing a spunge to be used for carriage cleaning, the form should be of a hollow cup about the size of the hand, this form having the finest and most delicate edge for cleaning a smooth surface such as a carriage panel. The substance should have a fresh appearance and fair colour, tough, and free of sand and grits. Never buy a sponge offered at a small price for its size, as it will be sure to be rotten, and most likely of a dead brown colour. Before using any new sponge, it should be thoroughly and repeatedly washed with soap and warm water.

1540. In selecting a chamois skin, it should be equally thick throughout, feel delightfully smooth, be large, and free of hard spots. Chamois leather as sold in the shops is not all made of the skin of the chamois of the Alps, that of the common goat and the doe being manufactured as that of the real chamois.*

1541. A saddle-horse stable, when more than one horse is kept, should be provided with 2 pails for water, and one for washing the feet in, or the carriage wheels. It is a dirty habit to give the horse his drink of water out of the same pail in which his feet is usually washed, which should never be allowed to be used for any other purpose. The other furniture of such a stable consists of a fork to shake up the straw, a

* Ure's *Dictionary of the Arts*,—art. *Leather*, p. 767.

broom, a mop to wash the floor when of India rubber pavement, or the carriage-wheels, and a box for holding stuffing of cow-dung for the feet. The corn-chest should be provided with a sieve to purge out the dust and sand from the corn.

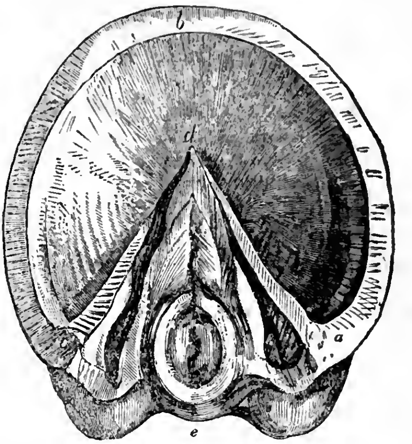
1542. The horse should be provided with a rug and roller, the wearing of which serves to keep his skin free of dust. A rug costs 13s. 6d., and a roller 5s. 6d.; a riding-saddle £4, 10s.; double bridle, 30s.; stall collars, 6s. 6d.; water-brush, fig. 116, 3s. 6d.; and a set of harness for gig or carriage for one horse, £8—all of the best materials and workmanship.

1543. Wax lights are best and cleanest for carriage lamps, and for all the number a farmer will require in a season he should not hesitate on using them. The reflectors are now made large and bright, and are best cleaned with a soft clean muslin rag.

1544. Besides all the diseases mentioned as incidental to the farm-horse, the saddle-horse is liable to many more, arising from affections in the foot. When we consider the violence of the action of the horse in trotting, and that he has to trot not only with a load on his back, bearing a large proportion to his own weight, but upon a hard road, which yields but in a very slight degree to his weight, and at times for several hours at a stretch, we need not be surprised to find his feet become much heated, and even injured. So used, without protection, his feet, in a natural state, would soon be so seriously injured as to be incapable of resisting the concussion of a hard road; and the only protection capable of resisting so hard a substance as an artificial road, and, at the same time, be so light as not materially to interfere with his action, is a plate of iron fastened upon the sole of the foot, and commonly denominated a *shoe*. Were this shoe fastened upon the foot so as to allow the foot its natural freedom when in action, we might easily believe that the protection afforded by so tenacious and obdurate a substance as iron would be most effectual to the feet; but, alas! so far is the shoe, as ordinarily made and fastened on, from giving the foot its natural freedom, there is great reason to believe, that all the variety of lameness exhibited by the saddle-horse may truly be ascribed to the manner in which his feet are shod. This statement is highly important to every one who has a horse to feel interested in; and that it is founded on observation and reason, a recent publication enables me to prove convincingly to the agricultural student.

1545. The horse's foot is not circular, as is generally supposed, but is curved considerably and abruptly outwards; while the inner quarter is carried back in a gradual and easy curve as is shown in fig. 117, where the outer crust from *a* to *b* is more curved than the inner one from *b* to *c*;

Fig. 117.



THE HORSE'S FOOT IN THE NATURAL STATE.

and the outer crust is also thicker than the inner, as is also shown in the figure. "There are very few things so little varied in nature as the form of the ground surface of the horse's foot," says Mr Miles of Dixfield, near Exeter; "for, whether the hoof be high-heeled and upright or low-heeled and flat, large or small, broad or narrow, the identical form of the ground surface is maintained in each, so long as it is left to nature's guidance. The advantage of this form is so obvious, that it is matter of wonder it should be interfered with. The enlarged outer quarter extends the base, and increases the hold of the foot upon the ground; while the straighter inner quarter lessens the risk of striking the foot against the opposite leg. It should surely be our object to retain these valuable qualities as long as we can, and not lightly sacrifice either of them to a false notion of what may be considered a prettier form. Whenever we observe nature steadily persevering in one plan, depend upon it, it is not within the range of man's ingenuity to amend it; and he will better secure his own interest in accommodating his views to her laws, than in attempting to oppose them." Instead, therefore, of attempting to alter the form of the foot to the circular one given to the shoe, the shoe ought to be made to fit the form of the natural foot.

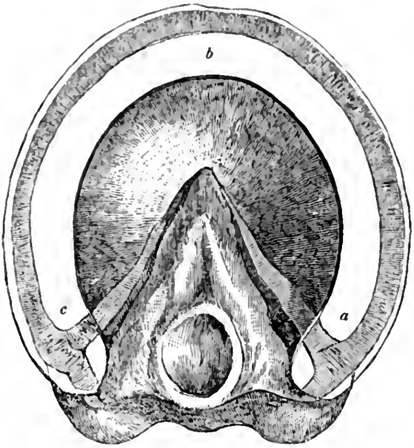
1546. In preparing the foot for the shoe, both judgment and skill are requisite. The outer crust *a b c*, as well as the sole *d*, should be well *rasped* down; and the operator mostly errs in taking away too little than too much. The quantity depends on the form of the upper part of the foot, which varies considerably in different horses. In upright feet and high heels horn grows abundantly, especially towards the toe, and such feet are benefited by having the toe shortened, the heels lowered, and the sole well pared out; while with flat feet and low heels the horn grows sparingly, and such will admit of very little shortening in the toe, being always weak, and the heels are already too low for the rasp; and the sole presents so little dead horn, that the drawing-knife should be used with great discretion. Perfect and tolerably well formed feet, with a fair growth of horn, should have the toe shortened, the heels lowered, and the sole well pared out—that is, all the dead horn removed, and, if need be, some of the living too—until it will yield, in some small degree, to hard pressure from the thumb. Besides the form of the foot, other circumstances regulate the degree of paring to which the foot should be subjected; such as, it is manifestly unwise to pare the sole as thin in a hot dry season, when the roads are strewed with loose stones, as in a moderately wet one, when they are well bound and even—the most favourable surface that most of our horses ever have to travel upon—when advantage should be taken to give the sole a thorough paring, in order that the internal parts of the foot may derive the full benefit arising from an elastic and descending sole—a state of things very essential to the due performance of their separate functions.

1547. The corners formed by the junction of the crust and bars, as at *a* and *c*, fig. 117, the bars being *a d* and *c d*, should be well pared out, as this is the seat of corn; and no accumulation of horn should be allowed to take place, to increase the pressure on the particular part. The bars should be pared down to the level of the sole. "I prefer paring them down to the level of the sole," observes Mr Miles, "or very nearly so, avoiding, however, any approach to what is called 'opening out the heels'—a most reprehensible practice, which means cutting away the sides of the bars, so as to show an apparent increase of width between the heels, which may for a time deceive the eye; but it is a mere illusion, purchased at the expense of impaired power of resistance in the bars, and ultimate contraction of the foot. It is self-evident, that the removing any portion from the sides of the bars must diminish their substance, and render them weaker, and consequently less able to resist contraction."

1548. With respect to the frog *a*, fig. 117, Mr Miles observes, that "the layer of horn that covers the frog is thinner in substance, and more delicate in texture, than that of any other part of the foot, and, when once destroyed, is very imperfectly and sparingly reproduced. The first stroke of the knife removes this thin horny covering altogether, and lays bare an undue surface, totally unfitted, from its moist, soft texture, for exposure either to the hard ground or the action of the air; and, in consequence of such unnatural exposure, it soon becomes dry and shrinks; then follow cracks, the edges of which, turning outwards, form rags; these rags are removed by the smith at the next shoeing, whereby another such surface is exposed, and another foundation laid for other rags; and so on, until at last the protruding plump elastic cushion, interposed by nature between the navicular joint and the ground, and so essential to its preservation from injury, is converted, by the mischievous interference of art, into the dry, shrunk, unyielding apology for a frog to be seen in the foot of almost every horse that has been regularly shod for a few years." This shrinking of the frog is produced by the shoeing without the additional assistance of the knife. Indeed, shoeing seems almost to check its growth entirely in the generality of feet; for, if we compare the size of the frog with the circumference of the foot in a horse being accustomed to be shod, we shall find the space occupied by it will not exceed one-tenth, or even one-twelfth, of the whole circumference, whereas in the natural and unshod foot it occupies about one sixth. The evident practice, then, should be to leave the frog alone, and never allow a knife to approach it. Nature will remove the superfluous horn, and the rags can do no harm, and, if unmolested, will soon disappear altogether.

1549. The shoe should not be too light, because it is then liable to be bent, and becomes an insufficient covering to the foot. The web of the shoe should be broad, and continued through the whole shoe to the heels, to give increased covering and protection to the sole of the foot. The outside of the shoe should exactly fit the crust of the hoof, thereby giving the entire foot an equal bearing on all its parts from the toe to the heel. The usual practice is to have a portion of the shoe projecting outwards, along both the outer and inner quarters of the hoof; and when this form of shoe is connected with a narrowing of the web at the heel, the effect is to place the heel upon the inside line of the web, thereby producing an unequal bearing upon the ground surface of the foot. The setting off of the shoe at the heels is a great inconvenience to the horse when his foot sinks into the ground, inasmuch as the part set off forms a base for the ground to resist the foot when pulled up; and doubtless it is in this way that most of the shoes are pulled off and lost in the ground. It is evident, when the shoe fits the foot of the horse exactly, that when the foot is pulled up through the ground after sinking, the shoe must follow the foot without detriment or difficulty. "I always employ," remarks Mr Miles, "a tolerably wide-webbed shoe, and bring in the heels of it almost close to the frog, so as to reduce the opening between the heels as much as I conveniently can; and if in fitting the shoe I observe a corner pressing upon, or in any way interfering with the frog, I cause it to be cut off rather than have a shoe opened out to let in the frog—for in opening out the shoe a portion equal to the objectionable corner must be thrust out beyond the hoof, which is very undesirable, as presenting a ready hold for stiff ground to pull the shoe by. This plan of bringing in the heels, while it covers and protects the angles where the bars are reflected, at the same time draws the sides of the shoe nearer together, and opposes to a stoney road a surface of iron instead of the unprotected foot, warding off, thereby, many a blow that would otherwise prove injurious." Suppose such a shoe, and so put on, were made of glass, it would show the parts of the foot through it as represented in fig. 118, where *a b c* is the crust

Fig. 118.

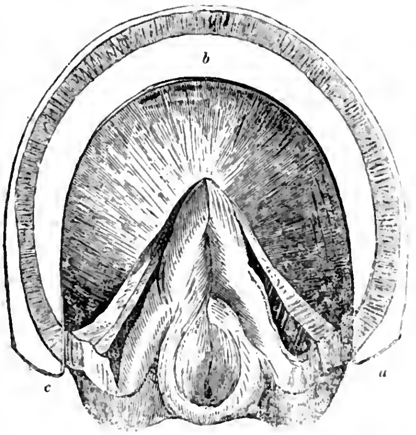


THE TRANSPARENT SHOE, SHOWING THE CLOSE FITTING OF THE SHOE TO THE FORE-FOOT.

with the shoe closely fitted on ; at *a* and *c* the angles formed by the bars and crust are protected and supported by the shoe. The shoe is made sufficiently long, fully to support the entire structure of the heels.

1550. Fig. 119 shows, by a transparent shoe,

Fig. 119.



THE TRANSPARENT SHOE, SHOWING THE USUAL SEAT GIVEN TO THE SHOE UPON THE FORE-FOOT.

the usual seat given to the shoe *a b c* upon the foot, where it is obvious that the heels of the shoe at *a* and *c* are made to project a considerable distance on the outside of the crust of the hoof, at both heels of the foot—the consequence of which arrangement must be, that, when the horse's foot sinks into the ground, especially in soft tough clay, the force requisite to draw it out of the ground, while the ground presses with considerable weight upon the projecting portions of the shoe at *a* and *c*, will not only bring an undue strain upon the nails of the shoe, but most probably draw the shoe off the foot altogether, accompanied with a severe sprain of the fetlock joint ; and the effects of such an accident will be in proportion to the speed the horse is running, and the weight he has to carry.

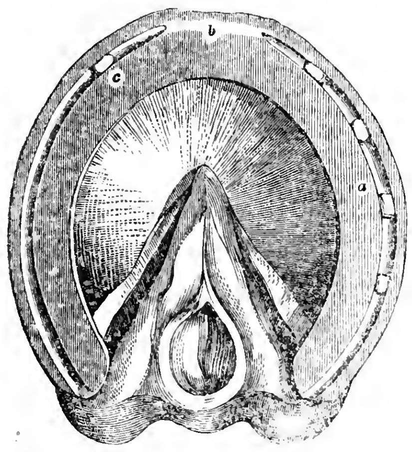
1551. The shoe should be of equal thickness throughout, and the toe turned a little up out of the line of wear, thereby imparting to the toe of a new shoe, when placed on a flat surface, the same elevation from the ground line as that of an old one. The common practice is to have the shoe thickest at the heels, whereby the toe is thrown forward, and is caused to strike against every projection which comes in its way ; and a lump of steel is welded on the toe, which not only increases its thickness and the number of obstacles it necessarily encounters, but, being of a harder texture, is longer in wearing down, and consequently exposes the foot to the greatest amount of concussion. A small clip at the point of the toe is very desirable to prevent the displacement of the shoe backward : it need not be driven up hard, being merely required as a stay or check. The ground surface of the shoe should be perfectly flat, with a fullering or groove running round the outer edge, just under the plain surface on which the crust bears. The groove protects the heads of the nails; and as it further increases the hold of the shoe on the ground, it should be always carried back to the heels.

1552. No shoe should ever be nailed to the foot until it has been ascertained that the pressure of the hands is sufficient to keep it steadily in its place, and preclude any appearance of daylight between it and the foot. A hot shoe, to scorch any part that bears unevenly upon it, is the only way by which the even bearing necessary to a perfect fitting of the shoe can be insured. A notion prevails that the shoe gives the particular form to the foot. This is a mistake, for no foot can possibly be affected by any form of shoe it may stand upon. It is the situation of the nails which alters the form of the foot, by preventing its expansion, and such prevention of expansion is the sole cause of all the lameness affecting the foot; and as long as the present mode of placing the nails shall be persevered in, so long will the foot of the horse be liable to be affected by lameness. If, on the contrary, the nails are placed on the outside quarter and toe, leaving the heels and quarters in the inside, which are the most expansive parts, free, the form of the foot will in no degree be affected by the shoe, for, supposing the shoe to be too contracted, the foot will expand out over it. The nails should be lightly driven before their clenches are turned up. The clenches should not be rasped away too fine, nor should the covering of the hoof be allowed to be rasped away, as it destroys the covering provided by nature as a protection against the too rapid evaporation of the moisture of the hoof, which causes the horn to become dry and brittle.

1553. When the foot has thus freedom to play with outside nailing, and the strain upon the nails by the expansion and contraction of the hoof removed, the shoe may be held in its place, as long as it should be at a time, with a much fewer number of nails than is the common practice. By a series of experiments conducted for years, with a number of horses doing both fast and slow work, Mr Miles has been enabled to demonstrate that 3 nails will keep on a shoe as firmly as 8, the common number. "Since the publication of the preceding edition of this treatise," observes Mr Miles, "I have had seven months' additional experience in the use of 3 nails, during the whole of which time all my horses have been shod with that number. . . . These last experiments are not recorded with a desire of inducing others to trust to such slender fastening; for, however desirable it may have been to ascertain with precision the smallest number of nails indispensable to the security of a shoe, it by no means follows that it is therefore either prudent or expedient to adapt it for general use. The chief value of such knowledge is the unanswerable argument it supplies against the supposed necessity for 7 or 8 nails. I do not know that any very great advantage is to be expected from 3 to 4 nails over 5, further than the confirmation of the valuable and important fact that a shoe can be securely retained by a few nails; and, that being the case, the fewer we employ, in reason, the better, because, the smaller the number the larger the intervening space of sound horn to nail to at the next shoeing." The practical conclusion I would draw from all that has just been said on this interesting and important subject, is, that 5 nails are sufficient for a saddle-horse, and 4 quite so for a farm-horse in the fore feet, 1 inside the toe, 3 outside, the quarters being free.

1554. In illustration of the nailing, fig. 120 represents a foot shod with 5 nails, where 4 are

Fig. 120.

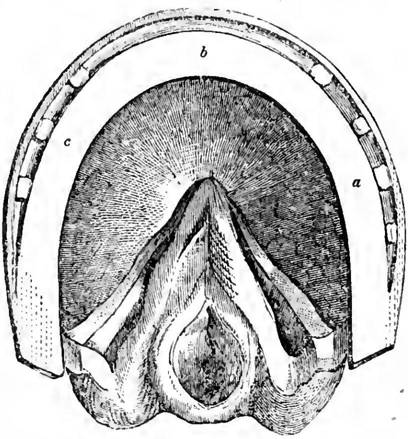


SHOEING THE FORE-FOOT WITH FIVE NAILS.

spread over the outside crust at *a*, from the vicinity of the toe *b* to near the heel, and 1 is placed in the vicinity of the toe in the inside crust at *c*, leaving the entire space from it to the heel free. The small turn up clip on the shoe is shown at *b*. The fullering is carried down to the heels, but not across the toe.

1555. In comparison with this nailing, fig. 121 is given to show an ordinary mode of nailing with

Fig. 121.



SHOEING THE FORE-FOOT WITH SEVEN NAILS.

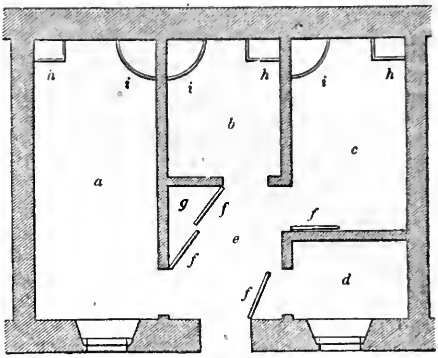
7 nails, 4 in the outside at *a* and 3 in the inside crust at *c*, dispersed equally over both the outside and inside quarters, with the fullering carried round the toe *b*, and terminating at each quarter, while the heels of the shoes expose the angles formed by the crust and bars of the foot.

1556. With respect to the hind foot, Mr Miles' experience recommends the employment of 7 nails for security, 4 in the outside and 3 in the inside crust, with the latter placed closer and as far removed from the quarter as possible. Instead of the mischievous practice of turning down the outer heel of the shoe, to throw an uncomfortable strain upon the fetlock joint alone, he recommends the hind shoes for saddle and harness horses to be made thicker for the last two inches towards the heels, the last inch being flush with the ground to prevent strain upon the back sinews when the horse is suddenly stepped with his hind foot far under him, as when he has to hold back against a steep hill. For this last reason, calkins, if both turned down equally, which they seldom are, may be useful to farm horses that are much upon the road; but if much at home, thick heels to the hind shoes will suffice for this purpose. Clips, however, on the toes of the hind shoes will tend much to keep the shoes secure in their place, and ease the pressure on the hind heels in going down hill with a load.

1557. In connexion with the proper shoeing of the foot is the nature of the accommodation afforded the saddle-horse for giving the hoofs of his feet liberty to expand and contract; and such liberty can only be awarded him, off the road, in a loose box instead of a stall. Mr Miles' observations on this subject at once show the utility and rationale of employing loose boxes instead of stalls. "The almost perpetual movement of a horse in a state of nature, while grazing, greatly tends to preserve the different elastic parts of his foot in a sound and healthy condition, by the regular compression and expansion they undergo, according as his weight is thrown upon or removed from them; but if we chain him to a post for twenty-two out of every twenty-four hours, we can scarcely wonder that so unnatural a proceeding should derange an organ that requires motion to preserve it in health. . . . . Let us see how loose boxes are to prevent evils. When a horse is free to move, he very rarely remains long in the same place or the same position; he is perpetually turning himself about, either to catch a distant sound, or observe an approaching footstep,—every thing attracts him, every thing interests him; and, what is of far greater moment, every thing causes him to *move*, whereby each foot is benefited to the extent of some four or five expansions and contractions, and the sound of the corn-bin at feeding time will produce at least fifty such. It is far otherwise with the poor beast chained up in a stall: he is attracted by the same sounds, hears the same step approach, and feels the same interest; he pricks his ears, bends his head, and strains his neck! but, alas, he does not move,—his feet are not expanded,—turning about he knows to be impossible, and therefore he does not attempt it. Even the sound of the corn-bin, though it excite him to jump and play, will scarcely cause him to expand his feet: the excitement inclines him to rush forward, while the wall forbids him to comply, and he is forced to collect himself, so as to throw his weight on his hind quarters, almost to the entire exclusion of the fore feet. Horses accustomed to a loose box generally acquire a slow deliberate movement in it, allowing their weight to dwell evenly and fully upon each fore foot; whilst those kept in the stalls for the most part move in it with a quick, sudden, catching motion, scarcely ever intrusting their whole weight to either foot for more than a moment." Loose boxes are not so useful to farm as to saddle horses, as they have regular exercise every day, and they consequently have more need of rest than of motion in the stable.

1558. Fig. 122 gives a very convenient arrangement of such loose boxes, where *a* is a large one, 18 feet by 8 feet, for a large harness horse, or a mare with a foal for a time; *c* is the next largest, 13 feet by 8 feet; and *b* is the smallest one, 10 feet by 8 feet; *h* are the corn mangers; *i* the hay racks; *d* the harness-room, 8 feet by 5 feet, with a window; and *g* a space to contain the pails, fork, shovel, and broom. The doors of the loose boxes, and the outer door *f f*, are so made to open as to leave a clear passage *e* for the horses to go out and come in with freedom; while the door of the harness-room and the various utensils are covered by these doors, and placed out of reach of the horses. The partition-walls between the horses should be made of brick, and lined with deal 4 feet high, and carried to 6 feet at the hay-racks, and iron rails should surmount the walls to the height of 8 feet. The rails separate, while they allow the horses to associate.

Fig. 122.

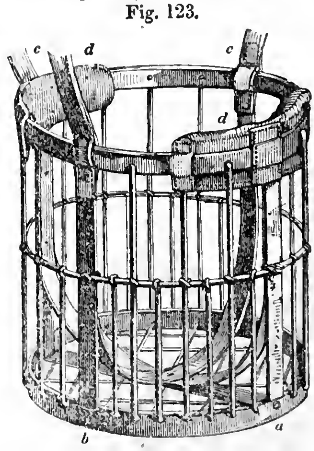


PLAN OF LOOSE BOXES FOR SADDLE-HORSES.

1559. Objections have been made against loose boxes, on the ground that they occupy much larger space than stalls; but this objection should bear little weight in a set of offices in the country, where space is no object. It is also said that horses are always dirty in loose-boxes, by their moving about casting up dust, and lying down upon their own dung. Such an objection is most likely to be urged by an indolent country groom. They are also said to allow foul-feeding horses to eat their litter. This is true, but any horse can be prevented doing so by means of a muzzle.

1560. A light muzzle of iron is given by Mr Miles, as in fig. 123, the construction of which

Fig. 123.



THE HORSE MUZZLE FOR SADDLE-HORSES.

explains itself, the frame-work *a b* being made of flat iron rod, supported with iron-wire, and the muzzle is suspended from the horse's head by means of leather straps *c c*; the nose and jaws being protected by cushion *d d*. "It is not necessary," says Mr Miles, "that the head should go farther into it than three inches above the angle of the mouth; but it is essential that the bottom of the muzzle should hang fully three inches below the lips, because the horse is thus obliged firmly to deposit the muzzle before he can be able to reach the bottom of it with his lips, in doing which the weight of the muzzle, and the pressure thus made upon it, will effectually flatten the straw out of his reach; and, by disappointing his hopes, soon cause him to discontinue his fruitless efforts. But if the bottom of the muzzle be brought tight up against the lips, the head and muzzle will act together, and the horse will eat just as much of his bed as he pleases. Its whole utility depends upon the horse's nose being so free of the muzzle that he shall not be able to reach any part of it with his lips without putting it down, when he instantly defeats his object." * With such an instrument as this muzzle, any horse may be prevented eating the litter in a loose-box.

1561. The horse having liberty to move freely about in a loose box, it is necessary that its floor be level and smooth, entirely free from inequalities. Common causewaying is neither even nor smooth. A pavement of flags makes a floor both even and smooth; but it is very hard, not yielding in the least to the weight of the horse's foot. It would be desirable could a substance be found to make a floor even, smooth, and elastic, and such a substance is India rubber pavement, which has already been described (1121.)

1562. The saddle and harness horse are subject to all the diseases incidental to the farm horse, and to many more, from which the latter is almost always exempt. The parts of the body of the saddle horse and harness horse most susceptible of disease are the feet and legs, and the diseases affecting these arise from the peculiar treatment received by the horse, whether from *idleness, or excess of work.*

1563. When a horse obtains more rest than his work requires, he is idle. Absolute idleness is, when he suffers close confinement in a stable or loose-box. He soon becomes weak, fat, short-winded, and stiff. If well fed, he may retain health and spirits two or three months; but in this time he almost loses the use of his legs, and his skin becomes foul and itchy. "I am unable to say," observes Stewart, "how soon absolute repose will entirely destroy working condition. The time must vary with the horse's employment and the manner in which he is fed. Those of slow work may suffer confinement for six or eight weeks before they become as feeble as idleness can make them. If half starved, or fed so poorly that the horse loses flesh, less than a month will produce the effect. If fully fed, he accumulates a load of fat, which makes him weaker than idleness with moderate feeding would make him. Fast workers lose their condition much sooner; one week of superfluous rest impairs the condition of a hunter; he loses wind, but he is still able for much work. To destroy his condition entirely, he would in most cases require about four weeks of close confinement; some would need less, and some would perhaps retain a portion of their condition nearly eight weeks. A great eater degenerates fastest. Comparative idleness is that in which the horse gets exercise, or perhaps some work, yet not sufficient to maintain his condition. The owner may not use him oftener than once or twice a fortnight, and he receives exercise from a groom in the intervals. Horses kept for work of this kind rarely have good grooms to look after them. They are generally in the charge of men who seem to think exercise is of no use but to keep the horse in health. A daily walk, with a smart trot, will keep the horse in condition for moderate work; but if the owner ride or drive fast and far, and at irregular intervals, as much exercise as keeps the horse in health is not sufficient. Every second, third, or fourth day, the exercise should resemble the work. The horse should go nearly, or quite as far, and as fast, as the owner usually rides him. It may be too much to do every day, or every second day; but, keeping always within safe bounds, the horse should have work or exercise equal to his work, at regular intervals. Many people work a horse on Sunday, as if they thought six days of idleness should enable him to perform a week's work in one day. When the horse has much to do on Sunday, he should in general do nearly as much on Wednesday, and on other days he may have walking exercise.

1564. A single day of *severe exertion* may destroy the horse's working condition. His *lungs* may be injured, a disease may succeed, and require many days to cure it. Between the disease, the cure, and the idleness, the condition may be wholly gone before any thing can be done to keep or restore it. This is termed over-working, and is not the excess I here mean. That to which I allude is not the excess of one day. The horse may perform the work for several days, or even weeks, quite well, yet it may be too much to be done long. One of two things will happen, or both may occur together. The horse will lose flesh and become weak, or his legs fail, and he will become lame. Emaciation, the loss of flesh from excess of work, is easily explained. The work is such as to consume more nutriment than the digestive apparatus can supply. The horse may have as much of the best food as he will eat, yet the power of the stomach and bowels is limited. They can furnish only a certain quantity of nutriment. When the work demands more, it is procured from other parts of the body. The fat, if there be any, is consumed first; it is converted into blood; a little is taken away every day; by and by it is all removed, and the horse is lean. Should the demand still continue, other parts are absorbed; the cellular tissue, and ultimately every particle of matter which the system can spare, is converted into nutriment. When the whole is consumed, the supply must be wholly furnished by the digestive apparatus; and if that were unable to

* Miles *On the Horse's Feet*, 6th edition, p. 14, *et seq.*—a valuable practical work, every sentence of which being the result of extensive experience, carries conviction of the sentiments of the author to the mind of the reader.

meet the demand at first, it is still less able now. By this time the horse is very lean: his bones stare through the skin, he is spiritless, stiff and slow, and his belly is tucked up almost to his back-bone. The horse becomes unfit for work. Rest and good food soon restore him; but if the work be still exacted, the solids and fluids change, the system falls into decay, and a disease, such as a common cold, or the influenza, from which a horse in ordinary condition would soon recover, produces in this worn-out animal *glanders* or *farcy*. Work is sometimes exacted till the horse is ruined: but the owner rarely escapes, for when glanders once appears, it seldom stays where it begins. General stiffness usually accompanies emaciation. When first taken from the stable, the horse seems to be stiff all over: he obtains greater freedom of motion after he is tolerably well warmed by exertion; but he never has great speed. In racers and hunters, the extent of stride is perceptibly contracted towards the close of their working season. They are termed *stale*, and require some repose, and green meat or carrots, and sometimes a little physic to *refresh* them.

1565. The *legs* are often so ill formed, that they fail without excess of work. But fast paces, long journeys, and heavy weights, ruin the very best. A single journey may produce lameness; it may give the horse *sparin*, or *grogginess*, or some other lameness may be the result of one day's work. But this is more than excess. The horse may have to perform it twice or thrice in his lifetime, but if it be such as to make him lame, it is too much to form regular work. The excess to which I allude does not produce lameness till after the horse has done the journey several times in succession. When in two or three he becomes lame, it is high time to make arrangements for preventing more. The distance may be shortened, the draught or weight lightened, or the pace retarded. The legs often show that the work is in excess, though the horse may not be lame. The fore legs suffer most, but the hind are not exempt. When there is much up-hill work, or much galloping, the hind fail as often as the fore. The pasterns become straight, and, in extreme cases, the fetlock joint is bent forward: this is termed *knuckling-over*. At a later period, the knees bend forward. The whole leg is crooked, deformed, tottering. Besides these, the legs become tumid, round, puffy. There is a general tumefaction, and the legs are said to be *gourdy*, *fleshy*, or *stale*. The deformity produces unsteadiness of action; the limbs tremble after the least exertion, and the horse is easily thrown on the ground. The tumefaction produces a tendency to *cracked heels* and to *grease*. Sometimes the pasterns descend backward, instead of inclining forward. Very often the back tendons suffer enlargement, which, in some cases, depends entirely upon accumulation of the fluid by which they are lubricated, not upon any enlargement of the tendons themselves. The back and fetlock joints are always large and puffy. These enlargements are termed *wind-galls*, *bog-sparin*, and *thorough-pin*. They are little bags containing joint-oil, which prevents friction. Rapid and lasting motion increases the quantity of the fluid, and dilates the bags which contain it. The legs of racers and hunters are always more or less the worse of wear towards the close of their working season. If these horses were wanted all the year through, the legs would demand rest, though the body might not. Hunters rest all summer, racers all winter, and during repose their legs regain their original integrity and form. The legs of horses are very differently constructed. Some are so well formed that they suffer a great deal before they begin to fail; others are so defective that they will not stand hard work. With racers and hunters, much may be done to save them: fomentations, hand-rubbing, and bandages, are of much service after severe work, but they require too much time and attendance to be employed for inferior horses. It is the fashion at present to dispense with breech-bands; and where the road is pretty level, or the carriage light, they are of little use. But it seems to me they have been too generally discarded. Without breech-bands, the whole weight of the carriage in going down hill is thrown upon the neck, and from the neck to the fore-legs. Hilly ground is destructive to both fore and hind legs, but the fore ones always fail first.

1566. The *feet* are often injured by excess of work. The fore-feet are liable to one disease, which has been emphatically denominated 'the curse of good horses.' I mean the *navicular disease*, or *grogginess*. It is very common among all kinds of fast workers. Bad shoeing, neglect of stable care to preserve the feet, hard roads, and various other agents, have been blamed for producing it. But it seems to me the most common and the most certain cause has been too little considered. Long journeys at a fast pace will render almost any horse groggy. Bad shoeing and want of stable care both help, but I am sure they *alone* never produce grogginess. The horse must go far and fast: if his feet be neglected, or bad shoeing, a slower pace and a shorter distance will do the mischief; but I believe there is nothing in the world will make a horse groggy, except driving him far enough and fast enough to alter the synovial secretion of the navicular joint. Cart horses are quite exempt; those working in the omnibuses, always on the stones, and often at 10 miles an hour, but never more than a mile without stopping, are nearly exempt. The horses most liable are those which work long and fast. *Founder* is sometimes, though very rarely, the result of excessive work, but in most, if not in every case, there is also some error in feeding or watering in operation at the same time. Of all these evils, it most frequently happens that the horse is affected in more ways than one. In general, emaciation, stiffness, and staleness of the legs, go together.

1567. Horses that are doing full work, as much as they are able to do, can hardly have an excess of food. Some kinds of work, such as that given to mail and stage horses, require an unlimited allowance. If the horse have good legs, or legs equal to the pace, distance, and weight, he cannot perform all the work of which he is capable without as much corn as he will eat. But there are some kinds of work, such as racing and hunting, and especially steeple-chasing, which are so injurious to the legs that long intervals of repose are necessary—sometimes eight or ten days must elapse before the horse can repeat his task. In this time, a great eater will become fat and short-winded upon a full allowance of food, or his skin will itch and rise in pimples. In such a case, bran mashes or a few carrots should be given now and then, instead of corn. Alteratives, diuretics, and suchlike evacuants, may be given; but I think more economy in the distribution of food would render them less necessary. Deficiency of food impairs condition much sooner, and more certainly, than excess. It produces emaciation and stiffness, dulness and weakness, in less time than excess of work. The food is deficient when the horse loses flesh, and gets less corn than he could eat. The work is in excess when he loses flesh, and has all the corn he will consume."*

1568. You thus clearly perceive that, as regards the saddle and harness horse, idleness, excess of work, excess of food, and deficiency of food, are one and all fruitful sources of disease, affecting both the legs and feet, and the hind-legs as well as the fore.

1569. *Trimming the heels.*—Cart-horses, however much hair they may have on the heels, are never trimmed; blood-horses never require trimming; and saddle-horses, having now more blood in breeding than formerly, their heels are not so rough, and do not require so much trimming—so that trimmed heels are rarely to be seen. Nevertheless, it may be necessary to make a few remarks on the effects of trimming on the constitution of the horse.

1570. "There has been considerable difference of opinion," observes Mr Stewart, "as to the propriety of trimming the heels. Some contend that the long hair soaks up the moisture, keeps the skin long wet and cold, producing grease, sores, cracks, and scurfiness. By others this is denied: they affirm that the long hair, far from favouring the production of these evils, has a tendency to prevent them. But there is another circumstance to be taken into consideration, and that accounts sufficiently for the difference of opinion. When the horse is carefully tended after his work is over, his legs quickly and completely dried, the less hair he has about them the better. The moisture which that little takes up can be easily removed; both the skin and the hair can be made perfectly dry before evaporation begins, or proceeds so far as to deprive the legs of their heat. It is the cold produced by evaporation that does all the mischief, and if there be no moisture to create evaporation, there can be no cold, no loss of heat save that which is taken away by the air. If there were more hair about the heels, they could not be so soon nor so easily dried. If the man requires ten minutes to dry one leg, the last will have thirty minutes to cool; if he can dry each in two minutes, the last will only have six minutes to cool, and in that time cannot become so cold as to be liable to grease. Whenever, therefore, the legs must be dried by manual labour, they should have little hair about them. . . . . During two very wet winters, I have paid particular attention to the subject; my practice has brought it before me, whether I would or not; I have had opportunity of observing the results of trimming and no trimming among upwards of 500 horses. Nearly 300 of these are employed at coaching and posting, or work of a similar kind, and about 150 are cart-horses. Grease, and the other skin diseases of the heels, have been of most frequent occurrence where the horses were both trimmed and washed; they have been common where the horses were trimmed, but not washed; and there have been very few cases where washing and trimming were forbidden or neglected. I do not include horses that always have the best of grooming; they naturally have little hair about the legs, and some of that is often removed; their legs are always washed after work, but they are always *dried before they have time to cool.* If, then, the horse have to work often and long upon wet or muddy roads, and cannot have his legs completely dried immediately after work, and kept dry in the stable, and not exposed to any current of cold air, he must not have his heels trimmed. In most well regulated coaching stables, this operation and washing are both forbidden."†

1571. The saddle and harness horse is subject to many complaints of the legs and feet. It is not my province to treat of all these fully. Suffice it to nominate the most common complaints in those members, and you may consult the works of veterinarians on their origin, symptoms, and treatment.

1572. In the fore legs and feet are oone-spavin mallenders, founders, grogginess, broken-knees, sprains, wind-galls, corns, sand-cracks, quitters, ring-bone, laminites, navicular disease, contracted hoof.

1573. In the hind-legs and feet, spring-halt, curb, knapped hough, sprains, bone-spavin, bog-spavin, thorough-pin, sallenders.

ON THE FATTENING OF SWINE IN WINTER.

1574. There should be no litter of young pigs in winter on an ordinary farm, because young pigs are very susceptible of cold; and as a chance of being exposed to it will frequently occur in the most comfortable sty, it is scarcely possible to avert its injurious effects—which are, reddening of the skin, staring of the coat, and, if not actually killing, chilling them

* Stewart's *Stable Economy*, p. 378-84.

† *Ibid.* p. 113.

to such a degree as to prevent their growth until the return of a more genial temperature in spring. If circumstances, however, render it profitable to raise sucking pigs at Christmas,—and a roast pig at that merry season is a favourite dish in England, — the matter may be accomplished as easily as the raising of house lamb, by having sties for the sows under a close roof, with doors and windows to shut out cold and admit light.

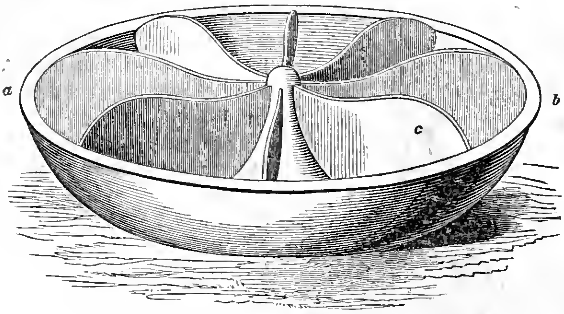
1575. But as few pigs are so accommodated, the usual practice is the best, of refraining from the breeding of young pigs in winter, and of letting those which are able to provide for themselves have the liberty of the courts; but still that liberty should be guarded with discretion. Of several litters on foot at the same time, the youngest should receive more nourishing food than the older; and the reason for giving them better treatment is founded on the general principle, that creatures when stinted of food, so long as they are growing to the bone, never attain the largest size of frame they are capable of. Those growing to the bone, until it is capable of carrying as much flesh as is best suited to the market, need not be fattened. Those which have attained the full size of bone require but a short time to fatten into a *ripe* state. This mode of treatment, which delays the *fattening*, is peculiarly applicable to swine, which, having at all times a ready disposition to fatten, can be made to lay on *fat* almost to any degree, at any time, at any age, and upon any size of bone.

1576. That the youngest pigs may receive better treatment, they should have a court and shed for themselves. These pigs consist, probably, of the last litters of the season of as many brood sows as are kept. Here they should be provided daily with turnips as their staple food—of the sort given for the time to the cattle, and sliced as small as for sheep; and they should, besides, have a portion of the warm mash made for the horses, with such other pickings from the farm-house which the kitchen affords. They should also be provided with a trough of clean water, and plenty of litter under the shed every day. Their court-yard should be cleaned out every day. Pigs are accused of dirty habits, but the fact is otherwise; and the accusation really applies more to their owners, who keep them dirty, than to the animals themselves. When constrained to lie amongst dirt, and eat food only fit for the dunghill, and dealt out with a grudging hand, how can they exhibit other than dirty propensities? But let them have room, choice of clean litter, and plenty of food, and they will soon be seen to keep their litter clean, place their droppings in one corner of the court, and preserve their bodies in a wholesome condition. It is the duty of the cattle-man to supply the store pigs with food, and clean out their court-yard; and this part of his duty should be conducted with as much regularity as the feeding of the cattle. Whatever food or drink may be obtained from the farm-house is brought to their court by the dairy-maid.

1577. The older pigs have the liberty of the large courts, amongst the cattle, where they make their litter in the open court, when the weather is mild, and in the shed when it is cold. Though thus left at liberty, they should not be neglected of food, as is too often the case. They should have sliced turnips given them every day, in troughs, and they should also have troughs of water. Pigs, when not supplied with a sufficiency of food, will leap into the troughs of the cattle, and help themselves with turnips; but such dirtying of the cattle's food and troughs should not be tolerated, and it arises from their keeper neglecting to give the pigs food. The cattle-man attends upon those pigs, and should give them turnips and water at regular times.

1578. I have seen in England a handsome pigs' trough adapted for standing in the middle of a court. It consists of cast-iron in one entire piece, and is represented in perspective by fig. 124. Its external appearance, when viewed as it stands on the ground, approaches to that of a hollow hemisphere, with the apex flattened; and interiorly the flattened part rises up in the centre, in the form of a central pillar—thus converting the hemisphere into an annular trough, whose transverse section presents two troughs in the form of two semicircles conjoined. The diameter *a b* of this trough is 30 inches, the edge is finished with a round baton, serving both for strength and for comfort to the animals who eat out of it; the depth is about 9 inches, and it is divided into 8 compartments by the divisions *c*, which are formed with a convexity on the upper edge, to prevent the food being thrown from one compartment into the other. This trough stands upon

Fig. 124.



THE RING PIGS'-TROUGH, TO STAND IN A COURT.

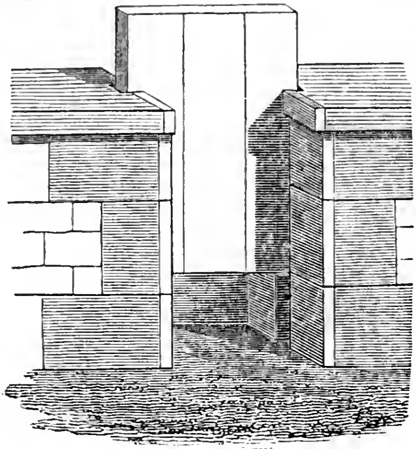
the top of the litter, is not easily overturned,—the cattle cannot hurt themselves upon it,—while it is easily pushed about to the most convenient spot for it to stand.

1579. It is seldom that farmers take the trouble of fattening pigs for the market, because, if the breed has a kindly disposition, the pigs are generally sufficiently fat for converting into pickled pork by the time they have attained the weight most desirable for that method of curing,—namely, from 4 to 6 stones imperial. Dealers and butchers purchase porklings of those sizes; and finer meat of the kind cannot be obtained than what is thus brought up at liberty in a farm-yard, being firm, sweet, tender, well proportioned in lean, and sufficiently fat for the table. Pork-curers buy from farmers and dealers in the carcass, and none alive. But the farmer should once a-year fatten a few pigs for his own use as ham. These should be at least a-year old, attain the weight of 18 or 20 stones, and be slaughtered about Christmas. Castrated males or spayed females are in the best state for this purpose; and are placed in separate sties. Four pigs of 20 stones each every year, will supply a pretty good allowance of ham to a farmer's family. Up to the time of being placed in these sties, the pigs have been treated as directed above; but when confined, and intended to be fattened to ripeness, they receive the most nourishing food.

1580. Piggeries or pig-sties are highly useful structures at the farm-stead. They are of three kinds—1. Those for a *brood-sow with a litter of young pigs.* This kind should have two apartments: one for the sow and litter to sleep in, covered with a roof, and entered by an opening; the other an open court, in which the feeding-trough is placed. For a breeding-sty each apartment should not be less than 6 feet square. 2. Those for *feeding pigs.* These should also have two apartments: one with litter for sleeping in, covered with a roof and entered by an opening; the other an open court for the troughs for food. A sty of 4 feet square in each apartment, will accommodate 2 feeding pigs of 20 stones each. These two sorts of sties may each have a roof of its own, or a number of them may have one roof over them in common. The former is the common plan; but the latter is the most convenient for cleaning out, and inspecting the internal condition of the sties, and the state of the pigs. 3. The third kind of sty is for the accommodation of weaned young pigs, when they are confined, to receive better treatment than the older ones. It should have a shed and court of from 20 to 25 feet square.

1581. As swine have very powerful necks, and are apt to push open doors of common construction, a form of one such as is represented in fig. 125 is very secure. The door slips up and down in grooves in the masonry, and the contrivance is such as to elude the ingenuity of the most

Fig. 125.

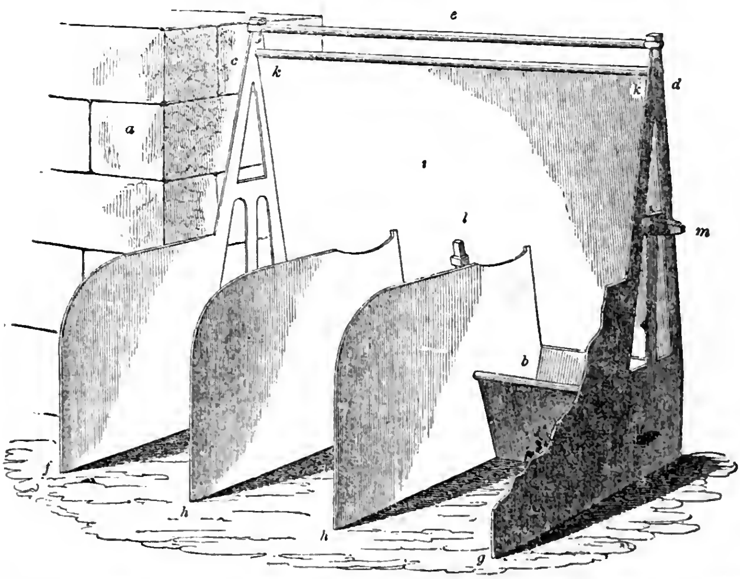


DOOR FOR A PIG-STY.

cunning old brood-sow to discover a mode of escape.

1582. A very convenient trough for a piggery containing a number of pigs—such as the young ones, as above, or others confined in summer from roaming about—has been long manufactured by the Shotts Iron Company, of which fig. 126 is a view in perspective from the interior of the court. It is nearly all made of cast-iron, and possesses the great convenience of allowing the troughs to be filled with food from the outside of the building, the feeder being at the same time free of any annoyance from the inmates. Troughs of this kind are placed in proper sized openings in the external wall of the piggery court, in the manner shown in the figure, where *a* marks the wall on one side of the opening—that on the hither side being left out of the figure, in order to exhibit the form of the trough. The trough, part of which is seen at *b*, is 4 feet in length, 16 inches wide at top, and 8 inches at bottom, and is 9 inches deep. The two ends *c* and *d* rise in a triangular form to the height of 3½ feet, and are connected at the top by the stretcher-bolt *e*. The lower part of each end extends inward to *f g*, making a breadth of 3 feet 4 inches when complete; but this part of the end *g* in the figure is broken off, to show part of the trough *b*. Two intermediate divisions *h h* divide the trough into 3 compartments—these divisions extend to the same length as the ends *f g*, and are all 21 inches in height. By means of these divisons, each animal, when there are more than one together, has its own stall, and can take its food undis-

Fig. 126.



THE PIGS' TROUGHS, WITH SUBDIVISIONS, TO STAND IN AN OPENING OF THE OUTER WALL OF THE STY.

turbed by its neighbours. A swing-door *i* is jointed on the pivots *k k*, to complete the form, by filling up the opening of the wall. In the figure this door is thrown to the full extent outward, where it always stands during the time the animals are feeding, and is fixed there by a slide-bolt on the outside. When food is to be introduced the bolt is withdrawn, and the door moved from that position to *l*, and there bolted until the compartments of the trough are cleaned and filled, when the door is again swung back to its original position, and the food is placed before the animals. The door has slits formed in it corresponding to the divisions *h h*, to allow of its swinging freely, and yet have depth sufficient to close the entire opening down to the outward edge of the trough. A dowel or stud *m* is let into the wall at each end, to secure the upper part of the trough. On several visits to the Duke of Buccleuch's home-farm at Dalkeith Park, which is conducted by Mr Black, I have been much interested with the piggery, where the stock is of the finest quality, and, amongst other things of interest, saw what is very probably the original of the trough here described. The troughs in this piggery are composed of wood, but precisely on the same principle as here figured and described, and their introduction there dates as far back as the time of the late Duke Henry of Buccleuch, whose invention they are supposed to be, and which must be at least more than 40 years' standing.

1583. By direct experiment, it has been ascertained that pigs fatten much better on cooked than on raw food. This being the case, it is only waste of time and materials, as also loss of flesh, to attempt to *fatten* pigs on raw food of whatever kind; for although some sorts of food fatten better than others in the same state, yet the same sort, when cooked, fattens much faster and better than in a raw state. The question, therefore, simply is—what is the best sort of food to *cook* for the purpose of *fattening* pigs? Roots and grains of all kinds, when cooked, will fatten pigs. Potatoes, turnips, carrots, parsnips, mangold-wurtzel, as roots; and barley, oats, pease, beans, rice, Indian corn, as grain, will all fatten them when prepared. Which, then, of all these ingredients should be selected as the most nourishing, and, at the same time, most economical? Carrots and parsnips amongst roots are not easily attainable in this country, and therefore cannot be regarded economical food; and as to the other sorts of roots, when cooked, potatoes doubtless contain more nourishment than turnips, even in proportion to their former prices—for it was as easy to obtain 10s. for a ton of swedish turnips as 8s. for a boll of 40 stones of potatoes; and yet potatoes contained solid matter in the proportion of 25 to $10\frac{1}{2}$ as regards turnips. It is now, however, questionable whether potatoes can be depended on as a crop at such a price as to fatten pigs on economically. But mangold-wurtzel presents properties for supporting animals which are worthy of attention. It contains 15 per cent of solid matter, potatoes having 25 per cent; but it contains a larger proportion of the protein compounds —those ingredients which supply the materials of muscle, than potatoes. Thus they contain respectively, when dried at 212° Fahr.:—

	Portein compound.	Other nutritive matter.
The dried potato .	8 per cent.	82
... ... yellow turnip	$9\frac{1}{4}$	80
... ... mangold-wurtzel	$15\frac{1}{2}$	75

So that the proportion of the protein compounds in the mangold-wurtzel is nearly twice as great as in the potato. "This is a very important fact," observes Professor Johnston, "and worthy of further investigation. If, as at present supposed, the protein compounds serve the purpose, when eaten, of supplying to animals the materials of their muscle, the mangold-wurtzel ought to be considerably superior in this respect to the potato. Even in their natural state this should be the case, for 100 lbs. of mangold-wurtzel contain of these protein compounds, according to the above determination, $2\frac{1}{4}$ lbs.; while the potato contains, on an average, only 2 lbs."* As to grains, I have never heard of wheat or wheat-flour being given to pigs—it would certaily not be economical—barley or oat-meal being usually employed. Pease and beans, whether raw or cooked, are proverbially excellent food for pigs.

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 916.

And as to rice and Indian corn, they will both fatten well if cooked. Amidst all these ingredients for choice, regarding the question of economy alone, it may be assumed that entire feeding on grain, of whatever kind, would be too expensive; so that as boiled roots are of themselves nourishing food, a proportion, with any of the grains, should form a moderately priced food which will insure fatness. It has been ascertained in England, that 2 pecks of steamed potatoes, mixed with 9 lbs. of barley-meal and a little salt, given every day to a pig weighing from 24 to 28 stones, will make it *ripe* fat in 9 weeks. Taking this proportion of food to weight of flesh as a basis of calculation, and assuming that 2 months will *fatten* a pig sufficiently well, provided it has all along received its food regularly and fully, I have no doubt that feeding with steamed potatoes and barley-meal, for the first month, and in the second with steamed potatoes and pease-meal, (both seasoned with a little salt,) and lukewarm water, with a little oatmeal stirred in it, given by itself twice a-day as a *drink*, will make any pig, from 15 to 30 stones, *ripe fat for hams*. The food should be given *at stated hours*, 3 times a-day—namely, in the morning, at noon, and at nightfall. One boiling of potatoes, or turnips, where these are used, in the day, at any of the feeding hours found most convenient, will suffice; and at the other hours the boiled roots should be heated with a gruel made of barley or pease-meal and boiling water—the mess being allowed to stand a while to incorporate and cool to blood-heat. It should not be made so thin as to spill over the feeding-trough, or so thick as to choke the animals; but of that consistence which a little time will soon let the feeder know the pigs best relish. The quantity of food given at any time should be apportioned to the appetite of the animals fed, which should be ascertained by the person who feeds them; and it will be found that less food, in proportion to the weight of the animal, will be required as it becomes fatter. It is the duty of the dairy-maid to fatten the bacon-pigs, and that of the cattle-man to keep them clean and littered.

1584. Washing pigs with warm water and soap rapidly promotes their fattening; and, after the first trial, they delight in the scrubbing.

1585. When pigs are fattening they lie, and rest, and sleep a great deal, no other creature showing "love of ease" so strongly in all their actions; and, in truth, it is this indolence which is the best sign of their thriving condition. The opposite effects of activity and indolence on the condition of animals is thus contrasted by Liebig:—"Excess of carbon," says he, "in the form of fat, is never seen in the Bedouin or in the Arab of the desert, who exhibits with pride, to the traveller, his lean, muscular, sinewy limbs, altogether free from fat. But in prisons and jails, it appears as a puffiness in the inmates, fed as they are on a poor and scanty diet; it appears in the sedentary females of oriental countries; and, finally, it is produced under the well-known conditions of the fattening of domestic animals;"* and, amongst these last, the pig may be instanced as the most remarkable.

1586. In some parts of England, as well as on the Continent, such as Holstein, the food given to pigs is always in a sour state. Arthur Young recommends the construction of tanks, for the express purpose of containing mixtures of 5 bushels of meal to 100 gallons of water until they become acid, and says they are not ready to be given until in that state. "Two or three cisterns," he says, "should be kept fermenting in succession, that no necessity may occur of giving it not duly prepared. The difference in profit between feeding in this manner, and giving the grain whole or only ground, is so great that whoever tries it once will not be apt to change it for the common method." The acid thus produced by the fermentation of vegetable matter is the lactic acid. It is not deemed necessary in Scotland to make the food of pigs acid; and although pigs no doubt do relish an acid diet, it does not follow it should necessarily be in that state to render it the more wholesome. But he seems to entertain some doubt on the subject, for he says,—"Pease-soup, however, is an excellent food for hogs, and may, for what I know—but I have not suffi-

* Liebig's *Animal Chemistry*, p. 89.

ciently compared them—equal the above, especially if given in water milk-warm." After mentioning that the food of pigs is warmed in Gascony, and that the practice has long been discontinued in England, he gives it as his opinion that "warm food in water, regularly given, I should suppose, must be more fattening than that which is cold, and, in bad weather, half frozen."* In Mexico, pigs are fattened entirely on Indian corn moistened in water.

1587. The denominations of pigs are the following:—When new born, they are called *sucking pigs*, or simply *pigs;* and the male is a *boar pig*, the female *sow pig*. A castrated male, after it is weaned, is a *shot* or *hog*. Hog is the name mostly used by naturalists, and very frequently by writers on agriculture; but, as it sounds so like the name given to young sheep, (hogg,) I shall always use the terms pig and swine for the sake of distinction. The term *hog* is said to be derived from a Hebrew noun, signifying "to have narrow eyes," a feature quite characteristic of this species of animal. A spayed female is a *cut sow pig*. As long as both sorts of cut pigs are small and young, they are *porkers* or *porklings*. A female that has not been cut, and before it bears young, is an *open sow;* and an entire male, after being weaned, is always a *boar* or *brawn*. A cut boar is a *brawner*. A female that has taken the boar is said to be *lined;* when bearing young she is a *brood sow;* and when she has brought forth pigs she has *littered* or *farrowed*, and her family of pigs at one birth form a *litter* or *farrow* of pigs.

1588. Of judging of a fat pig, the back should be nearly straight; and though arched a little from head to tail, that is no fault. The back should be uniformly broad, and rounded across along the whole body. The touch all along the back should be firm, but springy, the thinnest skin springing most. The shoulders, sides, and hams, should be deep perpendicularly, and in a straight line from shoulder to ham. The closing behind should be filled up; the legs short, and bone small; the neck short, thick, and deep; the cheeks round and filled out; the face straight, nose fine, eyes bright, ears pricked, and the head small in proportion to the body. A curled tail is indicative of a strong back. All these characters may be observed in the figure of the brood sow in Plate V; though, of course, the sow is not in the fattened state.

1589. A black-haired pig is always black in the skin, and a white one white—which latter colour gives to it a cleaner appearance than the black.

1590. The breed which shows the greatest disposition to fatten is the pure Chinese; but as it lays on too large a proportion of fat, it is not bred for its own sake, and only for crossing with. I never saw a breed to equal that originated by the late Lord Western, in Essex, for laying on a due proportion of lean and fat, and I believe it to be a cross between the Essex and Chinese breeds. I received a present of a young boar and sow of that breed from Lord Panmure, and had the breed as long as I farmed; and such was the high condition constantly maintained by the pigs, on what they could pick up at the steading, besides the feed of turnips supplied them daily, that one could be killed at any time for the table, as a porkling. They were exceedingly gentle, indisposed to travel far, not very prolific, could attain, if kept on, to a great weight; and so compact in form, and small of bone and offal, that they invariably yielded a larger weight of pork than was judged of before being slaughtered. Though the less valuable offal was small, the proportion of loose seam was always great, and more delicious ham than they afforded was never cured in Westphalia.

1591. An experiment on the comparative advantages of feeding pigs on raw and boiled food was made in 1833 by Mr John Dudgeon, Spylaw, Roxburghshire. He put up 6 *he*-pigs in one lot, and 5 *she* ones in another, and they were all carefully *cut*, and 9 weeks old. The he-pigs were put on *boiled* food, namely, potatoes and hashed beans; the she ones on raw of the same sort. The 6 he-pigs increased in live-weight, from 2d July to 12th October, 38 stones, 6 lbs. 4 oz., or 6 stones, 5 lbs. 11 oz. each; whereas the 5 she ones only increased, in the same time, 17 stones, 11 lbs. 8 oz., or 3 stones, 7 lbs. 14 oz. each. Other 3 pigs were fed at the same time on boiled and raw food indiscriminately, as it happened to be

* Young's *Farmer's Calendar*, p. 518 and 560.

left over after serving the other two lots. The facts brought out in this experiment are, that the pigs "fed exclusively upon boiled meat did thrive in a superior manner to the others, and even to those which had an occasional mixture of raw and boiled meat; thus showing that boiled meat is at all times more nutritive than raw." The "pigs were repeatedly washed with soap and water, which refreshed them greatly, and caused them to relish their food." Those "which got a mixture of food both prepared and raw, approached nearer to those which were fed on boiled to their feeding properties; but they appeared occasionally shy at having their meat so mixed. It is therefore better, in general, to continue for some time only one description of food; as, whatever the animals become accustomed to they begin to relish, and thrive upon it accordingly."*

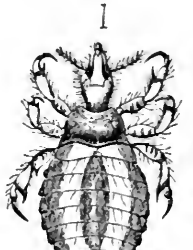
1592. Mr Robert Walker, Ferrygate, East Lothian, also made an experiment on the same subject in the same year. He put 5 pigs on steamed potatoes and prepared broken barley, and other 5 on raw potatoes and raw broken barley. The pigs were $2\frac{1}{2}$ months old. On the 4th March 1833, the live-weight of the 5 pigs fed on raw food was 7 st. 10 lbs.; on the 1st June following, it was 16 st. 13 lbs., showing an increase of 8 st. 3 lbs. or on each pig of 1 st. 9 lbs. On the 4th March the live-weight of those fed on steamed food was 7 st. 8 lbs., and on the 1st June it was 19 st. 13 lbs., showing an increase of 12 st. 5 lbs., or on each pig of 2 st. $6\frac{1}{2}$ lbs. The increase in the time was 67 lbs. more than double the original live-weight of the pigs fed on steamed food; whereas, in those fed on raw, the increase was only 7 lbs. more than the double; "so that there can be very little doubt," as Mr Walker concludes, "that steamed food is more profitable for feeding pigs than raw food. In fact, I do not think it possible to make pigs *fat* on raw potatoes, without other food, when confined to them alone."†

1593. The late Mr James Scott, Beauchamp, Forfarshire, on converting potatoes into tapioca, which he raised in great quantities on that large farm, used part of the refuse for his horses, and part, assisted by peas, for feeding pigs, to the number of 400 every year.

1594. Dairy farms are well suited for rearing pigs on the dairy refuse in summer; but in winter the most that can be done is to keep the brood sows in pig in fair condition for littering in spring. On carse and pastoral farms, no more pigs can conveniently be reared than to serve the farmer's family. On mixed farms, pigs constitute a portion of the regular stock.

1595. With regard to the *diseases* of swine, they are fortunately not numerous, as it is no easy matter to administer medicine to them. The safest plan, in most cases, I believe, is to slaughter them whenever any symptoms of internal disease show themselves. Swine are infested with a louse (*Hœmatopinus suis*,) like all domesticated animals. It was described by the old naturalists under the name of *Pediculus suis*. It is represented in fig. 127. Head and thorax of a dull rusty colour, the former pear-shaped and narrow, with an angular black line at the apex, and one on each side before the eyes; abdomen large, flat, and oval, of a bluish or yellowish ash-gray colour, most of the segments with a black horny prominence at each side, surrounding a white breathing-hole; legs pale ochre-yellow, the thigh marked with dusky bands; length $1\frac{1}{4}$ to $1\frac{3}{4}$ line. This species is generally very plentiful on swine, more particularly on those fresh imported from Ireland. It appears to abound most on lean animals. "In walking," says Mr Denny, "it uses the claw and tibial tooth with great facility (which act as a finger and thumb) in taking hold of a single hair; the male is much smaller, sub-orbicular, and the segments lobate. The egg or nit is $\frac{3}{4}$ of a line in length, of a cream colour, and elegantly shagreened, oblong, and slightly acuminated, surrounded by a lid which, when the young insect is ready to emerge, splits circularly—or, as a botanist would say, has a circumcisile dehiscence."‡ Oil in the first stage, and mercurial ointment in after stages, will destroy this insect.

Fig. 127.



THE SOW-LOUSE, (HŒMATOPINUS SUIS.)

1596. *Consumption* is a disease which affects pigs. It is brought on by "neglect and exposure to cold and damp. The animal becomes thin, the coat staring, the skin appearing as if glued to the ribs; obstinate cough supervenes; discharge is frequent from the nose, and glandular swellings appear about the neck. On dissection, the lungs are studded with tubercles." "It is in the early stage alone of the complaint," observes Professor Dick, "that any thing can be done, and the prospect of cure is but faint."§ In alluding to the lungs, I may mention a remarkable instance of their state I once observed in a sow of my own. She had borne several litters, and became asthmatic, which increasing so as to appear distressing to the animal, she was killed; and one lobe of the lungs was found to be so completely ossified, that its surface was converted into a shell nearly as hard as the crust of a crab, and was filled with a thick yellow fluid. Having understood afterwards that this was a remarkable case, I regret that the lobe was not examined by a veterinarian. I take this opportunity of suggesting to every farmer, who may happen to meet with an instance of structural

* *Prize Essays of the Highland and Agricultural Society*, vol. x. p. 275-9.
† *Ibid.* vol. x. p. 279-80.
‡ Denny's *Monographia Anoplurorum Britanniæ*.
§ Dick's *Manual of Veterinary Science*, p. 84.

disorganisation, whether external or internal, in a part of any animal he owns, to have it examined by a competent veterinarian.

1597. Pigs are subject to a cutaneous disease called *measles*, which is supposed to render the flesh unwholesome. "The measles," says a writer, "are very prevalent, though seldom fatal; and if not checked, affect the grain of the meat, which may be commonly seen in the shops of a faded colour, and the flesh punctured, as it were, with small holes, or distensions of the fibre. The commencement of the disease appears in languor and decline of appetite, followed by small pustules in the throat, together with red and purple eruptions, more distinct after death than during the life of the animal; but may, it is said, be removed in this stage by giving small quantities of levigated crude antimony in the food. Generally speaking, even if the animals be in health, a small quantity of nitre and sulphur, occasionally mixed up with their food, besides stimulating their appetite, will frequently prevent disease: neither can we too much insist on cleanliness, nor upon the punctual regularity of feeding at stated times."* The injunction contained in the last words, if followed, will do more for the preservation of health in pigs, than the administration of any specific after disease has once shown itself. I can truly say, that, with the simple means here enjoined, I never had a pig in the least affected in the skin by disease or vermin.

ON THE TREATMENT OF FOWLS IN WINTER.

1598. Of all the animals reared on a farm, none are so much neglected by the farmer, both as regards selection of their kind and disposition to fatten, as every sort of domesticated fowl. Indeed, the supposition that any farmer should devote a part of *his* time to the consideration of poultry, is regarded by him as an unpardonable affront on his manhood. Women only, in his estimation, are fit for such a charge—and doubtless they are, and would do it well too, were they not begrudged of every particle of good food they may bestow on poultry. The consequence is, as might be expected in every farmstead, the surprise to find a single fowl of any description in *good* condition—that is, such as it might be killed at the instant in a fit state for the table. The usual objection against feeding fowls is, that they do not pay—and no doubt the market price received for lean, stringy-fleshed, sinewy-legged fowls is far from remunerative; but whose fault is it they are sent to market in that state, but the rearer of them? and why should purchasers give a high price for fowls in such a condition? Some excuse might be made for having lean fowls, were any difficulty experienced in fattening them: but there is none; and the idea of expense is a bugbear, and, like all other fears, would vanish were a plan adopted for rearing fowls more consonant with common-sense than the one usually pursued, which seems to be founded upon the notion that fowls can never be ill off if they are at liberty to shift for themselves. Such a sentiment involves a grievous error in the rearing of any kind of live stock. Better keep no stock at all than rear them on such a principle. Fowls may be deemed a worthless stock, and so they generally *are*; but they are so only on account of the mode of managing them. Apart from every consideration of profit to be derived from sales in market towns, a desire should exist in the farmer to have it in his power, *at all times*, to present a well-fed fowl at his own table; but he cannot feel such a desire, while he grudges the food required to make them so. He may rest assured that economy would attend good feeding in the long run, as *good* poultry always at command would save a long butcher's bill now and then, which must be settled with cash—and *cash* cannot be commanded by the farmer except by sale at market of some commodity of the farm. Few farmers kill their own mutton, that is, keep fat sheep for their own use: lamb, they do kill in the season; but as to beef, it is always purchased—so that, situate as the farmer's family usually is, the produce of the poultry-yard and pig-sty should constitute the principal fare upon their board. And why should they not have these in the highest perfection?

1599. In winter, no fowls are brought forth in Great Britain. The climate is too severe for them; the cold would either kill chickens outright, or prevent their growth so as to render them unprofitable for the rearing they would require. None of the fowls lay many eggs in winter. But notwithstanding these natural barriers, both chickens and eggs may be obtained in that season by good management.

1600. The ordinary fowls on a farm are,—the cock (*Phasianus gallus*,)—the

* *British Husbandry*, vol. ii. p. 530.

turkey (*Meleagris gallopavo*),—the goose (*Anas anser*),—the duck (*Anas domestica*)—and the pigeon (*Columba livia*),—the white-backed or rock-dove, which was long confounded with the blue-backed dove (*Columba œnas*). In regard to all these, I shall first state their condition in winter, and then describe the mode in which they should all be fed on nearly the same ingredients.

1601. And first, in regard to the condition of the *hen*. As hatchings of chickens are brought out from April to September, there will be broods of chickens of different ages in winter—some as old as to be capable of laying their first eggs, and others mere chickens. The portion of the broods taken for domestic use are the young cocks and the older hens, there being a natural reluctance to kill young hens, which will lay eggs largely in the following season. At all events, of the hen-chickens, the most likely to become good layers should be preserved. The marks of a chicken likely to become a good hen are, a small head, bright eyes, tapering neck, full breast, straight back, plump ovoidal-shaped body, and moderately long grey-coloured legs. Every yellow-legged chicken should be used, whether male or female, their flesh never being so fine as the others. As to the colour of the feathers, that is not a matter of much importance, some preferring to have them all white, others all black; but I believe there is none better for every useful purpose than the mottled grey. Young fowls may either be roasted or boiled, the male making the best roasted, and the female the neatest boiled dish. The older birds may be boiled by themselves, and eaten with bacon, or assist in making broth, or that once favourite winter-soup in Scotland—*cockieleekie*. A chicken never eats more tenderly than when killed a short time before being dressed; but if not so soon used, it should hang in the larder for three or four days in winter. An old fowl will become the more tender on being kept for a week before being used. The criterion of a *fat* hen, when alive, is a plump breast, and the rump feeling thick, fat, firm, on being handled laterally between the finger and thumb. The skin of the abdomen should be thick and fat, and fat should be found under the wings. White flesh is always preferable, though poulterers insist that a yellow-*skinned* chicken makes the most delicate *roast*, which I very much doubt. A hen is deprived of life by dislocation of the neck on being overdrawn, and there the blood collects and coagulates.

1602. *Turkeys*, being hatched in May, will be full grown in stature by winter, and, if they have been well fed in the interval, will be ready for use. Indeed, the Christmas season never fails to create a large demand for turkeys; and it must be owned there are few more delicate and beautiful dishes presented at table, or a more acceptable present to a friend, than a well-fed turkey. Young cocks are selected for roasting, and young hens for boiling, and both are most relished with a slice of ham, or of pickled ox-tongue. The varieties in common use are white, black, or mottled grey; and of these the white yields the fairest and most tender flesh. The criterion of a good turkey, when alive, is the great fulness of the muscles covering the breast-bone, thickness of the rump, and existence of fat under the wings; though the turkey does not yield much fat, its greatest property being abundance of tender white flesh. Young turkeys attain to great weights. I have had, year after year, young cocks weighing, at Christmas, 18 lbs. each in their feathers. Norfolk has long been noted for its turkeys, where they are fed on buck-wheat, and large droves are annually sent to the London market. A turkey is deprived of life by cutting its throat, when it becomes completely bled. The barbarous practice of cutting out the tongue, and hanging by the feet to bleed slowly to death, for the alleged purpose of rendering the flesh white, ought to be strictly forbidden.

1603. *Geese*, having been hatched in the early part of summer, will also be full grown and fit for use in winter. I believe little difference in flavour or appearance, as a dish, exists between the young male and female goose, though there may be of size. The criterion of a fat goose is plumpness of muscle over the breast, and thickness of rump, when alive; and, in addition, when dead and plucked, of a uniform covering of *white* fat under a fine skin on the breast. It is a good young goose that weighs in its feathers 12 lbs. at Christmas. The goose is a favourite dish at Michaelmas in England, and at Christmas in Scotland; but people tire sooner of goose than of turkey, and, in consequence, it is not so frequently served at table. A green goose, however, is considered a greater delicacy in England than a turkey-poult. Geese are always roasted in Britain, though a boiled goose is not an uncommon dish in Ireland; and their flesh is certainly much heightened in flavour by a stuffing of onions, and an accompaniment of apple-sauce. A goose should be kept a few days before being used. It is bled to death by an incision across the back of the head, which completely frees it of blood. Large flocks of geese are reared in Lincolnshire, and from thence driven to the London market, and many more find their way from Ireland to this country. It is rare to see a *grey* gander, and as rare a *white* goose. I remember seeing large flocks of geese on the islands in the Elbe near Hamburg, where they were reared chiefly for their quills, their carcasses being salted and sent to Holland. The invention of the steel pen has much injured the quill-dressing trade, and, in consequence, *good* quills are now not easily obtained. Geese have long been proverbially good watchers. I have seen a gander dispute the approach of beggars towards the kitchen door, as pertinaciously as a watch-dog.

1604. *Ducks*, being also early hatched, are in fine condition in winter, if they have been properly fed. Ducklings soon become fit for use, and are much relished with green peas in summer. I believe there is no difference in flavour and delicacy betwixt a young male and female duck. They are most frequently roasted, and stuffed with sage and onions—though often stewed; and if smothered among onions when stewed, few more savoury dishes can be presented at a farmer's table. A duck never eats better than when killed immediately before being dressed. It is deprived of life by chopping off the head with a cleaver, which completely drains the body of the blood.

1605. Hens and turkeys are most easily caught on their roosts at night with a light, which seems to stupefy them; and geese and ducks may be caught at any hour, in the out-house they may be driven into.

1606. As young pigeons alone are used, and as pigeons do not hatch in winter, they require no other notice at present than what regards their feeding; and to give an idea of their gastronomic powers, of three rock-doves sent to Professor MacGillivray, "the number of oat-seeds in the crop of the second amounted to 1000 and odds, and the barley-seeds in that of another were 510. Now supposing," he observes, "there may be 5000 wild pigeons in Shetland, or in Fetlar, which feed on grain for 6 months every year, and fill their crops once a-day, half of them with barley and half with oats, the number of seeds picked up by them would be 229,500,000 grains of barley, and 450,000,000 grains of oats,—a quantity which would gladden many poor families in a season of scarcity. I am unable," he adds, "to estimate the number of bushels, and must leave the task to the curious."* I was curious enough to undertake the task, and found the result to be 422 bushels, or 52 quarters 6 bushels of barley, and 786 bushels, or 98 quarters 2 bushels of oats, or 151 quarters of grain in all.†

1607. The prices of poultry in towns are pretty high. In Edinburgh, for instance, in winter a couple of chickens are 2s. 6d.; hens from 1s. to 1s. 9d. each; ducks 3s. per couple; turkeys, 3s. 6d. to 8s. a-piece; geese, 3s. 6d. to 5s. each; and eggs are from 1s. 2d. to 1s. 8d. per dozen. In the country towns, the prices are fully one-third below, though in London the highest prices are not above these. In Russia, fat turkeys are 1s. 10d.; geese, 2s., and fowls and ducks, 1s. 3d. *per couple!*‡

* MacGillivray's *History of British Birds*, vol. i. p. 285.

† I ascertained the result by weight; and as the facts may be worth recording, I may mention that, in an average of three drachms, there were 75 grains of chevalier barley in each drachm, of a sample weighing 56½ lbs. per bushel; and 97 grains of Siberian early oat in 1 drachm of a sample weighing 46 lbs. per bushel. Of Chidham white wheat, a favourite food of the pigeon, weighing 65 lbs. per bushel, there were 86 grains in the drachm.

‡ Venables' *Tour in Russia—Appendix.*

In Ireland, poultry of all kinds are cheap, but not so cheap as in Russia.

1608. Farmers usually sell poultry alive, excepting in some parts of the country, such as the Borders, where geese are killed and plucked, for the sake of their feathers, before being sent to market. Poulterers in towns, on the other hand, kill and pluck every sort of fowl for sale—so that the purchaser has it in his power to judge of the carcass; and if he buys an inferior article at a high price, the fault is his own. It is easy to judge of a plucked fowl, whether old or young, by the state of the *legs*. If a hen's spur is hard, and the scales on the legs rough, she is old, whether or not you see her head; but the head will corroborate your observation, if the under bill is so stiff that you cannot bend it to a curve, and the comb is thick and rough. A young hen has only the rudiments of spurs, the scales on the legs smooth, glossy, and fresh-coloured, whatever the colour may be, the claws tender and short, the under bill soft, and the comb thin and smooth. An old hen-turkey has rough scales on the legs, callosities on the soles of the feet, and long strong claws; a young one has none of these. When the feathers are on, an old turkey-cock has a long beard, a young cock but a sprouting one; and when off, the smooth scales on the legs decide the point, beside difference of size in the wattles of the neck, and in the elastic snot upon the nose. An old goose, when alive, is known by the roughness of the legs, the strength of the wings, particularly at the pinions, the thickness and strength of the bill, and the firmness and thickness of the feathers; and when plucked, by the smooth legs, weak pinions and bill, and fine skin. Ducks are distinguished by the same marks, but there is this difference, that a duckling's bill is much longer in proportion to the breadth of its head than that of an old duck. A young pigeon is easily recognised by its pale-coloured, smooth-scaled, tender, collapsed feet, the yellow long down interspersed among the feathers, and the soft under bill. A pigeon that can fly has red-coloured legs, no down, and is too old for use.

1609. The hen-house should be divided into at least four apartments, included within a court-yard. The use of four apartments is, to devote one of them to the hens and turkeys, which roost high; and therefore wooden roosts should be put up for them, not narrower than to allow the feet of the fowls to be spread out. The roosting-house for these fowls is in G, Plate II., under a part of a granary. The geese and ducks should rest on the floor, and have a house for themselves, and this may be at the hatching-house. When geese and ducks are obliged to rest below hens, they are made uncomfortable and dirty by the droppings from the latter. There should be a hatching-house to accommodate both classes of birds, when they sit upon their eggs, in separate nests. The fourth apartment is the one for the use of those which are laying their eggs. For convenience, compartments are made in it for containing nests, which are made to suit the nature of the fowls. The largest apartment should be occupied by the most numerous body of fowls, namely, the hens and turkeys; and the egg-house should have access by a trap-ladder and opening through the wall from the outside, to admit the laying hens. There should be an opening with a sliding-shut in the outer door of this, as well as one in those of the geese-house and hatching-house, to give admittance to the birds when disposed to go to rest in the afternoon; and these shuts should be closed every night. In the accommodation thus appropriated to every class of fowls, each apartment will be occupied by its own class. The usual practice is to put all kinds of fowls into the same apartment; and the small space occupied by even a single room seems to be grudged; as if any sort of accommodation, however hampered or incommodious, were good enough for poultry. How breeders and feeders of stock can reconcile their minds to such indifference towards any class of their live-stock, while cherishing the desire of having a good fowl at their table, is more than I can imagine, unless they believe that quite opposite modes of treatment will produce similar results in different classes of animals. In very cold weather, the apartment occupied by the hens and turkeys should be kept warm by any expedient, such as the shutting of doors, and putting straw upon the slated roofs of all the apartments during a continued storm. Snow forms a warm covering on a roof, but the heat from fowls roosting under, soon melts it; so it is better to remove the snow and put on straw, and allow the snow to fall upon the straw. Fowls thrive best in a mild temperature, and not great heat; and such expedients will afford sufficient heat during the severity of a winter storm. I do not enter into all the particulars usually to be found in a regularly constructed poultry-house—for these are best suited to a proprietor's offices: those I have referred to are quite well enough constructed for a farm, and if the fowls were as well attended to as such accommodation would afford them protection and comfort, they would exhibit a much better appearance than they usually do about farmyards.

1610. A *pigeon-house* is a necessary structure, and may be made to contribute a regular supply of one of the best luxuries raised on a farm. As pigeons are fond of heat at all seasons, a room in the gable, above the bulls' hammels, as seen in Plate I., would suit well. A large pigeon-house is not required, as with ordinary care, pigeons being very prolific breeders, a sufficient number for the table may be obtained from a few pairs of breeding birds. I had a pigeon-house not exceeding 6 feet cube, and not very favourably situated either for heat or quietness, which yielded 150 pairs of pigeons every season. The flooring should be strong and close, and the sides, front, and roof, in the inside, lathed and plastered. A small door will suffice for an entrance, to which access may be obtained from the wool-room. The pigeon-holes in the gable should be made of stone, and kept bright with white paint. The nest-cells should be made of wood, 9 inches cube all round the walls.

1611. When pigeons receive artificial heat, they not only continue to hatch longer in autumn, but will recommence in spring sooner than they would otherwise do. Indeed, by a little management, and keeping the house always pretty full of pigeons, to retain heat amongst themselves, they might be encouraged to hatch all the year, with the exception, perhaps, of two months in the depth of winter, in December and January. Pigeons, like other birds, are most prolific when not too old; and as old cocks tyrannise over the young ones, they should be destroyed as well as the oldest hens. It is no easy matter to get hold of old pigeons to kill them, as they are always on the alert, and ready to make their escape; but there are various ways of destroying them, and a favourite one is shooting, which is not the best in this case, as young ones may be wounded in the act of killing the older birds. The safest plan is to mark the birds you wish to destroy daily for some time, in order to recognise them readily, and the old cocks are easily discerned by their froward manner, and the interruption they give at the pigeon-holes to the entrance of others, though the old hens never conduct themselves in that manner. Other means must therefore be taken to recognise them. The marks are rough scaly legs, callous soles of the feet, bright red scales on the legs, strong bill, strong wings, thick covering of feathers, and brilliancy of the play of colours upon the neck. All these marks are most conspicuous in winter, the season when the process of *cocking* a pigeon-house, as it is termed, should be performed, as then no young ones will be unknowingly deprived of their parents. The safest way of catching the old ones, is to enter the pigeon-house gently, late of a dark night, with a light, and on entering and shutting the door, the first movement should be to stop up the holes to prevent them escaping, which the old cocks will be the first to attempt; and, should the holes be beyond the reach of the floor, a ladder should have been placed in the pigeon-house, during the day, to assist in effecting the purpose. Two persons are required to capture the pigeons, as they will endeavour to elude every attempt; one to take special charge of the light, which would be bright and safe in the lantern, fig. 89. A light landing-net used by anglers is a convenient instrument for entrapping a pigeon, whether sitting or flying. Every bird caught should be examined and recognised, and every one exhibiting signs of old age should be destroyed, by striking the back of the head forcibly against the wall, or cutting it off with a large sharp knife. When the process of *weeding* is performing, it should be done effectually at once, and not repeated in the samo season; as such a nocturnal visitation cannot fail to intimidate the whole flock. Nor should it be done in the season of hatching, though done without fail every year; and the consequence will be, that your pigeon-house will be stored with prolific birds, which will receive no annoyance from barren ones. Perhaps a dozen of birds, male and female, so destroyed, may suffice at a time. The unstopping of the holes, and the removing of the slain birds and ladder, should be done quietly.

1612. The daily treatment of fowls may be conducted in this manner:—Some person should have special charge of them, and the dairy-maid is perhaps the best qualified for it. As fowls are very early risers, she should go to the hen-house in the morning, on her way to the byre, and let out all the fowls, giving the hens and turkeys a feed of light corn and cold boiled potatoes, strewed along at some convenient and established place out of the way of the general passage of horses and carts; such as between the hammels N, and the byre and calves' courts, Plate II. The ducks should get the same food either near the horse-pond, or at any pond or trough of water, placed for them, as they cannot swallow dry food without the assistance of water. Geese thrive well upon sliced turnips, a little of which, sliced small, should be left by the cattle-man for the dairy-maid at any of the stores, and given at a place apart from the hens. When stated places are thus established for feeding fowls at fixed hours, they will resort to them; at least, the well-known call will bring the hour to their recollection, and collect them together on the spot in a few seconds, the regular administration of food being as essential for their welfare as that of other stock. Ducks pick up a good deal of what falls about the stable, and near the corn-barn door, as well as in the straw-barn; and geese will help themselves to the turnips that may chance to fall from the troughs of the cattle; and they are also fond of raw potatoes. After her own dinner, say 1 o'clock P.M., the dairy-maid takes a part of the potatoes that have been boiled at that time, and while a little warm, gives them crumbled down from their skins, with some light corn, to the turkeys and hens. At this time of the day the spaces below the stathels of the stacks in the stack-yard form excellent dry sheltered places for laying down food, and the stack-yard is a very probable place for their resort after the morning meal, when it rains or snows. In laying down food for the fowls, the pigeons should be remembered, as they will feed with the hens, and on the same sort of food. Before sunset, the fowls are all collected together by a call, to be put into the house, which they will readily enter; and many will have taken up their abode in it already, especially the turkeys, which go very soon to roost. The ducks are the latest idlers. The floors of the different apartments should be littered with a little fresh straw every day, sufficient to cover the dung, and the whole cleaned out every week. Sawdust or sand, where they are easily obtained, forms an excellent covering for the floor of hen-houses. Troughs of water should be placed in their own court-yard, supplied with fresh water, and cleaned out every day.

1613. This mode of daily treatment will maintain fowls in a condition for using at any time; and it cannot be said to involve much expense, for the riddlings of potatoes and light corn boiled may be regarded as the offal of the farm: but the truth is, food administered to these creatures at *irregular intervals*, though it be of the finest quality, will be comparatively thrown away, when compared to the good effects of food of even inferior quality given at *stated hours*. This plan contrasts favourably with that which gives large quantities of food in one spot at long intervals, in a clammy state—as also with that which permits fowls to shift for their food at the farmstead. Either of these ways will never fatten fowls; and food given in over-abundance at one time, and restricted at another, will never *fatten* any animal; nor will they obtain sufficient food at all times when made to shift for themselves, because of fowls, like other animals, some can forage most perseveringly, whilst others are indolent and careless of food when not placed before them. A regular plan is recommended, and when repeated daily, their condition must increase, because it cannot decrease, the minimum quantity of food being always sufficient to appease hunger;

and they can never feel hunger when supplied with food at appointed times. Thus, in the long run, more nutrition will be derived from inferior food regularly administered, than from richer given irregularly.

1614. Should it be desired, however, to be particularly indulgent to fowls intended for immediate use, the following materials will render the respective sorts of fowls perfectly *ripe* in a short time. Boiled potatoes, warm, and light wheat, for hens; boiled potatoes, warm, and firm oatmeal porridge, warm, for turkeys; boiled potatoes, warm, and oats, for geese; and boiled potatoes, warm, and boiled barley, warm, for ducks. The potatoes and porridge should be crumbled down and strewed about in small pieces. As potatoes cannot now be depended upon, Indian corn boiled may be advantageously substituted for them. But *immediate* effects, even from superior food, should only be expected on fowls that have been regularly fed as recommended above, up to the time the superior food is indulged in. Let starved fowls receive the same ingredients, and a long time will elapse ere they exhibit symptoms of improved condition, besides the risk they run, in the mean time, of receiving injury from surfeit and indigestion. No doubt, superior feeding will incur cost, if persevered in throughout the season; but I am disposed to affirm that, were proper breeds of fowls only cultivated, and were the shortness of time taken into consideration in which a pure breed will *ripen* on good food, a profit would actually be derived from its use. The experiment has never been satisfactorily attempted by farmers, and all the instances we know of superior feeding, apart from experiments by men of science, are derived from the establishments of noblemen, whose object not being to obtain a profit, their fowls are fed with the view of producing the greatest results.

1615. Other ingredients may be used for feeding fowls, among which are buck-wheat, rice, and Indian corn. Buck-wheat is successfully grown in England, not so in Scotland. It is said to fatten poultry well, though not so well as grain. It is excellent feeding for pheasants. Rice may be given either raw or boiled: in the former state, fowls will pick it as readily as grain after feeding on boiled potatoes, and, when boiled, it will fatten without the aid of potatoes—but, of course, it is more expensive, as even *good* damaged rice can seldom be obtained under 16s. or 18s. per cwt., which is nearly 2d. per lb., without the expense of cooking. Fine barley, weighing 56 lbs. per bushel, selling at 4s. per bushel, is nearly one penny per pound. Indian corn is employed in America, in the southern parts of Germany, and in Lombardy, for feeding poultry, and they become very fat upon it. It is too large to be swallowed raw, like the horse-bean of this country; but when steeped in water, or boiled, it is easily eaten, and, if sold at 4s. per bushel, it would not cost 1d. per lb. "From a desire to save expense," says Boswell, "the bran of wheat, and sometimes pollard, or middlings, are given to fowls; but these bruised skins, where little if any of the farina of wheat remains, appear to contain a very small portion of nourishment in proportion to the cost price. M. Reaumur found by experiment, that it is little or no saving to substitute bran for good grain in feeding poultry. Bran is not given dry, but mixed with water to the consistence of paste. Some people boil this; but it does not increase the bulk, except in a very trifling degree, and is, therefore, of small advantage. He found that two measures of dry bran, mixed with water, were consumed by fowls in the same time that they would have eaten a single measure of boiled barley, equivalent to three-fifths of a measure of dry barley."* Bran, though not destitute of nutrition, is of little use to fowls as food; but may be the means of conveying nourishing food, in the shape of fat, broth, and other rich liquids from the kitchen, which they could not otherwise avail themselves of but by such an absorbent. Fowls are very fond of bread, and of butcher-meat, cooked or raw, and they will pick a rough bone very neatly. They sometimes display even carnivorous propensities. Many a time have I observed them watching for a mouse at the casting down of a stack in the stack-yard;

* Boswell's *Poultry-Yard*, p. 54.

and the moment one attempted to escape, away they would run, cocks and hens together, in full chase after it; and on mobbing it, peck it not only to death, but to pieces, and swallow it.

1616. I have said that *eggs*, and chickens too, may be obtained in winter by good management. The young hens of the first broods in April will be old enough to lay eggs in winter. A few of these should be selected for the purpose; and as the period of laying approaches—which may be ascertained by their chaunting a song and an increased redness of the comb—they should be supported by better, warm feeding, and warmer housing at night. The feeding consists of warm potato, or warm Indian corn, and firm oatmeal porridge, twice a-day—at morning when they are let out, and in the afternoon at 1 o'clock, with a few grains of oats. To give them peace in feeding upon their tempting fare, they may be fed by themselves in the court-yard of the hen-houses, and the outer-door shut upon them after the rest of the fowls have left their night's quarters. Their comfortable housing consists in directing them into the hatching-house betimes every afternoon, and therein making for them a number of comfortable nests of clean oat-straw, to choose amongst, and, when each has taken to the one she selects for her own, leaving an old egg in it for a nest-egg. A little lime and gravel should be placed within their reach—the gravel assisting the digestion, and the lime affording the calcareous covering for the egg. These three or four young hens will lay as many eggs every day; and though they are not so large as those of more matured fowls, being only pullets' eggs, still they are fresh; and it is no small luxury to enjoy a new-laid egg at breakfast every winter-morning—a luxury which I enjoyed as many years as I lived in the country.

1617. With regard to *young broods in winter*, I believe few people will impose upon themselves the trouble of setting hens on eggs so late in the season for the purpose of rearing chickens in winter—and yet it may be done without difficulty; but sometimes the task is imposed involuntarily upon one, inasmuch as some hens will secret their nests in the fields, at a hedge-root, or other safe place, and bring out strong broods of chickens on the eve of winter; and in such an event, the little innocents, brought into a cold world, cannot be allowed to perish for want of care. When a late brood makes its appearance, or is purposely brought forth, it should be kept apart from the rest, in a warm and sheltered place; and where no better place presents itself, it may be comfortably housed in a corner of the boiler-house, (Plate II.,) where a hamper or basket, placed over mother and chickens, or a fence of some kind, erected across a corner, near the fire, will protect them in their comfortable nests from external danger. From thence they should be let out for a while in the forenoon, to receive the fresh air and bask in the sun, and returned to their nest long before sunset. In rainy weather they may be conducted to a shed, and in hard frost kept in the house altogether, as frost soon benumbs their legs—and whenever they lose the power of these they soon droop and die. Their nest should be elevated some inches above the floor, to keep them above the draught of air that sweeps along it, with a broad sloping base to afford the chickens an easy access to their nest; and every evening, a little of the cleanest and warmest of the straw, from under a cow in the adjoining byre, will form an excellent lining for the nest for the hen to brood them upon. Food should be given them from morning to evening every three hours. It may consist of warm boiled mealy potatoes crumbled down small, picks of oatmeal porridge—mixed with oatmeal, and a flat low dish of clean water. With variety of food, daily attention, and warm housing, they will get on well, and by spring be as plump as partridges, and as valuable as ortolans. I am surprised to observe Mr Mowbray say, that "to *attempt* to rear winter chickens in this climate, even in a carpeted room, and with a constant fire, would in all probability be found abortive. I have repeatedly made the experiment," he adds, "with scores, without being able to preserve an individual through the winter."* The difficulty I am sure is small, though

* Mowbray's *Practical Treatise on Domestic Poultry*, p. 57.

the trouble may be unnecessary; but neither a "carpeted room," nor a "constant fire," will of themselves rear chickens: the whole art consists of suitable food, medium temperature, fresh air, and well-timed attention; and with these a large number of chickens may be reared in winter at one time, if desired.

1618. Such is the way I would recommend the feeding of poultry on a farm. It is not an expensive mode in a pecuniary point of view—at least not more so than should be incurred on a farm—for it consists entirely of ordinary fare, and regular attention; and therein depends the entire value and success of the plan. That the plan is a valuable one, and worthy of imitation, I have proved beyond doubt, as it supplied fowls of every kind in their respective seasons, in high condition—at any hour they were required—and without the least previous formal preparation. Thus, a chicken, a young cock, a hen, were at command throughout the year; a duckling in the autumn; a goose or a turkey from Michaelmas to March: and this not for one year, or only in a favourable season, but year after year for 15 years—as long, in short, as I had opportunity to practise it. In truth, a *young* fat fowl and a fresh egg were never awanting, from January to December; so that much truth was conveyed in Cobbet's remark, when he said, "one thing about fowls ought always to be borne in mind,—they are never good for any thing after they have attained their full growth, unless they be capons or poullards."* As with pigeons so with fowls; keep them always young, and they will always prove prolific and healthy.

1619. In regard to the undue means used for pampering fowls to fatness, I quite agree with Cobbet that "crammed fowls are very nasty things;" and when we reflect on the worse than imprisonment practised for the purpose, by cooping up fowls in the dark, and tying their feet together, the means used to attain the end become highly reprehensible. Liebig explains the rationale of this latter practice. "Experience," he says, "teaches us that in poultry, the maximum of fat is obtained by tying the feet and by a medium temperature. These animals, in such circumstances, may be compared to a plant possessing in the highest degree the power of converting all food into parts of its own structure. The excess of the constituents of blood form flesh and other organised tissues, while that of starch, sugar, &c., is converted into fat. When animals are fed on food destitute of nitrogen, only parts of their structure increase in size. Thus, in a goose fattened in the method above alluded to, the liver becomes three or four times larger than in the same animal when well fed with free motion, while we cannot say that the organised structure of the liver is thereby increased. The liver of a goose fed in the ordinary way is *firm and elastic;* that of the imprisoned animal *soft and spongy*. The difference consists in a greater or less expansion of its cells, which are filled with fat."† The practice of stuffing appears to me the more reprehensible, in that its principal effect is to increase the offal.

1620. The denominations of the common fowls of the farm are as follows:—The male of the fowl is the *cock*, and the female the *hen;* the young are *cock chickens* and *hen chickens* according to their sex. A hen chicken before it begins to lay eggs is a *pullet*, and a castrated cock is a *capon*. Turkeys are likewise termed *cock* and *hen turkeys*, and the young of both sex a *poult*. The male of the goose tribe is a *gander*, the female a *goose*, and the young of both sexes a *gosling*. A gosling fit for eating is a *green goose*. The male of the duck tribe is a *drake*, the female a *duck*, and the young of both sexes a *duckling*. *Pea cock* and *pea hen* are the terms for the old male and female, and *pea fowls* for the young of both sexes. Cock and hen are the distinguishing terms for the male and female of all the gallinaceous race of birds, and so also with the pigeon tribe.

1621. *Peacocks* may be treated in the same manner as turkeys.

1622. *Guinea-fowls*, notwithstanding the delicacy of their eggs, should never be tolerated in a farm-yard, both on account of the horrid grating noise they make,

* Cobbet's *Cottage Economy*.

† Liebig's *Animal Chemistry*, p. 94

and the strong propensity they evince of constantly annoying other fowls.

1623. The *feathers* of the various sorts of fowls used, are either disposed of or converted into domestic use. The following directions on sweetening and managing feathers are given by a lady of my acquaintance, who is a notable housewife; and as they very nearly accord with my own experience, I shall transcribe them in her own intelligent words. "Every one is aware that the feathers of cocks and hens are very inferior to those of geese and ducks, for the purpose of filling beds and pillows; and, consequently, it is scarcely necessary to mention, that the former should be kept separate from those of the two latter fowls. As the birds are plucked, the large feathers should be selected and placed asunder. Paper-bags are the best recipients. The pinion feathers should be stripped from the quill, and added to the other feathers; and, if great caution have not been used in plucking the birds, they should be carefully looked over, that no part of the skin has been torn and adhering to the base of the quills. The bags of feathers should be placed in the bread-oven on the day after it has been heated, and, after some hours, removed to a dry airy place; and this ought to be done every week." On this part of the subject, I may mention a less troublesome plan than the oven, where there happens to be an apartment behind the kitchen-fire, against the wall of which the bags containing the feathers may be hung up, and there the feathers will soon *won*. "Notwithstanding," continues our instructress, "every apparent caution shall have been used, the feathers are frequently found to be tainted, either from carelessness in plucking, or by neglecting to attend to them afterwards; and no *subsequent baking* or *picking* will be found available to restore them. In this case, the only method to render them sweet is to boil them, which is to be effected in the following manner: one or two large canvass or calico bags must be made, into which the feathers from the small paper-bags must be emptied and tied up; a washing-copper must be nearly filled with rain-water, and made to boil. The calico-bags, then, one at a time, are to be dipped, and, by means of a stick, pushed about, and squeezed, and kneaded, for the space of four or five minutes, then lifted out and taken out of doors; and being tied together and the openings kept secure, that no feathers may escape, they must be hung over a line, and left to drain and dry. Several times a-day the bags are to be shaken up and turned over; and as soon as the feathers appear to be light and drying, which will not be the case for nearly a week, the bags must be hung up during dry weather only, and taken in every night. In about a fortnight, the feathers will become perfectly sweet and ready for use; and the water in which they were boiled will sufficiently indicate that this plan was not only necessary, but efficacious, in cleansing them from impurities which would else have rendered them useless." As an attestation of the practical efficacy of the plan, the lady adds, "having tried the method ourselves, we can assure our readers of its eligibility."* Feathers are now efficaciously and quickly cleaned, and freed from all impurities, by the action of steam upon them.

1624. In regard to the *diseases* of fowls, I can say without the fear of contradiction, that, if fowls are attended to in a systematic manner, with wholesome food prepared for them every day, and their roosting place kept clean and airy, very little disease will affect them at any age. Mr Mowbray observes that "The diseases of our domestic animals kept for food are generally the result of some error in diet or management, and should either have been prevented, or are to be cured most readily and advantageously by an immediate change, and adoption of the proper regimen. When that will not succeed, any farther trouble is extremely questionable; and particularly with respect to poultry, little hope can be derived from medical attempts."† I am not of the opinion that, when fowls are observed to be affected by any disease, a mere change of regimen will readily effect a cure. On the contrary, the value of the animal is lost in the time permitted the disease to develop its symptoms. The plan, therefore, that averts the greatest amount of loss in the animal itself, and of expense in the attempt to cure its disease, is to kill the animal the moment the least symptom of disease is seen to affect it. If a fowl is found "in a corner" pining away, the fault lies with those who have the charge of it; for if they fulfilled their duty in daily noticing, as they ought to have done, the state of every creature under their charge, none could stray away from the rest under the effect of disease, or any other cause, without being immediately missed, and searched for.

1625. *Sniffters.*—The only disease I can remember to have seen in winter is what is vulgarly called the *sniffters*, that is, a discharge of matter from the nose, which causes a noise in the nose like stifled breathing. It is evidently a catarrhal affection, and has most probably been superinduced by exposure to rain or cold in stormy weather. When first observed to be affected with this complaint, any fowl kept in the condition it should be may be used without scruple, which is a much better plan than tormenting the animal by pursuing the usual practice of thrusting a feather through its nostrils. If the fowl is not fit for killing, the fault lies either with the person who has charge of the poultry or with the farmer himself, who grudges the creature its food.

1626. I have seen a classified list of the

* *Quarterly Journal of Agriculture*, vol. x. p. 480-1. A curious account is given in Head's Home Tour, of the modes of plucking feathers of fowls of various kinds in a large poulterer's establishment in Lincoln.

† Mowbray's *Practical Treatise on Domestic Poultry*, p. 211.

diseases alleged to affect poultry, given by a correspondent of the *Gardener's Chronicle* for 7th November 1846, and the numbers seem to me appalling, as I have seen but very few of them :—

1st Division—*Febrile and Inflammatory.*

Moulting fever.
Loss of feathers ; mange.
Hatching fever.

2d Division—*Digestive.*

Sick or full crop.
Oon, lush. or soft eggs.
Egg-bound.
Torpid gizzard.
Diarrhœa.
Fluxes.
Constipation.
Gapes, or Facciola.
Worms.
Canker.
Gout.
Dropsy.

3d Division — *Catarrhal, respiratory and pulmonary.*

Chip.
Pip.
Influenza, inflamed head, eyes, and nostrils.
Roup or glanders.
Asthma.
Phthisis.

4th Division—*Nervous.*

Meaghrims.
Apoplexy.
Paralysis.

5th Division—*External and accidental.*

Obstruction of rump gland.
Fractures.
Bruises.
Tumours.
Ulcers.
Vermin.
Corns.

1627. *Lice.*—As to vermin, every fowl, like every other animal, is affected with lice. The common hen is infested by more than one pedicular inhabitant, but the most frequent is the *Lipeurus variabilis,* which has a narrow body, the head rounded in front, the general colour dirty white, smooth and shining, the margins with a black band, the abdomen having a brown interrupted stripe down the middle. According to Mr Denny, our principal authority on this subject, it prefers the primary and secondary feathers of the wings, among the webs of which is moves about with great celerity.

1628. *Menopon pallidum* is almost equally common in poultry, running over the hands of those who are plucking their feathers, and difficult to brush off from the smoothness of their bodies.

1629. The peacock has a large and very singularly formed parasite of this nature, named *Goniodes falcicornis.*

1630. Another, not unlike the one just mentioned in general appearance, occurs plentifully on the turkey.

1631. Geese and ducks are infested by similar foes, particularly the latter, on which the *Docophorus icteroides,* a species common to the whole anserine tribe, is usually very abundant.*

1632. As I have mentioned bran as an ingredient at times administered to fowls as food, it may be worth while to notice what chemists say of its nutritive properties. The proportions of water, and of oil and fat, do not vary much in pure bran. The oil varied from 5·26 to 6·53 per cent, and the water from 11·82 to 13·23 per cent, in six different cases. The albumen varies in a greater degree. The composition of bran is very nearly as follows :—

Water	13·1
Albumen (coagulated)	19·3
Oil	4·7
Husk and a little starch	55·6
Saline matter (ash)	7·3
	100·0

The ash has not yet been analysed. As it appears that the nutritive matter, consisting of the albumen and oil, amounts to 24 per cent, bran should be a good ingredient to assist, at least in the feeding of pigs and other stock.†

1633. *Goose fat* is used for some purposes on a farm. It is useful in anointing the udders of cows in spring, should they become hard, and it has the property of evaporating slowly. It also keeps a poultice moist until it should be renewed ; and, on account of this property, it constitutes a good ingredient of grease for smearing the axles of cart-wheels. This fat may be *rendered* in the same manner as mutton-suet and lard, and kept in a jar covered with bladder. Goose fat "is colourless, and has a peculiar taste and smell, rather agreeable. If melted, it congeals at 80½° Fahr. into a granular mass, having the consistence of butter. When exposed to pressure between the folds of blotting paper at 28½°, it is resolved, according to Braconnot, into

	Fusible at 111°. Goose fat.	Fusible at 126½°. Duck fat.	Fusible at 113°. Turkey fat.
Stearin,	32	28	26
Elain,	68	72	74
	100	100	100‡"

1634. Professor Johnston says that the solid fat of the goose is the same as that of man, and as that in olive oil and butter, and is named *margarin ;* and that the solid fat of cattle, the sheep, the horse, the pig, differs from that of man, and is known by the name of *stearin.* The elain or fluid part of fat is identical in all animals, and is exactly the same thing as the fluid part of olive oil, of the oil of almonds, of many other fruits, and as the fluid part of butter ; and it exists in a larger quantity in the fat of the pig than in that of the sheep, and hence it is that lard is always softer than suet.§

1635. I have often heard it expressed as a decided opinion, that it is impossible to fatten fowls with a profit. It seems to me strange that fowls should not make a return for their keep when the other animals on a farm do ; so I cannot coincide with the opinion until I have seen the experiment fairly tried by a farmer ; and, so far as my own limited experience instructs me, my opinion is in the opposite direction. An Englishman has sent me a calculation by which he endeavours to prove, that the eggs alone fur-

* Denny's *Monographia Anoplurorum Britanniæ.*
† Johnston's *Lectures on Agricultural Chemistry,* 2d edition, p. 866.
‡ Thomson's *Animal Chemistry,* p. 138.
§ Johnston's *Lectures on Agricultural Chemistry,* 2d edition, p. 1011-2.

nished by good and young hens would afford a reasonable profit; and as the particulars of the calculation are very feasible, and it is evident he has thought seriously on the subject, I give the results he renders so probable. "I consider," he says, "that one man, with the occasional assistance of his wife, is sufficient to take charge of 10,000 head of poultry, as he would only have to feed them and keep the place clean, and collect the eggs, &c. I do not intend to keep a breeding stock, as I am quite aware it would be both expensive and difficult to breed 3000 chickens every year. I would fatten and sell, a little before the moulting season, about 3000 of the old hens every year, including a proportionate number of cocks, and with the same money purchase as many pullets and young cocks, so in the end it would be the same as breeding them; and I do not see why the old hens should not be eatable and saleable at about three years of age. If the pullets purchased yearly were hatched about March or April, they would begin to lay about the beginning of November, and would lay on an average at least 4 eggs a-week each, from that time to the moulting season the following year. Supposing the hens to stop in the moult 6 weeks —most good hens will get over it in a month—and begin to lay again in November, I calculate they would lay on an average about 5 eggs a week each for about 4 weeks; and from this time during 8 weeks, which would be into the winter quarter, about 4 eggs a-week each; as also from the last time during 12 weeks, which would be into spring, 5 eggs a week each; and continuing forward and during the summer for 22 weeks, until the moulting season again, 6 eggs a-week each.

1636. "I consider 12 acres of grass land, being 50 square feet for each fowl, quite sufficient space to roam in when they have an enclosed yard, well drained, with good surface, sheds for shelter from sun and rain, and green meat given them every day to supply the place of grass.

1637. "Supposing 1 peck of barley to weigh 14 lbs. each hen would have 18 oz. a week; and, taking the average number of eggs laid in a year between a pullet and a hen at 214, and allowing 2 oz. for each egg divested of its shell, the average would be 8 oz. a-week from each hen; and as, of course, that weight of corn would be required to produce the eggs, there would be left 10 oz. of corn a-week to support the life of each hen, supply insensible perspiration, and the manure. Besides the barley, I would allow 1½ oz. of oats to each hen a-day, which I would consider sufficiently high feeding.

1638. "Supposing, also, that we reckon the wholesale price of the eggs, during the summer, at 1s. per 36, and in winter 1s. per 24, and in the other parts of the year a medium between these two prices: eggs sold by retail scarcely ever exceed, in the summer, from 24 to 28 for 1s., and in winter from 12 to 15 for that sum.

1639. "I have not taken into account some few hens out of the stock, that might perchance want to sit, as I should try to avoid that casualty by having the best known everlasting layers, such as the Dorking, &c.

1640. "Suppose that each fowl voids as much as 1 oz. of dry dung every day, the 10,000 would yield about rather more than 100 tons every year, which may safely be considered worth £7 per ton.

1641. "Taking these data as correct, the following may be expected to be the results:—

Number.	Eggs a-week.	In weeks.		Number of eggs.	For one shilling.	Value. £ s. d.
5,800 hens	5	4	116,000			
3,000 pullets	4	..	48,000			
				164,000	30	273 0 0
5,800 hens	4	8	185,000			
3,000 pullets	4	..	96,000			
				281,600	24	586 0 0
5,800 hens	5	12	348,000			
3,000 pullets	4	..	144,000			
				492,000	30	820 0 0
5,800 hens	6	22	765,600			
3,000 pullets	4	..	264,000			
				1,029,600	36	1439 0 0
8,800 laying stock, 1,200 cocks		6 in the moult				
10,000 entire stock		52 weeks		1,967,200		3109 0 0
Reckoning one egg less out of every 15, to make up for the smallness of the pullets' eggs, would reduce the number by				131,146	30	216 0 0
Leaving				1,836,054		2893 0 0
Value of 102 tons of dung at £7 per ton						714 0 0
						3607 0 0

Deduct for expenses, namely:—		
1306 quarters of barley, at 30s.	£1959 0 0	
1070 .. .. oats, at 20s.	1070 0 0	
Wages of man and woman	70 0 0	
Green meat, such as lettuce, &c.	40 0 0	
Incidental expenses and casualties	50 0 0	
Rent	100 0 0	
		3289 0 0
Profit		£328 0 0"

1642. In regard to the right of farmers shooting pigeons, it has been decided that "The tenant was found not justified in shooting his landlord's pigeons, on the allegation that they destroyed his crops. (Easton, May 18, 1832; 10 S. D. 542.)"* This decision proves the fallacy of a common opinion, that a farmer may shoot pigeons in the act of destroying his crops, provided he does not carry them away after they are shot. If this opinion were supported by law, any tenant that had a grudge against his landlord might lure his pigeons by various means to a particular spot, and there shoot them, and let them lie: but such conduct, it is clear, could not be tolerated.

ON THE RATIONALE OF THE FEEDING OF ANIMALS.

1643. The action of the digestive organs of animals on the food eaten by them, and

* *The Farmer's Lawyer*, p. 35.

the appropriation of every particular constituent part of the food by those portions of the animal system most in want of them, is now better understood by the aid of chemistry, than when the former edition of this work was written. It is therefore necessary you should be made acquainted with what has been ascertained of the nature of the food raised on farms for the use of animals, that you may be enabled the better to understand the art of feeding those animals to the best possible advantage; and the properties of their food can only be understood from a previous knowledge of the functions performed by the digestive organs of the different animals fattened on the farm.

1644. The domesticated animals of the farm are all comprehended in two of the great divisions of animated nature, namely, quadrupeds and birds. Of the quadrupeds, they are all embraced under one class,—the *mammalia*, or those which suckle their young; and of this class they occupy two sub-classes,—one the ruminants, having compound stomachs, and the other having simple stomachs. The ox, the sheep, the goat, have compound stomachs; the horse, the pig, the ass, the mule, the dog, the cat, have simple stomachs. Of the birds, the few members of this family raised on the farm occupy both the great divisions of it, namely, land and water birds. The common fowl, the turkey, the peacock, the guinea-fowl, are the land birds; the goose and duck are the water birds.

1645. Differing as these quadrupeds and birds do in external appearance, their digestive organs are nevertheless very similarly constituted, thereby indicating that the same kind of food will maintain alike all the animals of the farm. These organs consist of the œsophagus, the stomach, and the large and small intestines, which last are divided into the duodenum, the jejunum, the ileum, the cæcum, the colon, and the rectum.

1646. The functions of these several parts are,—of the œsophagus or meat-pipe to convey the masticated food, mixed with a large quantity of saliva, from the mouth to the stomach. The stomach digests the food received in this state, and reduces it to a finer state of division, by means, it is supposed, of the action of a fluid which is exuded from the coats of the stomach during the process of digestion, and the fluid has been supposed to be an acid, and that the hydrochloric. But Dr R. D. Thomson doubts that digestion is effected by means of an acid. "An acid certainly makes its appearance in the stomach," he remarks, "when food is present; but whether this acid takes any part in the digestion or solution, is still disputed. During the digestion of vegetable food in pigs, whose stomachs bear a close resemblance to those of man, I have always found a volatile acid present in minute quantities, which corresponded with the properties of acetic acid; but it is the only acid which distils over from the liquor of the stomach at a temperature of 212°. The filtered liquid of the stomach, under such circumstances, contains no hydrochloric acid, but an acid which is either lactic, or corresponds very closely with it." After making attempts to discover the hydrochloric acid, he concludes, —"I regret, therefore, to be obliged to infer, that the commonly received view of digestion is scarcely admissible. It is perhaps safer to conclude that there is a deficiency of knowledge on this important subject; and that not only do we require to possess a few facts additional, before we can be said to understand the process, but we want an entirely new basis on which to found a theory of digestion. It seems highly probable, from my own observation, that the starch of food is converted into sugar, and that this again passes into simpler forms, as alcohol—perhaps acetic acid or lactic acid—by a kind of substitution so well explained by the theory of Dumas, and finally into gaseous forms, as carbonic acid and vapour of water, or after some such fashion as suggested by Liebig. . . . . The most superficial observer must have noticed that digestion is something more than a mere chemical action. Does not the famished man *feel* refreshed after eating, and does not the pulse beat quicker when food has been swallowed? There is, therefore, a nervous action induced, the nature of which it is only wise to admit we do not as yet understand."*

* Thomson's *Researches on the Food of Animals*, p. 19-23.

The duodenum is the commencement of the small intestines, and receives the food from the stomach in the form of chyme, through the pyloric duct. In its passage through the duodenum, the food receives the pancreatic juice from the duct connected with the pancreas or sweetbread, and bile from the bile-duct of the liver. Here these fluids effect a change of the chyme into chyle—the pancreatic juice converting one portion into a white, thick, milky fluid, and the bile into a yellow pultaceous mass. The next intestine, the jejunum, conveys the reduced food onwards, acts upon it, and retains it only a certain time, and on this account is called the empty-gut. There is little difference between this intestine and the next, the ileum. Both intestines are much convoluted, in order to lessen the pace of the food through them, until the great system of absorbents connected with the mysentery, shall have extracted the nutritive portion of the food or chyle from the innutritious, and carried it to the circulating system, to be distributed over every part of the body. The small intestine, the ileum, terminates in the large intestine, the cæcum or blind-gut, by a valve which prevents the return of its contents. The large intestines, the cæcum and colon, are destined to serve as a store-house for all that portion of the food which is of no use to the system, and which is usually known under the names of dung and fæces; but a portion of the absorbents have their vessels also in these, to extract all the nourishment possible to be obtained from the food, before it finally leaves the body. The rectum or straight-gut constitutes the lower termination of the abdominal viscera, and is the receptacle for the dung before it is ejected by the anus. Both the duodenum and rectum are straight, because it is not necessary that their contents should remain in them.

1647. The œsophagus of the *horse* enters the stomach in a somewhat curved direction, to prevent the regurgitation of the food. The stomach is globular, has four coats, and is small, not half so large as that of the human being compared with the bulk of the body. "The successive contraction of each part of the stomach, by producing a series of folds or wrinkles, serves to agitate the alimentary mass, and, by bringing every part of it in its time to the surface, to expose it to the influence of the gastric juice; while at the same time the whole of the contents are gradually propelled forwards. from the orifice which is connected with the œsophagus to that by which they are discharged." The duodenum in man is so named because it is twelve finger-breadths in length; in the horse it is nearly two feet in length, and is therefore misnamed. The pancreatic secretion and the bile are received into the duodenum about five inches from its commencement. The jejunum and ileum are very little distinguishable in the horse, the former being two-fifths, and the latter three-fifths of their united lengths, and both would contain eleven gallons of fluid. Of the large intestines, the cæcum is the first, and it is called the blind-gut because it has but one opening; and any thing that passes into it, having reached the blind or closed end, must return in order to escape. The ileum pierces it at right angles, and is furnished with a valve. It is principally the fluid part of the food which enters the cæcum. A horse will at one time drink a great deal more than his stomach will contain; and whatever quantity he drinks, does not remain in the stomach or small intestines, but passes on to the cæcum, and is there retained, as in a reservoir, to supply the wants of the system. The cæcum holds four gallons. The colon forms a very large portion of the large intestines, being capable of containing twelve gallons of liquid. Along the outside of both cæcum and colon run three strong bands, each of them shorter than the intestine, thus puckering them up, and forming them into sets of cells which detain the food in them for a very long time; and in order that, during this detention, all the nutriment may be extracted, they are largely supplied with blood-vessels and absorbents. At the termination of the colon commences the rectum or straight-gut, and though much smaller than the colon, is capable of containing three gallons of water. It has no bands, so that the passage of the fæces may not be retarded in it; but the sphincter muscles of the anus prevent the dropping of the dung until the horse is disposed voluntarily to expel it, which is effected by the efforts of the animal, assisted by the muscular coat of the rectum—which is stronger than any other of the intestines,—and aided by the compression of the internal oblique and transverse muscles. The entire length of the intestinal canal of a full-grown horse is ninety feet, of which the small intestines occupy sixty-six feet, and the large twenty-four. The intestines of the horse are thus about ten times as long as his body. The intestines are chiefly retained in their relative positions by the mysentery, which is a doubling of the peritoneum, including each intestine in its folds, and also enclosing the arteries, the veins, the nerves, and the vessels which convey the nutriment from the intestines to the circulation. The disproportion in size between the larger and smaller intestines, is much greater in the horse than in any of the other domesticated animals.*

1648. The stomach of the *pig* is also simple. "It is a truly omniverous one, and beautifully adapted by its pyramidal appendage and glandular structure, as well as by the villous mucous membrane with which it is lined, for the digestion of the heterogeneous food which it is destined to receive, being, perhaps, more analogous to that of the horse than to any other animal. In form it is globular." The intestines of the pig bear a stronger resemblance to those of the human being than we find in any other animal. They are sixteen times the length of the body of the animal, and the proportion of the small intestines to the large is as three to one. There are fewer cases of derangement in the intestines of the pig than in most of our domesticated animals, from the circumstance of its stomach and intestines being prepared, by the softening power of their highly mucous villous lining, for the reception and digestion of a heterogeneous mass of food, which to other animals would be actually poisonous; rendering it evident that, although the pig in a state of nature is a herbivorous animal, it was also destined to become omniverous for the service of man.†

1649. The compound stomachs of *cattle and sheep* are of very different construction from those which we have just been considering, and as the stomach alone presents any great peculiarity in the digestive organs of this and the above class of animals, our attention shall be particularly directed to it. The entire system of stomachs of the ruminants is divided into four compartments, the first being at the termination of the œsophagus, and is termed the rumen, ventriculus, or paunch. It is of great size, occupying nearly three-fourths of the abdominal cavity, and is divided into four unequal sacs, by the duplicature of the coats of the rumen. The left side of the rumen is elevated as high as to lie in contact with the left flank, through which the trochar (fig. 104) is introduced in cases of the hoven. All the food when first swallowed goes into the rumen, and is preserved there for the act of rumination; and a portion, and occasionally the greatest part, of the fluids that pass down the gullet enter the rumen. The office of the rumen is to macerate the food as received from the gullet, without altering it; and this it does by sending it into the different compartments, rubbing it down by the papillæ, and lubricating it with mucous. While in action the rumen has a swinging motion, both upwards and downwards, and backwards and forwards. The macerated and lubricated food thus passes by degrees into the second stomach or reticulum, which has the configuration of honeycomb on its surface. Its principal duty seems to be to roll the food into pellets, in preparation to be returned into the mouth by the gullet for remastication; and having apparently nothing else but this to do, it is the smallest of all the stomachs, and is ovoidal in form. The function of this stomach leads me to remark, that the œsophagus of the ruminants does not terminate in the first stomach it meets, as in the case of animals having single stomachs, but extends itself through the series of all the four stomachs, its internal lining forming portions of the roofs of all the stomachs which it passes through. The food, whether solid or fluid, may thus at the will of the animal, or under peculiar circumstances of the constitution, pass into the third or fourth stomachs without a particle of it entering into the first or second; and we know that this is the case with the food after it has

* Youatt *On the Horse*, p. 285-96,—edition of 1843.

† Youatt *On the Pig*, p. 89-90.

undergone the process of rumination, or a second mastication. The third stomach, also ovoidal in form, is called the many-plies, because it is furnished internally with a series of plies or sheets of various breadths, suspended across it, each covered with papillæ, and margined with a horny substance, for the purpose of macerating the food still more minutely, in preparation for the last or true stomach, the abomasum. This last is of an elongated form, and is covered with a villous lining, capable of supplying the gastric juice for the ultimate digestion of the food, which depends upon this organ.

1650. The smaller and larger intestines of the ruminants being divided into the same vessels, having to perform the same functions as in those of the horse and pig, it is unnecessary to recapitulate their individual structure and relative functions, further than to remark, that the larger intestines are not so cellated as in the horse, and not so disproportionably large to the smaller ones; but, that the food may not be hurried through them along their even surface, they are considerably elongated, being not less than twenty-two times the length of the body of the ox.

1651. As the internal structure of the organs of digestion of the sheep are so very similar to that of cattle, a separate notice of them seems unnecessary, further than the remark that the intestinal canal is still longer in proportion in the sheep than in the ox, being twenty-seven times the length of the body.*

1652. The process of rumination being an important one, and curious in its action, the manner in which it is performed is worth being described. "The cow is generally found couching on her right side, in order that the intestines, which are principally lodged on that side, may not press upon and interfere with the action of the rumen. After a pellet that has undergone the process of rumination is swallowed, there is a pause of two or three seconds, during which the cow is making a slow and deep inspiration. By means of this the lungs are inflated and press on the diaphragm; and the diaphragm, in its turn, presses on both the rumen and the reticulum, and assists their action. Suddenly the inspiration is cut short by an evident spasm; it is the forcible ejection of the pellet from the reticulum, and of a fresh quantity of food from the rumen over the valvular fold, to enter the reticulum as soon as it expands again. This spasmodic action is immediately followed by the evident passage of the ball up the œsophagus to the mouth. This prolonged inspiration is precisely the same as that to which the human being has recourse when he would expel a portion of the gas that distends the stomach."† No portion of the food is returned for rumination in less than 14 hours; the average period is 16 or 18 hours, and hard fibrous substances are detained 30 hours. In the ox, each pellet receives from 30 to 40 motions of the mouth: in the sheep it must receive a great many more. The stomach of the sheep is never less than half filled.

1653. The fact of the intimate connection of the œsophagus with all the stomachs of the ox or sheep, serves to explain the reason why, in administering medicine to these animals, it at times takes no effect, having dropped into the paunch instead of being carried along the œsophagian canal to the abomasum, or last stomach. This shows that a medicine, administered in the shape of a ball, would be very apt to enter into the paunch, and that medicine in a liquid state is best adapted to ruminants. Every such drink should be administered slowly to give it time to proceed to the farthest stomach.

1654. In giving drink to sheep, Youatt says, "If the assistant stands astride over the sheep, and holds the head firmly between his knees, the medicine may, in the majority of cases, be administered slowly and gently, and with the certainty of reaching its intended destination, instead of entering into and remaining useless, or worse than useless, in the paunch. There are very few things in the treatment of our ruminating patients that deserve more attention than the method of administering the required medicines. The opinions of practitioners would undergo material change with regard to the efficacy

* Youatt *On Sheep*, p. 410-65.

† Youatt *On Cattle*, p. 414-31.

of many drugs, and the doses in which they should be employed, were sufficient care bestowed on the mode in which they are given."

1655. The loss of cud in either ox or sheep is rather a symptom of approaching disease than a disease itself, and should not be overlooked, but recovered, by the administration of a little laxative medicine, accompanied with aromatic ingredients, as carraway seed and ginger. A slight circumstance will interfere with the process of rumination, such as raising an animal while in the act of rumination, or a sudden fright, or any thing that incites fear. Such interruptions, therefore, should be carefully avoided when animals are observed to be engaged in rumination.

1656. The paunch is of little use to the calf and lamb as long as they are supported wholly on milk, as that liquid, being in the prepared state, finds its way at once to the last stomach, and is easily digested. Hence it is that calves and lambs, when left at liberty, suck the teat frequently during the day.

1657. In order, therefore, to give exercise to the rumen, it is necessary, in feeding both cattle and sheep, to give at least a portion of their food in such an unprepared state as that it shall enter the rumen, and undergo rumination, before it is carried into the last stomach; and, on this account, dry fodder or cut chaff is a wholesome ingredient for cattle and sheep to partake of, along with the more nutritious and comminuted food which they receive.

1658. The digestive organs of *birds* consist of the several parts which have been enumerated as existing in quadrupeds, namely, the œsophagus, the stomach, the duodeum, jejunum, colon, and rectum; and these organs respectively perform nearly the same functions in birds as those in quadrupeds. Birds, however, are furnished with some additional organs of digestion, which perform peculiar functions—such as the crop, which is an enlargement of the œsophagus, situate between the mouth and the stomach, and seems to serve as a store for the newly acquired food which is swallowed at one time in greater bulk than could be contained by the stomach. This contrivance forms a connecting link betwixt birds and ruminating animals. Another peculiarity of structure is the preventriculus, which is also an enlargement of the œsophagus immediately above the stomach; and, being furnished with glands, its use is to furnish the stomach with a fluid which acts on the food in a similar manner to the gastric juice. The mechanical trituration of the food in the stomach is much assisted by the presence of small pieces of quartz. A third peculiarity is the insertion of the ureters into the enlarged portion of the rectum, named the cloaca. It is very generally imagined that birds pass no urine; but this is a mistake; and it is not observed to pass, because it is voided at the same time, and by the same organ as the dung, which it serves to liquify. Another gland, the bursa fabricii, is also found in the cloaca, which discharges a mucous fluid among the dung.

1659. The most important animals bred on the farm are to be found amongst the mammalia in the groups *Ruminantia*, or those which chew the cud, and *Pachydermata*, or those which have thick skins; and amongst birds in the groups *Rasores* or scrapers, *Gemitores*, or cooers, and *Natatores*, or swimmers. The characters of the quadrupeds of the farm are generally well understood, and require no particular description; but as those of the birds are less understood, it may be instructive to give here a characteristic sketch of each group from a very competent authority.

1660. *Rasores*, scrapers or gallinaceous birds. "The extensive order of the rasores or gallinaceous birds," says Professor Macgillivray, "is composed of species whose direct utility to man is more obvious than of any other group, the flesh of all of them affording a much esteemed and wholesome food, for which reason several of the larger kinds have been reduced to a state of domesticity, in which they are found to be highly profitable. In this respect, as well as in the nature of their food, and therefore also in the structure of their digestive organs, they bear an obvious analogy to the ruminating quadrupeds. To this important series belong the turkey, the peacock, the common fowl, the pheasant, and the numerous species of grouse and partridge, which, although not capable of being collectively defined by characters derived from the exterior, are yet clearly separated from all other birds by the peculiar form of their intestinal canal. . . . . Representatives of this order are found in all parts of the world, from the forests and jungles of the Indian isles, where the peacock unfolds his gorgeous train, to the frozen shores of Labrador and Greenland, where the ptarmigan burrows among the snow, in search of the scanty herbage. Certain genera are peculiar to particular regions, as the turkeys to America, the argus to India and China, the pheasants to the warm and temperate parts of Asia, the guinea-fowls to Africa; while others, as the grouse and partridges, are generally distributed. The affinities of the rasores are various; on the one hand to the pigeons, through *crax and penelope;* on the other with the bustards, which lead to the plovers; and with the gallinules and rails. They feed on seeds, berries, fruits of various kinds, and on buds, twigs, and herbaceous plants, as well as occasionally on insects and worms. Their digestive organs are peculiar, in possessing the large globular crop or recipient of their food, and the extremely large cæca, in which it undergoes a second elaboration after passing through the small intestines. The bill is, of course, admirably adapted for cutting, breaking off, or wrenching the vegetable substances on which they feed; and which are ground to a coarse pulp in the stomach, the action of which is aided by the numerous particles or fragments of quartz swallowed for that purpose. The food being comparatively nutritious, besides undergoing the usual elaboration in the intestines, requires for its complete assimilation a very great length of tube, which is supplied by the cæca. They seek their food in the ground, on which very many reside; but some are of arborial habit. They rise with great celerity, and many bear a strong, rapid, and continued flight, although for the most part they fly heavily, by continued quick flaps of their short curved wings. Their nests are placed on the ground, and very artlessly constructed, being usually a slight hollow, with some blades of green twigs or leaves. The eggs are numerous, and the young, which are born with their eyes open, and their bodies covered with short thickish down, are able to run about in a few minutes, or immediately after exclusion from the egg. From the nature of their food, they do not always require the care of their male parent, but are led by their mother, who manifests the greatest anxiety for their welfare—protects them from cold and wet under her wings, feigns lameness to draw intruders after her, while they remain squatted, and eagerly points out to them the substances on which they may feed. Many of the gallinaceous birds habitually scrape up the earth and dry leaves with their feet, for the purpose of exposing the seeds and insects; and it is for this reason that they have obtained the name of rasores or scrapers. They have also a habit, like the pigeons, huskers, and some other birds, of lying in the sand or dry earth, and scattering it over them with their feet and wings; or, rather, they are fond of basking in the sun, and of lying in warm sheltered places. The British species are too few, and too little diversified, to render it useful to speak generally of them here, farther than that, being all of moderate or large size, excepting one, they are exposed to numerous enemies, of whom, however, man, while he fosters them, commits greater havoc among them than all the rest. They belong to the genera *phasianus*, *tetrao*, *lagopus*, *perdix*, *coturnix*, and *ortyx*. The first of these belongs to the family gallinæ, of which it is not necessary to give the general characters, as our only species are the domestic fowl, with which every person is familiar—a representative sufficiently characteristic to afford a good general idea of those beautiful birds, whose natural residence is in the warmer and temperate parts of Asia, especially India and China."

1661. *Gemitores*, cooers, or pigeons.—"The beautiful, very extensive, and generally distributed family of birds known by the names of pigeons, doves, and turtledoves, appears to form an order of itself, separated by well-defined limits, but yet, as in other cases, presenting modifications of form indicative of its affinity to conterminous groups. The peculiar shape of the head and bill, more than any other external feature, serves to render the different species readily recognisable as belonging to a single tribe; for whatever may be the size, colour, or even shape of a pigeon, it cannot be mistaken. . . . . The columbinæ feed on vegetable substances, some chiefly on soft fruits, others on nuts, seeds of grasses and other plants, some on the herbaceous parts of plants. The process of assimilation seems to take place in a somewhat different manner to that of gallinaceous birds. The intestine is much longer; but in the latter the difference is made up by the great development of the cæca, which in the pigeons are merely rudimentary, that is, extremely small, and secreting a mucous fluid only. The œsophagus, crop, and gizzard are smaller in the two orders, as well as to a certain extent in the thick-billed gramineous birds. Although their legs are short, pigeons walk with great ease, and even celerity. Their flight is very unlike that of the gallinaceous birds, being strong, rapid, and protracted. Their nests are generally placed on the branches of trees or bushes, sometimes in holes, and even on the ground. They are formed of a broad basis of twigs, often without any lining, but also often lined with various soft substances, and for the most part flat. The eggs are generally two, elliptical and pure white. The young are at first scantily covered with soft down, and are fed with farinaceous or pulpy substances, which have undergone some degree of maceration in the crop of the parent bird, from the mouth of which they receive it by introducing their bill sideways. In this respect, also, pigeons differ greatly from the gallinaceous birds. In their mode of drinking, also, a remarkable difference is observed; for while they immerse their bill to the base in the water, and drink continuously, the gallinaceous birds take a mouthful, elevate their heads to enable them to swallow it with ease, and repeat the action until satisfied. The young remain in the nest until able to fly, soon after which they are left to shift for themselves; whereas the young rasores follow their mother abroad immediately after birth, and are never far from her mouth, but pick up the substance she points out to them. The pigeons, like many other birds, are fond of basking in the sun, and of rubbing themselves in the dust or sand, and scattering it over them. These birds are found in all the warm and temperate parts of the globe, but are much more abundant, and exhibit the most beautiful tints, in the former often rivalling the parrots in the splendour of their plumage. Only four species occur in Britain, three of which are resident; the fourth, the ringed turtle-dove, migratory, remaining in the south of England during the summer months." *

1662. *Natatores*, swimmers, anserian birds. In consequence of the valuable work on the British birds by Professor Macgillivray being in an unfinished state, I am unable to give any description of the digestive organs of the class of birds which embraces the goose and duck, the only aquatic birds bred on the farm. I must therefore confine myself to a few general remarks on the *Anatidæ*, or duck tribe, from the most recent publication I can find. "A family of web-footed birds; order Natatores. They are distinguished by a broad depressed bill, which is covered with a soft skin, and by the hind toe not being included in the web. The bill is furnished with a set of horny laminæ at the edge of each mandible, which serve to filter the fluid taken up by the bill, and retain the solid substances taken up with it; the tongue is large and fleshy, the gizzard strong and muscular, and lined with a tough coat, so as to be capable of grinding down the shells of the mollusca on which they feed. Many are migratory, and fly with great strength at a considerable elevation."†

1663. Having thus seen what the construction is of the peculiar apparatus which elaborates the food sent into it, and that the structure of the digestive organs of all classes of the domesticated animals, bred on the farm, bear so much similarity,—that the same sort of food may support them all alike,—we should now consider what are the constituent parts of the food which are required to support and increase the particular parts of the body.

* Macgillivray's *History of British Birds*, vol. i. p. 103 and 249. Those who desire to acquire a knowledge of the comparative anatomy of birds, cannot do better than peruse the introductory part of the first volume of this valuable work, from page 20 to page 92; and here they will also find an interesting account of a beautiful subject—the structure and classification of the feathers of birds.

† Maunder's *Treasury of Natural History*, art. *Anatidæ*.

The animal body, we all know, is made up, in a general sense, of a hard bony skeleton, which forms the frame-work that acts as a support to the rest of the body. Bone is found, by chemical analysis, to consist of 65 per cent of mineral matter, chiefly phosphate of lime. Upon and attached to this bone are large masses of fibrous flesh, which constitute the muscles of the body. About 77 per cent of this muscle consists only of water, and the remaining 23 per cent is chiefly composed of fibrin, the characteristic properties of which are supposed to be derived from the large proportion of nitrogen which it contains — about 16 per cent. Large quantities of fat are found dispersed over all parts of the animal body. It is found to be composed chiefly of carbon. The intestines, veins, nerves, are composed chiefly of fibrous matter. Of the juices of the body, the largest proportion consists of water; and of the fluids, the blood composes the largest proportion, and the dry part of the blood has much the same composition as fibrin.

1664. Now, you have seen from the composition already given of the several vegetables and grains raised on farms, for the support of the domesticated animals, that they contain principally starch and sugar, which consist of carbon, hydrogen, and oxygen, and the protein compounds, which last comprehend all the substances that contain nitrogen, such as albumen, fibrin, casein, gluten. And the composition of the ash of such of the vegetable substances as has been given, indicates that it is composed principally of lime, phosphoric acid, and the alkalies potash and soda. So that the vegetables and grains raised on the farm contain, in their composition, all the materials necessary to form all the water, bone, fibrin, fat, and fluids, which compose the animal body.

1665. In the application of these substances to the particular state of the animal economy, it should conform with reason to give such of them as contain phosphoric acid and lime most abundantly to young animals, because these are still forming their bones, and will until the skeleton is fully developed. The substances which supply fibrin freely should be given to animals at all ages, as the enlargement of muscle is one of the principal objects of the breeder of live-stock. And those substances which supply fat should chiefly be given when it is desired to fatten the animals for the butcher or domestic use. This seems a very simple view of the rearing and fattening of animals; but in practice it is not so easy as it is simple in theory, for the vital principle often interferes very influentially with the desired results, by creating differences in the constitution of animals reared under exactly similar circumstances, as to give so complete a bias to the results as evidently to place the forming of the condition of any particular animal almost beyond our control. Still, as much of the result accords with expectation as to encourage us to persevere in the improvement of the rearing and fattening of our live-stock.

1666. As no one has done so much of late years to explain the process of digestion, and, in consequence, to establish the practice of feeding animals upon rational and truly scientific principles—a rough sketch of which I have attempted to give in a preceding paragraph,—as the now famed Liebig of Giessen in Germany, it is but fair to give his views on the subject, and which I find ably done to my hand by Dr Gregory of Edinburgh, in his edition of a recent work of great merit. "The life of animals," he says, "is distinguished chemically from that of vegetables by the circumstance, that by animals oxygen is constantly absorbed and replaced by carbonic acid, while, by vegetables, carbonic acid is absorbed, its carbon retained, and its oxygen given out. Consciousness, and the power of locomotion, are peculiar to animals. In animals, two processes are constantly carried on—that of respiration, by which the animal heat is kept up; and that of nutrition, by which the matter consumed in the vital functions, and expelled from the body, is restored. Respiration is essentially a combustion of carbon and hydrogen, which, in combining with oxygen, are converted into carbonic acid and water, and at the same time furnish the animal heat. Liebig calculates that the amount of carbon daily burned in the body of an adult man is about 14 ounces, and that the heat given out is fully sufficient to keep up the temperature of the body, and to account for the evaporation of all the gaseous matter and water expelled from the lungs. This carbon is derived, in the first place, from the tissues of the body, which undergo a constant waste, but alternately from the food. . . . . The tissues can only be decomposed by the exercise of the vital functions, and the food of the herbivora contains but little of the albuminous compounds, only sufficient to restore the waste of the tissues; while the carbon required for respiration is supplied by the starch, gum, sugar, oil, &c., which form the great mass of their food, and no such amount of muscular motion is required in them as in the carnivora. It is in the form of bile, chiefly, that the carbon undergoes combustion. Hitherto the true function of the bile has been disputed. . . . . . The tissues, which are consumed, are resolved first into bile and urate of ammonia. The former is secreted from the liver, reabsorbed, and burned. The latter, in serpents and birds, is expelled unchanged; but in man and quadrupeds, in whom the amount of oxygen inspired is much greater, it also is oxidised, yielding finally carbonic acid, ammonia, and urea. . . . . . The urine of the herbivora differs from that of man, in containing, besides urea, much hippuric acid when they are at rest or stall-fed, and benzoic acid when they are in full exercise, and when, consequently, more oxygen is supplied. The bile of the herbivora is much more abundant than that of the carnivora,—an ox secreting, according to Burdach, 37 lbs. of bile daily. As the waste of matter in the herbivora is but limited, it is obvious that it cannot supply all the bile, and, consequently, a great part must be derived from the starch and other non-azotised constituents of their food, which lose oxygen, and enter into combination with some azotised product of the decomposition of the tissues. . . . Soda is necessary for the formation of bile, and is supplied in the form of common salt: when the supply of soda is defective, the metamorphosis of albuminous compounds can yield only fat and urea. Now, it is worthy of observation that, if we wish to fatten an animal, we must carefully avoid giving it much salt in its food. . . . . In the urine of the herbivora, soda is present in far larger quantity than that of the carnivora, and combined with carbonic, hippuric, or benzoic acid. This shows that the herbivora require a far greater amount of soda than is contained in the amount of blood—constituents daily consumed, which in them is small; and this soda is obtained from their food, and employed in producing their abundant bile. The plants in which the herbivora feed cannot grow in a soil destitute of alkalies; but these alkalies are not less necessary for the support of the animals than of the plants. The soda is found in the blood and bile; and the potash is now known to exist in large quantity in the juice of flesh, and to be absolutely essential to the production of casein, that is, the secretion of milk. In like manner the phosphate of lime, which is essential to the growth of grasses, is equally essential to the production of bone in the animals which feed on these plants. It is impossible not to be penetrated with admiration of the wisdom which is shown in these beautiful arrangements.

1667. "Let us now consider the changes which the food undergoes in the process of digestion. When the food has entered the stomach, the gastric juice is poured out, and after a short time the whole is converted into a semi-fluid homogeneous mass, the chyme. Many researches have been made to discover the solvent contained in the gastric juice, but in vain. It contains no substance which has the property of dissolving fibrin, albumen, &c.; and we are compelled to adopt the opinion of Liebig, according to which the food is dissolved in consequence of a metamorphosis analogous to fermentation, by which a new arrangement of the particles is effected. As in fermentation, the change is owing to the presence of a body in a state of decomposition or motion, which is propagated from the ferment to the sugar in contact; so, in digestion, the gastric juice contains a small quantity of a matter derived from the living membrane of the stomach, (1810,) which is in a state of progressive change; and the change or motion is propagated from this to the particles of the food, under certain conditions, such as a certain temperature, and, as it now appears, the presence of a free acid, which is phosphoric or lactic, or both. . . . Besides the gastric juice, the only other substance employed in digestion is the oxygen which is introduced into the stomach with the saliva, which, from its viscidity, encloses a large quantity of air. The chyme then leaves the stomach, and gradually passes into the state of chyle, which resembles blood, except in colour, being already alkaline, not acid like the chyme. By means of the circulation, oxygen is conveyed in the arterial blood to every part of the body. This oxygen, acting on the tissues destined to undergo change, produces a metamorphosis by which new soluble compounds are formed. The tissues thus destroyed are replaced by the new matter derived from the food. Mean time, those of the products of metamorphosis which contain the principal part of the carbon are separated from the venous blood in the liver, and yield the bile; while the nitrogen accumulates, and is separated from the arterial blood in the kidneys, in the form of urea or uric acid.

1668. "The blood has another important function to perform, namely, to convey for excretion to the lungs the carbonic acid formed in the extreme vessels or cells in all parts of the body. There is reason to believe that the globules of blood possess the property of absorbing oxygen in the lungs, when they become arterial, and thus convey this oxygen to all parts. The globules then give up the oxygen to the particles of the tissues undergoing change, and in its stead carbonic acid is taken up, and the blood becomes venous. It is not known what chemical compound in blood absorbs and carries the oxygen, but it is by some conjectured to be a compound of iron analogous to the protoxide. It is certain that air is indispensable to the blood, and it is remarkable that sulphuretted hydrogen and hydrocyanic acid both instantly destroy the power of the blood to perform its functions—hence their horrible energy as poisons, when inhaled. Now, these compounds both act on protoxide, protochloride, and other analogous compounds of iron, immediately depriving them of their characteristic power of acting on oxygen.

1669. "With regard to the carbonic acid which is produced in all parts of the body in the continual metamorphosis of the tissues, Enderlin has proved that blood contains no carbonates whatever; and Liebig has since recently pointed out that the required properties exist in a still higher degree in the phosphate of soda, which does exist in the blood, and appears to be altogether indispensable to its existence. No salt known is so well adapted for this function. It is truly remarkable that, while both phosphate of soda and phosphate of potash exist in the food, the former alone should occur in the blood; and this is especially wonderful when we consider that the juice of the flesh, which is only separated from the blood by various thin membranes, permeable to liquids by endosmose and exosmose, contain much phosphate of potash, and little or no phosphate of soda. It is evident that the vessels or cells must possess in their peculiar membranes a power of selection, or of allowing some salts to pass in one direction only, and others in the opposite. . . . . There can be no doubt that the function of the acid salt, the phosphate of potash, in the juice of the flesh, and apparently also in the gastric juice, is as important as that of phosphate of soda in the blood. Probably a part of that function is to insure the constant acidity of these fluids, as phosphate of soda does the constant and essential alkalinity of the blood, in which the power of absorbing and giving out carbonic acid—in other words, respiration—depends. And we see, too, that if this be so, the phosphate of potash, of the juice of flesh, and of the gastric juice, cannot be replaced, as far as its functions are concerned, by phosphate of soda.

1670. "Another probable function of the substances which give acidity to the juice of the flesh, and alkalinity to the blood, is the production of electric currents. It has been shown by Matteucci that such currents exist in the body; and we can easily see how they may arise, when we observe two fluids, one acid, the other alkaline, separated by a membrane permeable to one or both, and the fluids in contact with muscle and with nervous matter. At the request of Liebig, Buff constructed piles of discs of pasteboard steeped in blood, with slices of muscle and brain, which showed a powerful current from the blood to the muscle.

1671. "Since no blood can be formed without soda, no animal could live if confined to such inland plants as contain only potash. It is well known, indeed, that animals in countries far inland, as Bavaria, are habitually supplied with common salt, either in substance or in the form of salt-springs. Of both they are instinctively fond. But fortunately salt is found, in even inland countries, in all soils and in all waters, and consequently in most plants. Were it altogether absent no blood could be formed, unless salt or soda were artificially supplied to every animal. All inland plants contain earthy phosphates, and phosphate of potash, in variable proportion, often with mere traces of the compounds of sodium. When these phosphates act as common salt, (chloride of sodium,) there are formed chloride of potassium and the common alkaline phosphate of soda, which latter salt is absolutely indispensable to the formation of blood. The chloride of potassium is found in the juice of flesh.

1672. "It is truly a spectacle worthy of admiration, to see the essential properties of two of the most important animal fluids —the blood and the juice of flesh—thus secured by the existence of a difference, at first sight altogether insignificant, between the relation of phosphoric acid to two alkalies, which so much resemble one another that they may be mutually replaced, each by the other, in a multitude of cases—nay, do actually replace each other in many plants. The reader will not fail to remark, how emphatically these facts impress on us the necessity of attending carefully to the most minute characters of all the compounds which can be formed among the elements composing the organic kingdom, even when these characters appear, at the time, to have no considerable relation to the vital processes.

1673. "The researches of Dr R. D. Thomson have demonstrated, that the most favourable proportion between the albuminous or azotised, and the saccharine or non-azotised constituents in the food of animals, is that of 1 part by weight of the azotised to 7 or 8 of the saccharine. This proportion exists naturally in the most nutritious food, such as grain; while in such food as potatoes, the amount of albuminous matter is much too small. Hence potatoes alone must be regarded as very inferior in nutritive power to wheat, oats, rye, or maize, equal weights being compared.

1674. "There is another constituent of the animal body, namely, fat, the production of which deserves notice. It is not an organised tissue, but is formed and collected in the cellular tissue under certain circumstances. These are, rest and confinement,—that is, a deficiency of oxygen, and an abundance of food containing a considerable proportion of non-azotised matter, such as starch, sugar, &c. . . . . . Now the chief source of fat is sugar, the composition of which is such, that when deprived of oxygen fat remains. . . . It is obvious, therefore, that fat can only be formed by a process of deoxidation. But it is produced when oxygen is deficient; and it appears, as Liebig has pointed out, that, when there is a deficient supply of oxygen, the production of fat, which is the consequence of the deficiency, yields a supply of that element, and thus serves to keep up the animal heat and the vital functions, which would otherwise be arrested. This is another beautiful instance of contrivance equally simple and wonderful. That fat must be formed by the deoxidising process is proved by the phenomena of the fattening of animals. A goose tied up, and fed with farinaceous food, altogether destitute of fat, acquires in a short time an increase of weight of several pounds, the whole of which is fat. Again, the bee produces wax, a species of fat, from pure sugar.

1675. "With regard to the production of nervous matter, which animals alone can form, we see, from its composition, intermediate between that of albumen and fat, that it may be formed, either by depriving albuminous matter of some azotised product, or by adding to fat an azotised compound. Where it is formed we do not know, but it must be formed in the animal body; and Liebig has suggested, that the power of the vegetable alkalies to affect the nervous system may be owing to their composition, which approaches nearer to that of nervous matter than any other compounds. These alkalies may promote or check the formation of nervous matter, and thus produce their peculiar effects."*

1676. These observations tend to show, that we may expect in progress of time to explain a large class of phenomena connected with animal life on chemical principles. We cannot do so yet, notwithstanding the plainness of the views propounded by Liebig. He may have opened up the true path, but it is for experimenters to pursue it with research and perseverance, in order to confirm or refute his views. As yet, philosophers are by no means agreed as to the circumstances which regulate the process of digestion: some would ascribe our ignorance of it on account of the intricacy of the subject, the obscurity which attends it, and the deficiency of observation as to the true nature of the process; whilst others regard the process as simple, referring the preparation of the food in the stomach to the presence of an acid in that organ, which dissolves the food, and enables it to enter as a constituent of the circulating fluids of the animal system. The acid which effects this important object is the hydrochloric acid, which they consider to have been satisfactorily proved to be present during the period when food exists in the stomach; and they conceive they can imitate the process of animal digestion in glass, or other vessels out of the body, simply by exposing animal and vegetable food to the influence of dilute acids. The subject is not so very simple in nature as it would seem to be when conducted in a glass vessel. There are indications, no doubt, of the direction in which we are to search for a solution of the difficulties of the subject, but we are still at a great distance from the elucidation of the precise manner in which animals digest their food.

1677. "There cannot be a doubt," as Dr R. D. Thomson observes, "that if we understood the nature of the process by which the food which we swallow is converted into living flesh, important results would follow in reference to the preservation of the health of animals, and the treatment of diseases. If we were properly acquainted with every transformation through which the constituents of the food pass, after it has been masticated, until it is finally removed from the system, it is clear that, in cases where the stomach is unable to perform its accustomed functions, the assistance of art might be called in to minister to digestion." If Dr Thomson, who has experimented so largely on the subject, feels any difficulty in it, it must indeed be difficult. His own researches were conducted with a view to arriving at a practical result—namely, the comparative effects of certain given articles of food on the fattening or secreting powers of animals; and these "seem to demonstrate, that the fat of animals cannot be produced from the oil of the food, but must be evolved from the calorifiant or heat-forming portion of the animal, essentially assisted by its nitrogenous materials. By following out this principle, he has been enabled to detect an important relation existing between the nutritive and calorifiant portion of the food, upon the determination of which, for the various conditions of animals, he considers the laws of animal dieting depend. He endeavoured to apply the law to various articles of human food; and he trusts that the basis has been laid for future researches, which may be directed to administer to the health and comfort of mankind, and of the domesticated animals. In conducting the experiments upon cattle, he found not only his habitual acquaintance with animals, but also his medical knowledge, in continual requisition, in consequence of the tendency of the varied condition of the animal system, from the sudden and frequent changes of diet, to induce symptoms of disease. These were carefully watched and overcome, by such precautions as clearly follow from a close consideration of the principles announced in his work."† This work I would recommend for perusal by every student of agriculture.

ON THE ACCOMMODATION OF THE GRAIN CROPS IN THE STEADING.

1678. On looking at the plan of the stead-

* Turner's *Elements of Chemistry*, p. 1314–25, 8th edition, 1847. In Grisenthwaite's *Essay on Food*, the source of animal heat being the combustion of carbon, derived from the food, in the lungs, was demonstrated in 1838, much in the same way as it is by Liebig at the present time.

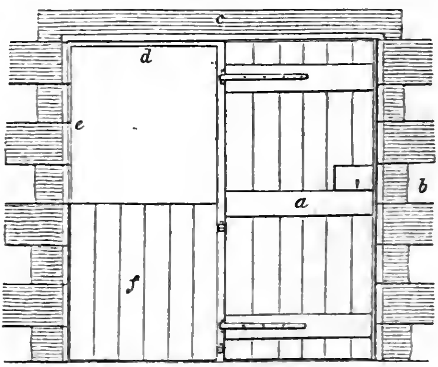
† Thomson's *Researches on the Food of Animals*, p. vi. Preface.

ing in Plate II, it will be observed that the thrashing-machine, placed in the upper barn above the corn-barn C, the machine for separating the corn from the straw, is in the middle of the great range of the steading, ready to receive the unthrashed crop from the stack-yard behind it, S, and as ready to deliver the straw thrashed into the straw-barn L, and the grain into the corn-barn C below. The *straw-barn* L, is purposely made of the height of the upper barn, to contain a large quantity of straw, as it is often convenient in bad weather to thrash out a considerable quantity of corn, when no other work can be proceeded with, or when high market-prices induce farmers to take advantage of them. There is another good reason for giving ample room to the straw-barn. Every sort of straw is not suited to every purpose, one sort being best suited for litter, and another for fodder. This being the case, it is desirable to have always both kinds in the barn, that the fodder-straw may not be wasted in litter, and the litter-straw given as fodder to the injury of the animals. Besides, the same sort of straw is not alike acceptable as fodder to every class of animals. Thus wheat-straw is a favourite fodder with horses, as well as oat-straw, whilst the latter only is acceptable to cattle. Barley-straw is only fit for litter. To give access to litter and fodder straw at the same time, it is necessary to have a door from each kind into each court. Thus four doors, two at each side near the ends, are required in a large straw-barn. Slit-like openings should be made in its side-walls, to admit air and promote ventilation through the straw. A skylight in the roof, at the end nearest the thrashing-machine, is useful in giving light to those who take away and store up the straw from the thrashing-machine when the doors are shut, which they should be whenever the wind happens to blow too strongly through them into the machine against the straw. Instead of dividing straw-barn doors into two vertical leaves, as is usually done, they should be divided horizontally into an upper and lower leaf, so that the lower may always be kept shut against intruders, such as pigs, whilst the upper admits both light and air into the barn. One of the doors at each end should be furnished with a good stock-lock and key, and thumb latch, and the other two fastened with a wooden hand-bar from the inside. The floor of the straw-barn is seldom or never flagged or causewayed, though it is desirable it should be. If it were not so expensive, the asphaltum pavement would make an excellent floor for a straw-barn. Whatever substance is employed for the purpose, the floor should be made so firm and dry as to prevent the earth rising and the straw moulding. Mouldy straw at the bottom of a heap superinduces throughout the upper mass a disagreeable odour, and imparts a taste repugnant to every animal. That portion of the floor upon which the straw first alights on sliding down the straw-screen of the thrashing-machine, should be strongly boarded, to resist the action of the forks when removing the straw. Blocks of hard wood, such as the stools of hard-wood trees, set on end causewaywise, and sunk into the earth, form a very durable flooring for this purpose. Stone flagging in this place destroys the prongs of the pitchforks. The straw-barn should communicate with the chaff-house by a shutting door, to enable those who take away the straw to see whether the chaff accumulates too high against the end of the winnowing-machine. The communication to the wool-room in this plan is by the straw-barn, by means of a stair made of wood or stone. The straw-barn is 72 feet in length, 18 feet in breadth, and 15 feet in height to the top of the side walls.

1679. C is the *corn-barn*. Its roof is formed of the floor of the upper barn, and its height is generally made too low. The higher the roof is, the more easily will the corn descend to be cleaned from the thrashing-machine down the hopper to the winnowing-machine. Nine feet is the least height it should be in any instance. The plan gives the size of the corn-barn at 31 feet by 18 feet; by taking 5 feet for partitioning off the machinery of the thrashing-mill, the extent of the workable part of the barn floor will be 26 feet by 18 feet. In that space I have seen much barn-work done. The corn-barn should have in it at least two glazed windows, to admit plenty of light in the short days of winter, and they should be guarded outside with iron stanchions. If one window cannot be got to the south, the door when open will answer for the admission of sunshine to keep the apartment comfortably dry for the work-people and the grain. The door is generally divided into upper and lower halves, which, as usually placed, are always in the way when the winnowing-machine is used at the door. A more convenient method is to have the door in a whole piece, and when opened, to fold back into a recess in the outer wall, over the top of which a plinth might project to throw off the rain. In this case the ribats and lintel must be giblet-checked as deep as the thickness of the door, into which it should close flush, and be fastened with a good lock and key, and provided with a thumb-latch. The object of making the corn-barn door of this form is to avoid the inconvenience of its opening into the barn, where, unless it folds wholly back on a wall, is frequently in the way of work, particularly when winnowing roughs, and taking out sacks of corn on men's backs. As to size, it should not be less in the opening than 7½ feet in height and 3½ feet in width. A light half-door can be hooked on, when work is going on, to prevent the intrusion of animals, and the wind sweeping along the floor. The floor of the corn-barn is frequently made of clay, or of a composition of ashes and lime; the asphaltic composition would be better than either; but in every instance it should be made of wood,—of sound hard red-wood Drahm battens, ploughed and feathered, and fastened down to stout joists with Scotch flooring sprigs driven through the feather-edge. A wooden floor is the only one that can be depended on being constantly dry in a corn-barn; and in a barn for the use of corn, a dry floor is indispensable. It has been suggested to me that a stone pavement, square-jointed, and laid on a bed of lime over 9 inches of broken stones—or an asphaltum pavement, laid on a body of 6 inches of broken stones, covered with a bed of grout on the top of the stones, would make as dry and a more durable barn-floor than wood, and which will not rot. No doubt stone or asphaltum pavement is durable, and not liable to rot; but there are objections to both, in a corn-barn, of a practical nature, and it is certain that the best stone pavement is not proof against the undermining powers of the brown rat: whilst a wooden floor is durable enough, and certainly will not rot, if kept dry in the manner I shall recommend. The objections to all stone pavements as a barn-floor are, that the scoops for shovelling the corn pass very harshly over them,—the iron nails in the shoes of the work-people wear them down, raise a dust upon them, and crush the grain,—and they are hurtful to the bare hands and light implements, when used in taking up the corn from the floor. For true comfort in all these respects in a barn-floor, there is nothing like wood. The walls of this barn should be made smooth with hair-plaster, and the joists and flooring forming its roof cleaned with the plane, as dust adheres much more readily to a rough than to a smooth surface. The stairs to the granaries should enter from the corn-barn, and a stout plain-deal door with lock and key placed at the bottom of each. And at the side of one of the stairs may be enclosed on the floor of the barn, a space *t*, to contain light corn to be given to the fowls and pigs in summer, when this sort of food becomes scarce.

1680. As the method of hanging doors on a giblet-check should be adopted in all cases in steadings where doors on outside walls are likely to meet with obstructions on opening inwards, or themselves becoming obstructive to things passing outwards, the subject deserves a separate notice. In fig. 128, *a* is the inside form

Fig. 128.

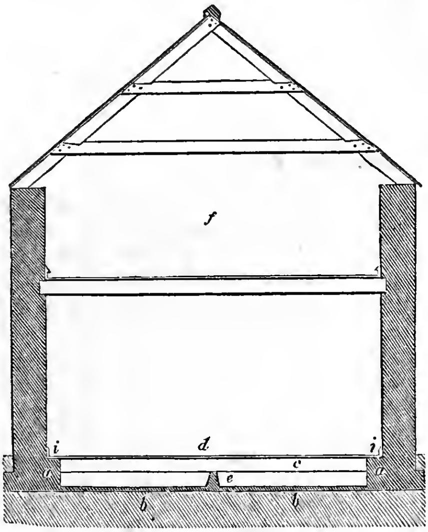


THE CORN-BARN DOOR.

of a strong door, mounted on crooks and bands, fully open, and thrown back into the recess of the wall *b*, the projecting part of the lintel *c* protecting it effectually from the rain; *d* is the giblet-check in the lintel, and *e* that in the ribats, into which the door shuts flush; *f* is the light movable door used when work is going on in the corn-barn.

1681. The wooden floor of the corn barn is liable to decay unless precautions are used to prevent it; but a much too common cause of its destruction is vermin—such as rats and mice. I used a most effectual method of preventing the destructive ravages of either vermin or damp, by supporting the floor in the particular manner represented in fig. 129.

Fig. 129.



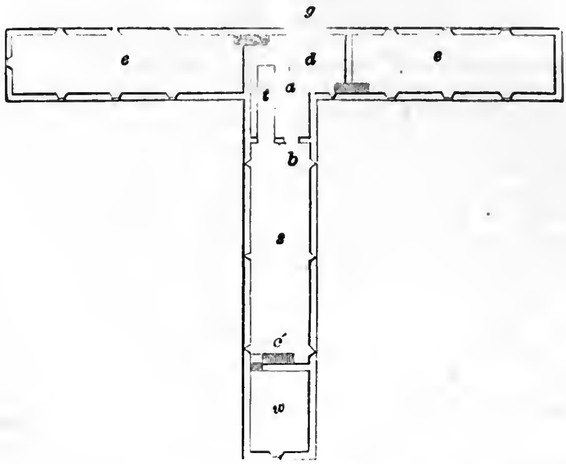
SECTION OF THE CORN-BARN FLOOR.

The earth, in the first instance, was dug out of the barn to the depth of the foundation walls, which should be two feet below the door soles, and in the case of the building of a new steading, this can be done when the foundations of the walls are taken out. The ground is then spread over with a layer of sand, sufficient to preserve steadiness in the stout rough flags *b b* which are laid upon it and jointed in strong mortar. Twelve-inch thick sleeper walls *a a*, of stone and lime, are then built on the flags, to support the ends of the joists of the floor. The ends of the joists *c*, formed of 10 by $2\frac{1}{2}$ inch plank, are then laid on edge upon the walls 16 inches apart, and the spaces between them filled up to the top of the joists with stone and lime. The building between the joists requires to be done in a peculiar way. It should be done with squared rubble stones, and on no account should the mortar come in contact with the joists, as nothing destroys timber, by superinducing the dry rot, more readily than the action of mortar. For the same reason care should be observed in building all the joists into the walls, in placing the safe-lintels over the doors and windows dry-bedded; and in beam-filling between the couple-legs. The floor *d* is then laid on a level with the door-sole, and finished with a neat skifting board *i i* round the walls of the barn. By this contrivance the vermin cannot possibly reach the floor but from the flags *b*, which are nearly 2 feet under it. A hewn stone pillar *e*, or even two, are placed on the flags under each joist to support and strengthen the floor. This construction of floor freely admits the air above and below to preserve it, and affords room under it for cats and dogs to hunt after the vermin. The figure also gives a section of the building above the corn-barn, constituting the upper barn *f*, having similar outside walls, coupling, slating, and ridging of the roof to the middle range of the building.

1682. The *chaff-house* stands between the corn and straw barns. It is separated from the former by a wooden partition, and from the latter by a stone wall. Its height is the same as that of the corn-barn, the floor of the upper barn forming a roof common to both. It is 18 feet in length and 14 feet in width. It contains the winnowing-machine, or fanners of the thrashing-machine, from which it receives the chaff. It has a thin door with a thumb-latch into the straw-barn, for a convenient access to adjust the gearing of the fanners; as also a boarded window, hung on crooks and bands, fastened in the inside with a wooden hand-bar, and looking into the large court K; but its principal door, through which the chaff is emptied, opens outwards into the large court I. This door should be giblet-checked, and fastened from the inside with a wooden hand-bar. The space between the head of the fanners and the wall should be boarded up, but not to interfere with the action of the fanner-belts, and merely to prevent the chaff being scattered among the machinery, and persons climbing up by it into the upper barn.

1683. The *upper barn d*, fig. 130, occupies the whole space above the corn-barn and chaff-house. It is 32 feet in length and 30 feet in breadth, and its roof ascends to the slates. It has a good wooden floor like the corn-barn, supported on stout joists. It contains the principal machinery of the thrashing-machine, and is wholly appropriated to the storing of the unthrashed corn previous to its being thrashed by the mill. For the admission of barrows loaded with sheaves from the stack-yard, or of sheaves direct from the cart, this barn should have a door at *g* towards the stack-yard of 6 feet in width, in two vertical folds to open outwards, on a giblet-check, one of the folds to be fastened in the inside with an iron cat-band, and the other provided with a good lock and key. It is in this barn that the corn is fed into the thrashing-mill; and to afford light to the man who feeds in, and ample light to the barn when the door is shut, which it should be when the wind blows strongly into it, a skylight should be placed above the place where the man stands. The large door should not be placed immediately behind the man who feeds in the corn into the thrashing-machine, as is frequently the case in farmsteads, to his great annoyance when the sheaves are bringing in. There should be slits in the walls for the circulation of air among the corn-sheaves, which may not at all times be in good order when taken into the barn. A hatchway *a*, 3 feet square, in the floor, over the corn-barn below, is useful for handing up any corn or refuse that has to be again put through the mill. Its hatch should be furnished with strong cross-tailed hinges, and a hasp and staple, with a padlock and key, by which to secure it from below in the corn-barn. An opening *b* of 4 feet in height and 3 feet in width, should be made through the wall to the straw-barn, to receive any straw that may require to be put through the mill again. This opening should be provided with a door of one leaf, or of two leaves, to fasten with a bar, from the upper barn. The thrashing-machine is not built on the floor, but is supported on two very strong beams extending along the length of the barn: *t* is the site of the thrashing-machine in this figure. The allusion to the entrance to the wool-room when speaking of the straw-barn (in 1678,) is here shown by the stair *c′* into the wool-room *w*, which is above the bulls' hammels X, Plate II., and on a level with the upper barn *d*.

Fig. 130.

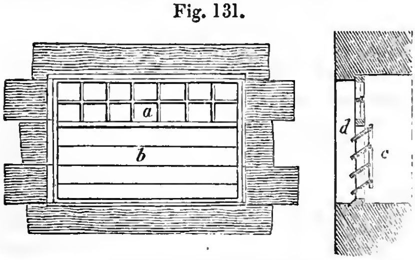


PLAN OF UPPER BARN, GRANARIES, AND WOOL-ROOM.

1684. Immediately in connexion with the upper barn is the *gangway g*, fig. 130. It is used as an inclined plane, upon which to wheel the corn-barrows, and forms a road for the carriers of sheaves from the stack-yard. This road should at all times be kept hard and smooth with small broken stones, and sufficiently strong to endure the action of barrow-wheels. Either asphaltum or wood pavement would answer this purpose well. To prevent the gangway affecting the wall of the corn-barn with dampness, it should be supported on a semicircular arch of masonry. Some farmers prefer taking in the corn on carts instead of by a gangway, and the carts in that case are placed alongside the large door, and emptied of their contents by means of a fork. I prefer a gangway for this reason, because it enables the farmer to dispense with horse-labour in bringing in the stacks if they are near at hand, and they should always be built near the upper barn for convenience. Barns, in which flails alone are used for thrashing the corn, are made on the ground, and the barn-door is made as large as to admit a loaded cart to enter and empty its contents on the floor.

1685. In fig. 130, *e e* are two granaries over the cattle sheds, poultry-house, and hay-house. That on the left is 76 feet in length and 18 feet in width, and the other 65 feet in length and 18 feet in width. The side walls of both are 5 feet in height. Their roofs ascend to the slates, as in the upper barn *f* fig. 129. Their wooden floors should be made strong, to support a considerable weight of grain; their walls made smooth with hair plaster; and a neat skifting-board should finish the flooring. Each granary has 6 windows, three in front and three at the back, and there is one in the left-hand gable. These windows should be formed to admit light and air freely; and I know of no form so capable of affording both, as fig. 131. The opening is 4½ feet in length and 3 feet in height. In the frame *a* are a glazed sash 1 foot in height, composed of two rows of panes, and *b* Venetian shutters, which may be opened more or less at pleasure: *c* shows in section the

Fig. 131.

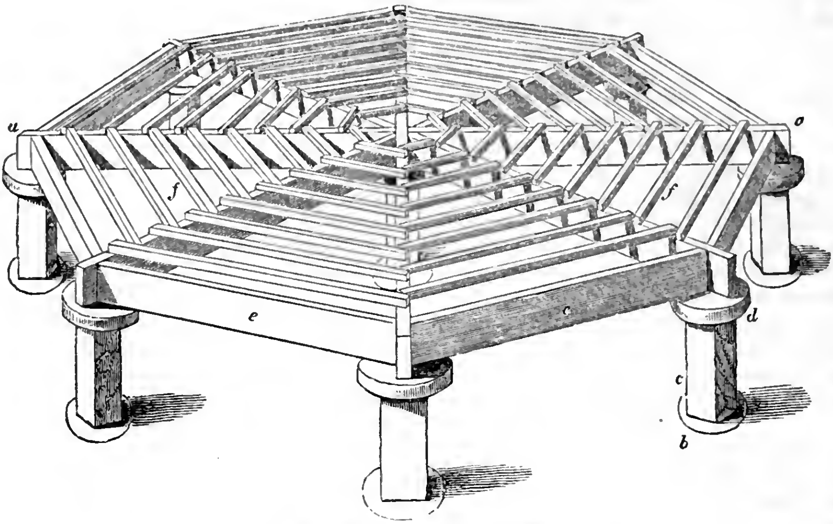


GRANARY WINDOW AND SECTION OF SHUTTERS.

manner in which these shutters operate. They revolve by their ends, a round pin, in holes in the side-posts of the frame *d*, and are kept in a parallel position to each other by the bar *c*, which is attached to them by an eye of iron, moving stiff on an iron pin passing through both the eye and bar *c*. The granary on the right hand being the smallest, and immediately over the work-horse corn-chest in the hay-house, should be appropriated to the use of horse-corn and other small quantities of grain to be first used. The other granary may contain seed-corn, or grain that is intended to be sold when the prices suit. For repairing or cleaning out the thrashing-machine, a large opening in the wall of this granary, exactly opposite the machinery of the mill in the upper barn, at *t*, fig. 130, will be found convenient. It should be provided with a movable board, or folding doors, to close it in, and to be fastened from the granary. This opening is not shown in fig. 130.

1686. S is the plan, Plate II., of the *stack-yard*. As most of the stacks must stand on the ground, it should receive that form which will allow the rain-water to run off and not injure their bottoms. This is done by forming the ground into ridges. The minimum breadth of these ridges may be determined in this way: The usual length of the straw of the grain crops can be conveniently packed in stacks of 15 feet diameter; and as 3 feet is little enough space to be left on the ground between the stacks, the ridges should not be of less width than 18 feet. The stack-yard should be enclosed with a substantial stone and lime wall of 4½ feet in height. In too many instances the stack-yard is entirely unenclosed, and left exposed to the trespass of every animal. It is desirable to place the outside rows of the stacks next the wall on *stools* or *stathels*, which will not only keep them off the wet ground, should they remain a long time in the stack-yard, but in a great measure prevent vermin getting into the stacks. These stathels are usually and most economically made of stone supports and a wooden frame. The frame is of the form of an octagon, and under its centre and each angle is placed a support. The frame-work consists of a plank *a a*, fig. 132, 15 feet in length, and of others 7½ feet in length, 9 inches in depth, and 2½ inches in thickness, if made of Scots fir, but less will suffice with larch. The supports consist of a stone *b*, sunk to the level

Fig. 132.



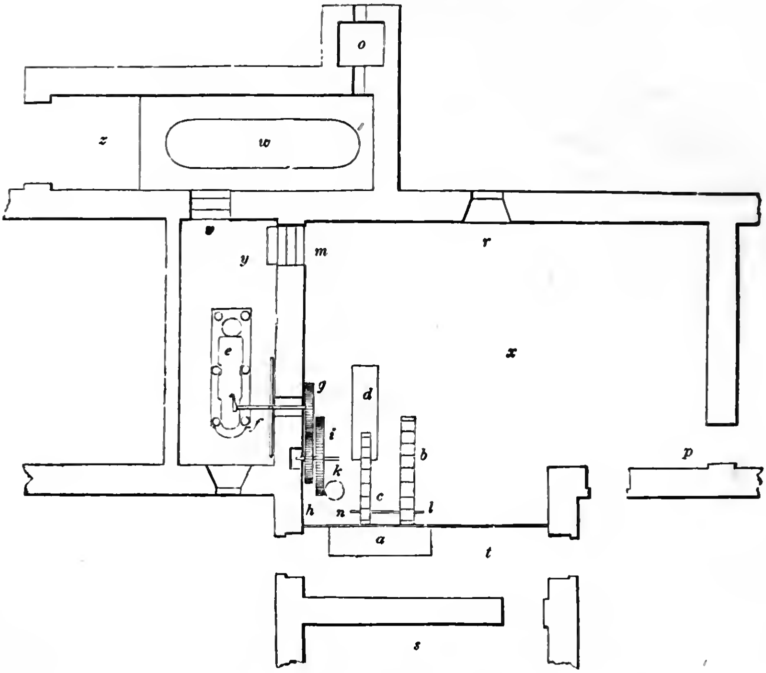
A WOODEN STATHEL FOR STACKS.

of the ground, to form a solid foundation for the upright support *c*, 18 inches in height, and 8 inches square, to stand upon, and on the top of this is placed a flat rounded stone or bonnet *d*, of at least 2 inches in thickness. The upright stone is bedded in lime, both with the found stone and bonnet. All the tops of these stone supports must be on the same level. Upon these are placed on edge the scantlings *a a*, to the outer end of which are fastened with strong nails the bearers *e e*, also 9 inches in depth and 2 inches in thickness. The spaces between the scantlings *a* are filled up with fillets of wood, *f f*, nailed upon them. If the wood of the framework were previously preserved by Kyan's or Burnett's process, it would last perhaps twenty years, even if made of any kind of home timber, such as larch or Scots fir. There should be a wide gateway into the stack-yard, and where the corn is taken on carts to the upper barn to be thrashed, the same gateway may answer both purposes; but where there is a gangway to the upper barn, the gate may be placed in the most convenient side of the stack-yard. Where carts are solely used for taking in the corn to the upper barn, the rows of stacks should be built so widely asunder as to permit a loaded cart to pass at least between every two rows of stacks, so that any particular stack may be accessible at pleasure. When a gangway is used, this width of the arrangement of the stacks is not necessary, the usual breadth of 3 feet between the stacks permitting the passage of corn-barrows, or of back-loads of sheaves. Thus, where a gangway is used, the stack-yard may have a smaller area to contain the same bulk of grain. Stack-stools, or *stathels*, or *staddels*, as they are variously called, are sometimes made of cast-iron; which, though neat and efficient, are expensive and liable to be broken by accidental concussion from carts. Malleable iron stathels would remove the objection of liability to fracture, but would not remove that of expense. Stacks on stathels are represented in Plate I. in the stack-yard S. It has been recommended to divide the frame of the stathels into two parts, so that they might be put under cover when not in use in the stack-yard. Were the stathels made removable, they would be more convenient in two pieces than in one; but the propriety of removing them is questionable, when it is accompanied with the necessity of removing the supports also; for it is clear that the supports could not be left standing in the stack-yard with the slightest chance of remaining in that position for any length of time, and the found-stones upon which they stand would be liable to be broken; and obliged to be put up every year, which would be intolerable trouble.

1687. *Rats and mice* being very destructive and dirty vermin in steadings, and particularly so to grain in granaries, means should be used in the construction of steadings to prevent their lodgment in any particular part. Many expedients have been tried to destroy them in granaries, such as putting up a smooth triangular board across each corner, near the top of the wall. The vermin come down any part of the walls to the corn at their leisure, but when disturbed run to the corners, up which they easily ascend, but are prevented gaining the top of the wall by the triangular boards, and on falling down either on the corn or the floor, are there easily destroyed. But preventive means, in this case, are much better than destructive, inasmuch as the granaries should always be kept free of them, and the grain will then only be sweet and clean. The great means of prevention is, to deprive vermin of convenient places to breed in above ground, and this may be accomplished in all farmsteads by building up the tops of all the walls, and beam-filling between the legs of the couples with stone and mortar—taking care to keep the mortar from contact with the timber. These places form the favourite breeding-ground of vermin in farmsteads, and should therefore be occupied with substantial stone and mortar. The top of every wall, whether of stables, cow-houses, hammels, and other houses, should be treated in this manner; for, if one place be left them to breed in, the young fry will find access to the granaries in some way. The tops of the walls of old as well as of new farmsteads should be treated in this manner, either from the inside, or, if necessary, by removing the slates or tiles until the alteration is effected. Precaution is necessary in making beam-fillings, especially in new buildings, to leave a little space open *under* every couple face, to allow room for subsidence or the bending of the couples after the slates are put on. Were the couples, when bare, pinned firmly up with stone and lime, the hard points would act as fulcra, over which the long arm of the couple, while subsiding, with the load of slates new put upon it, would act as a lever, and cause its points to rise, and thereby start the nails from the wall-plates, to the imminent risk of pushing out the tops of the walls, and sinking the top of the roof. Besides the tops of the walls, rats and mice breed under ground, and find access into apartments through the floor. To prevent lodgment in those places also, it will be proper to lay the strongest flagging and causewaying upon a bed of mortar spread over a body of 9 inches of small broken stones, around the walls of every apartment on the ground-floor where any food for them may chance to fall, such as in the stables, byres, boiling-house, calves' house, implement-house, hay-house, pig-sties, and hen-house. The corn-barn has already been provided for against the attacks of vermin; but it will not be so easy to prevent their lodgment in the floors of the straw-barn and hammels, where no causewaying is usually employed. The principal means of prevention in those places are, in the first place, to make the foundation of the walls deep, not less than two feet, and then fill up the interior space between the walls with a substantial masonry of stone and lime mixed with broken glass; or perhaps a thick body of small broken stones would be sufficient, as rats cannot burrow in them as in the ground.

1688. *Arrangement of the machinery.*—A plan of the ground-floor of the corn-barn, with portions of the adjacent apartments, is shown on a large scale in fig. 133; *x* is the corn-barn, *t* the chaff-house, *s* a part of the straw-barn, *y* the engine-house, and *z* the boiler-house. In this arrangement *a* is the position of the first fanners, *b* that of the elevator from the seconds-spout, and *c* that from the clean-spout, when these are used: *d* is the position for the second fanner, supplied by the elevator *c*, when such is not driven by hand, and is attached to the machinery. In the engine-house *y*, *e* is the position of the steam-engine, *f* the main shaft, carrying the fly-wheel, and which is put in motion by the action of the engine upon the crank. The main shaft carries also, in the usual construction, a spur-wheel *g*; but this member is subject to variation, according to the position of the engine-house and barns. In the present arrangement, and in many others, the spur-wheel *g*, as well as that marked *h*, act merely as intermedia, to bring the power into contact with the

Fig. 133.



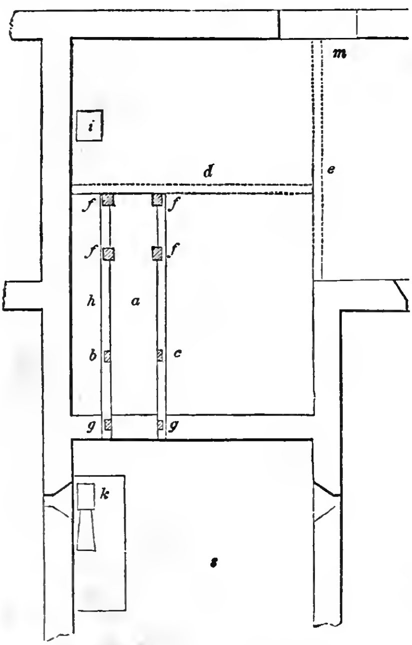
THE ARRANGEMENT OF THE GROUND-FLOOR OF THE BARNS.

main spur-wheel *i*, the last giving motion to the drum-pinion, as will be more distinctly shown in another figure. The lasting advantage of having the straw-barn placed in the most central position to the whole steading, induces the trifling addition of the intermediate wheels *g* and *h*, for the purpose of carrying the motive power from the main shaft to the shaft of the great spur-wheel *i*; and this arises from the present arrangement not admitting of the steam-engine being advanced so far towards the straw-barn as that its main shaft might lie nearly opposite to the drum of the thrashing-machine. In cases, again, where the corn and the straw barns lie in one line of range—or even although their position may be at right angles, as here laid down, but their relation being such as to admit of the main shaft coming nearly opposite to the drum—the intermediate wheels become unnecessary, and the great spur-wheel *i* is then placed upon the main shaft *f* itself. It is of small importance which of these methods of taking up the power be adopted, the additional wheels adding but a small increase to the expense, and a little to the resistance; but the lasting advantages of the position of the straw-barn much more than balance these. Cases frequently occur also, where only one intermediate wheel is required; and in others, it has been judged by some engineers more appropriate and expedient to dispense with all these wheels, and to substitute a large pulley in the place of the wheel *g*. In these cases, a pulley of proportionate dimensions is placed upon the drum shaft, and the motion conveyed through a belt. The only subsidiary machine that is usually placed on this floor is the hummeller, at *k*. The door from the corn-barn into the engine-house is at *m*; that to one of the granaries at *p*; and *r* is the window of the corn-barn.

1689. The engine-house *y* is for the steam-engine *e*, when one is used. It is 18 feet in length and 8 feet in width, and the granary floor above forms its roof. It has a window looking into the large court I, and a door *v* with steps into the boiler and furnace-house *z*, which house is 24 feet in length and 8 feet in width, and has an arched opening at the left or end door. The boiler is seen at *w*. The chimney-stalk *o* is 6 feet square at the base, and rises tapering to a height of not less than 50 feet. If wind or horses are preferred as the moving power, the windmill-tower or horse-course would be erected on the site of the boiler-house *z*.

1690. In the upper or thrashing-barn, that appropriated to the corn in the straw, the outline arrangement is represented in fig. 134, wherein the space *a*, formed by the

Fig. 134.



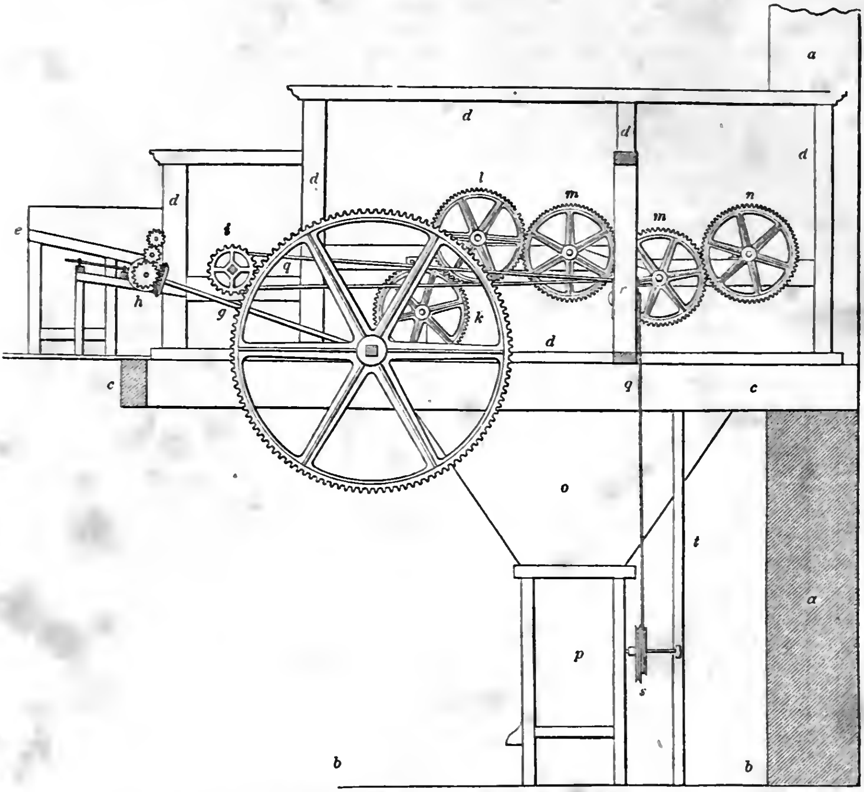
THE ARRANGEMENT OF THE UPPER FLOOR OF THE BARNS.

placement of the foundation beams *b* and *c*, is the position occupied by the thrashing-machine. The foundation-beams are, in the present case, framed into beams *d* and *e*, represented by the dotted lines; the space *a* varies in length, according to the circumstance of the arrangement of the machinery, from 12 to 16 feet, and in width, according to the power by which the machine is intended to be worked, from 3 to 4 feet; *f f f f* mark the places of the posts which form the frame-work of the drum, and *b c g g* those of the shakers. The space *f f h b* is appropriated to the gearing or driving apparatus of the machine, corresponding to the space occupied by the spur-wheels *g h i* in fig. 133. Of the subordinate machines that occasionally have, but which always should have place in this floor of the barn, I may point out the position *i* as one very appropriate for the corn-bruiser; and, on the other hand, in the straw-barn *s*, the position *k* is equally appropriate for the straw-cutter. The door for taking in the corn from the stack-yard is seen at *m*.

1691. The arrangements mentioned in the two preceding paragraphs are subject to considerable variety, arising from local circumstances in the relative positions of the beams, the power, and other accessories; but of these relations the experienced mill-wright will always be able to form that arrangement of the parts of his machinery that will bring out the most beneficial results; while the inexperienced will find, in the arrangements here laid down, data founded on experience and extended observation. It may be observed that the foundation-beams *b* and *c*, fig. 134, should be of the best Memel timber, or of oak, ash, or beech, where hard woods are plentiful.

1692. *Details of the Thrashing-machine.* — In describing the thrashing-machine, it is necessary to begin with the *frame-work*, and in that which supports the main-shaft. This, it invariably falls out, has its bearing for one point in the wall that separates the barn from the locality of the power, whatever that may be. For this purpose, when the altitude of the position of the shaft has been determined, an opening of 2 feet square is formed in the wall, the sill of which should be of one solid stone, laid at the proper level, and upon which the pillow-block of the shaft is bedded. If intermediate wheels are employed, another and similar opening must be formed for the bearing of the shaft of the great spur-wheel. Such other shafts, also, as may require to be extended to the wall of separation, should have bearings in recesses, formed in the wall at the respective positions, such as for the extension of the shafts of the drum and of the feeding-rollers, which, in general, may be arranged in one recess. The sills and bearers in these minor recesses will be found more convenient if formed of good sound Memel timber, than of stone. In further describing the machine, the letters of reference apply to corresponding parts of fig. 135, an elevation; and of

Fig. 135.



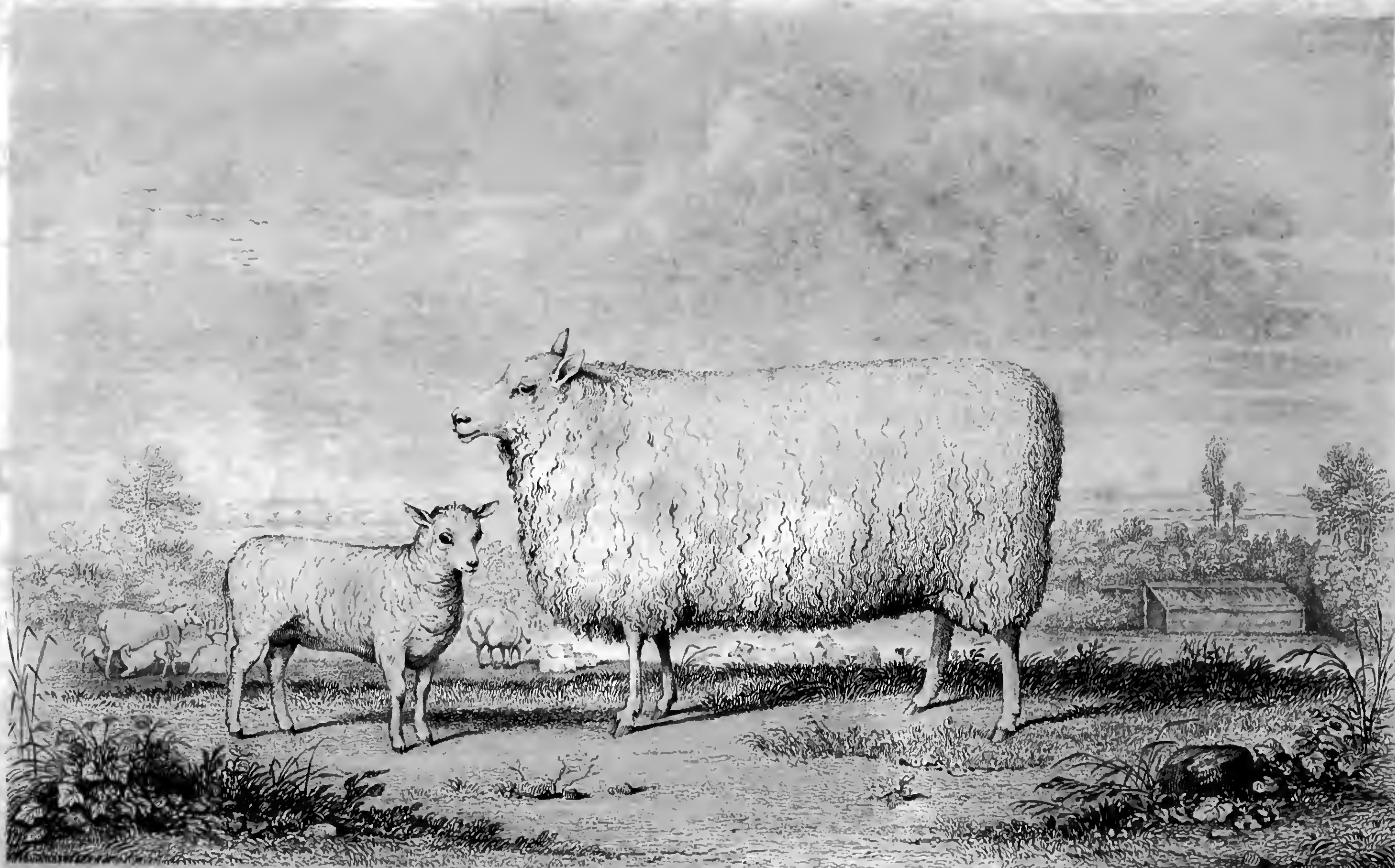
THE ELEVATION OF A THRASHING-MACHINE.

fig. 136, a longitudinal section. In these figures, *a a* mark portions of the barn-wall, *b b* the ground-floor line, and *c c* the foundation-beams. The letter *d* marks the different parts of the frame-work of the case of the machine. The position and form of the feeding-board is marked by the letter *e;* and as this appendage is not required of great strength, it is usually of a temporary construction, and sometimes even portable. The two sides of the frame-work *d* require to be tied by means of cross-rails, which are most conveniently fixed upon the top-rails of the frame-work by bolting.

1693. The openings in the two sides of the framing are filled in with panels, neatly fitted and strengthened with cross-bars at each end of the panels. Those panels that fill up the frame on the gearing side of the machine, may be permanently fixed in their respective places; but all those on the other side must be made easily movable, for giving access to the different parts of the interior, for the purpose of cleaning. In the panels that close up the drum-case, it has been recommended to leave an opening of 6 inches diameter round the shaft, for the purpose of admitting a current of air, which, it is supposed, might prevent the winding of straw round the shaft and ends of the drum. When the construction is good in other respects, it does not appear that this precaution is necessary.

1694. As to the gearings of the thrashing-machine, enough of them to let you understand their use may be described in a few words, by referring to figs. 135 and

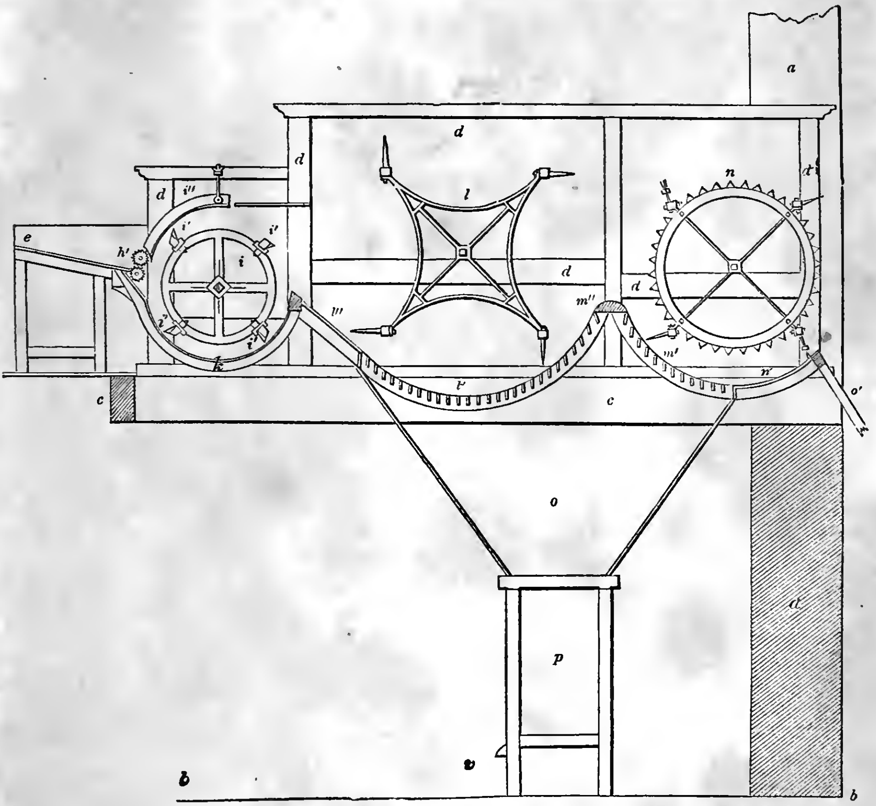
PLATE VIII.



136. In fig. 135, *f* is the great spur-wheel, corresponding to *i*, fig. 133, which gives motion to all the internal machinery. It has a small bevelled wheel on its shaft, which moves the small inclined shaft *g*, giving motion to the feeding-gear *h*, which moves either from 45 to 50, or from 65 to 70 rotations in a minute, according as the straw is wished to be taken in fast or slow; but the immediate action of the great spur-wheel *f* is on the pinion *i*, which is placed on the shaft of the drum, and moves it: and as the two wheels have a great disparity of size, it will be easily understood that the drum moves at a high velocity, which is not less than 360 revolutions in a minute, and the spur-wheel 50 rotations. A small pinion on the spur-wheel shaft, gives motion to the intermediate wheel *k*, which drives the wheel *l* on the shaft in the first shaker. The two intermediate wheels *m m* are required to move the wheel *n* of the second shaker, and to give it a contrary motion to the first shaker. Instead of such wheels, a small wheel on the shaft of the spur-wheel *f*, is sometimes made to move the feeding-gear, and both shakers, by means of pitch-chains; but although this is a simpler, and perhaps cheaper construction than the other, it is much more likely to go out of working order.

1695. The description of the machine is as far advanced as to enable you to trace the progress of the straw through the machine. The spur-wheel *f* moves from right to left to give the beaters *i'* of the drum *i*, fig. 136, a motion from left to right, that is, they shall beat the straw in an upward direction. The sheaves of corn are placed in the feeding-board *e*, and are taken from it by the rollers of the feeding-gear *h'*, and retained hold of

Fig. 136.



THE LONGITUDINAL SECTION OF A THRASHING-MACHINE.

while the beaters of the drum, passing in an upward direction, separate the corn from the straw, which are both prevented being driven upwards into the air by the drum-cover i''. On the straw being carried over the top of the drum, it is drawn by its force towards the first shaker l, and throws it towards the second shaker n, which lifts it over itself, and throws it down upon the straw screen o', upon which it slides further down to the floor of the straw-barn. The shakers have a lower velocity than the spur-wheel.

1696. The corn passes through the machine in this manner:—The straw and corn pass together over the top of the drum i, and are raked together by the shaker l, near the screen l', through which the corn immediately falls into the hopper o, descends still farther upon the vibrating shoe of the fanners p, and on falling still farther, from which the wind, created by the fan, separates the chaff from the corn, carrying the former into the chaff-house, and allowing the latter to pass through the spout v to the floor of the corn-barn. As much of the corn as passes over the ridge m'' between the two shakers l and n, is met by the brushes of the shaker n, which sweep it clean off the board n' towards the screen m', through which it falls into the hopper o and fanners p, in company with that passed through at first through the screen l'.

1697. The fan of the fanners is moved by means of a leathern belt or a hempen rope q q, fig. 135, which is given motion to by a sheave on the shaft of the drum, and carried by a couple of sheaves at r, one of which conveys the rope down to the sheave s, on the spindle of the fan, and the other carries it back again to the drum. The sheave s is composed of sheaves of different diameters, to allow the fan to be driven at different velocities, according to the state and nature of the corn to be cleaned, and its spindle is supported at one end by the upright post t. The velocity of the fan is 220 rotations per minute.

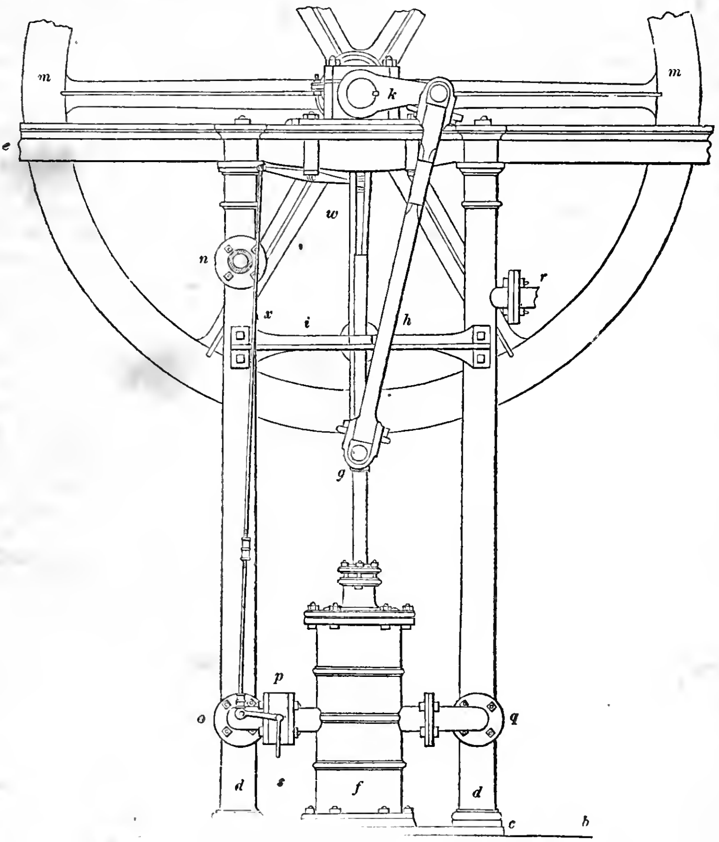
1698. The thrashing-machine is set in motion by different kinds of power,—by steam, by horse-strength, by the wind, and by water. Of these, wind power is getting more and more out of use in driving farm machinery, on account of the great uncertainty attending the motions of so fickle an element, in so variable a climate as ours; and every day, as the management of the steam-engine is more and more understood, it is becoming more in use on farms. Where water is sufficiently abundant, it is the simplest, as well as the cheapest, of motive powers, and is always preferred to all others; but where the supply is insufficient, although it may be ample enough for a time in winter, it partakes of the disadvantages attending wind,—it may be insufficient at the time it is most wanted. Experience has abundantly proved that thrashing-machines dependent on water derived chiefly from the drainage of the surface of the ground, frequently suffer from a short supply in autumn, and late in spring, or early in summer, thereby creating inconvenience for the want of straw in the end of autumn, and the want of seed or horse-corn in the end of spring. Wherever such casualties are likely to happen, it is better to adopt a steam-engine at once. Although coal should be both distant and dear, for all that a steam-engine requires, a steam-engine should be erected in preference to using horses in the thrashing-machines; for besides having to keep a larger number of horses on a large farm, in the proportion of one pair in every five pairs, the tear and wear of horses in the rotary motion of the horse-course is very considerable.

1699. Of the three classes of steam-engines,—the atmospheric, the low, and the high pressure,—the high pressure is most commonly used on farms, partly from the notion that it requires less water, is more simple in its construction and management, and cheaper than the condensing or low pressure engine. It is certainly very simple in its construction, and its management is easily understood, even by country people, and it is generally less costly than the condensing engine; but a sufficient reason for the preference may be found in the fact, that an engine from four to six horse power is quite sufficient to move most thrashing-machines, whereas the condensing engine is better applicable to purposes requiring a higher scale of power.

1700. The high-pressure steam-engine is so called because the steam is generated in the boiler, at so great a degree of tension as to exert a considerable pressure on the boiler,—not less, perhaps, than 25 lbs. to the square inch, and it may be increased to a much higher rate without difficulty; that is, the pressure on the interior of the boiler above that of the atmosphere on its exterior, which is equal to 14 lbs. to the square inch. It is also called non-condensing, because it gets quit of the steam in the elastic state, and is not condensed again into water as in the condensing engine. And it is sometimes called the puffing engine, because it emits the steam it has used in successive jets or puffs.

1701. *Crank high-pressure Steam-Engine.*—The high-pressure steam-engine may be formed with a beam or an overhead crank, besides a variety of other forms; but these two are the forms found on the farm, and of these the crank engine is the most common, and it is on this account that I have selected its figure for illustration. It is represented in fig. 137, where *b b* is the ground floor, *c c* the sole plate, which is bolted down to a mass

Fig. 137.



THE CRANK HIGH-PRESSURE STEAM-ENGINE.

of solid masonry, upon one or two blocks of stone of at least one foot in thickness; *d d* are cast-iron columns, supporting an entablature *e e* of the same metal, which, extending across the house, is let into the walls on both ends to support the lying shaft of the engine; *f* is the steam cylinder; *g* is the piston-rod of the cylinder; *h* the connecting-rod between the piston-rod and the crank *k*; *i* is a guide-bar extending between the columns through which the head of the piston-rod passes to preserve its parallelism; the end of the lying shaft is seen at the letter *k*; *mm* is the fly-wheel; and the small circle at *i* is one of the balls of the governor. The steam-pipe leading from the boiler joins the engine at *n*, from whence the steam descends to *o*, and passing through that branch, and the throttle-valve case *p*, it enters a channel that half embraces the cylinder, and opens into a small steam-chest that contains the slide-valve, which are concealed behind the cylinder in the figure. The steam-chest covering the slide being thus in communication with the boiler, the steam, from its elasticity, is always ready to flow into any channel that is opened for it. Hence, as the slide is moved alternately from off the passage leading to the upper and to the lower ends of the cylinder, the piston is made to reciprocate between the top and bottom. At every change of the slide, the passage leading to the atmosphere is put in communication with the top or with the bottom of the cylinder, and the steam which had, in the previous stroke, done its duty on the piston, is drawn off and discharged through a channel corresponding to that by which it entered, and passing through the branch *q*, into the column *q r*, it is discharged into the atmosphere by the pipe *r*, which frequently terminates in the chimney. The crank-shaft carries two eccentrics—the one for the pump-rod, to which is jointed the plunger of the pump, for supplying water to the boiler; the other moves the slide-valve rod, which is so adjusted as to move the valve at the precise time and place required for the due admission and emission of the steam to and from the cylinder. The shaft likewise carries the pair of level wheels that give motion to the governor. The governor consists of two oblique rods, with balls attached to their lowest extremities; and these being suspended by a joint on the vertical axis, the whole is rendered capable of revolving horizontally upon that axis. If the machinery that gives motion to the governor is accelerated, the revolving balls partake of the acceleration, and the centrifugal action thus generated gives them a tendency to fly off from the centre of revolution. This outward motion is converted into the means of regulation, for while the balls and rods extend their circle of gyration, they act upon two jointed arms. The lever *w* is applied to the collar above the joint of the rods, and being suspended near its centre, has its opposite extremity jointed to the rod *x*, the lower end of which acts upon the lever of the throttle-valve *s*. The throttle-valve is a thin circular plate of metal, having an axis fixed across its diameter, and is nicely fitted into the steam-way passing through the case *p*. The spindle passes the sides of the case steam-tight, and carries on one end a small lever by which the valve can be turned, and the lever is put in connexion with the lower end of the rod *x*. The extension of the balls of the governor, acting through the lever *w* and rod *x*, depresses the lever *s* of the valve, and by thus turning the valve, reduces the steam-way, and prevents further acceleration of the machine.

1702. In *setting down the engine*, we have to consider the space necessary to receive it. This, in the direction of the barn wall, need not be larger than $8\frac{1}{2}$ feet, or a few inches more than the diameter of the fly-wheel; the breadth, in the other direction, should not be less than 8 feet, but may extend to 9 or $9\frac{1}{2}$ feet. An engine-house, therefore, of the form and dimensions afforded by the plan Plate II., is not well adapted to this form of engine, its length in the direction of the barn being too great for the entablature beam; and if adopted for such a form of house, a wall must be run up, or a beam placed across, reducing its length to $8\frac{1}{2}$ feet, or thereby. In almost every case this form of engine is the most commodious for its application to a thrashing-machine, especially in regard to the direction of height; for the height that the crank-shaft stands above the floor of the engine-house will generally bring it near to the large spur-wheel, which, though not in all thrashing-machines, is yet to be found in a large majority of them. This is supposing that the floor of the engine-house is nearly on a level with the barn floor, which will generally be the case, unless artificially changed.

1703. Mr Slight has given this rule for finding the horse-power of such a non-condensing engine:—

Multiply the square of the diameter of the cylinder in inches, by sixth-tenths of the entire pressure of the steam in the boiler in lbs., on the circular inch, *minus* half an atmosphere, or 5·57 lbs., on the circular inch; and multiply the product by the velocity of the piston, in feet per minute. The last product is the power of the engine in lbs. to raise one foot high per minute; and for the horse-power divide as usual by 33,000. For example,

Let the cylinder be 9 inches diameter, the length of stroke 20 inches, and the number of strokes per minute 64, being equal to a velocity of 214 feet per minute for the piston, and the pressure in the boiler 25 lbs. on the circular inch, equal to 32 lbs. on the square inch nearly; then (·6 × 25 — 5·75 = 9·35; and

$$\frac{9 \cdot ^2 \times 9 \cdot 35 \times 214}{33{,}000} = \text{5-horse power nearly.}$$

By this rule for the power of non-condensing engines, a cylinder of 10 inches diameter, with a pressure of 25 lbs. on the circular inch, and making 60 strokes per minute, is equal to 6-horse power; and the piston will move at a velocity of 214 feet per minute, making the consumpt of steam, allowing for waste, equal to 128 cubic feet per minute, or 7680 per hour. The proportion of water to steam consumed at this pressure, is about 1 to 850, or a little more than 9 cubic feet of water, being about 57 gallons per hour for the supply of the boiler. This calculation is stated merely to show how small the quantity of water is that suffices for a non-condensing engine of 6-horse power.

1704. The setting on and stopping the non-condensing engine is an exceedingly simple operation; and its simplicity is even simplified by the addition of a cock or valve on the steam-pipe, which is very frequently adopted, and in that case the throttle-valve is not required to be so accurately fitted as where no stop-cock is employed. To *set on the engine*, the steam must first be brought up to the requisite degree of pressure. When this is accomplished, which is known by the safety-valve rising so as to allow the escape of steam, the stop-cock, if there is one, is opened, the throttle-valve being also opened; the steam is admitted both above and below the piston by moving the slide with the handle of the wiper-shaft, to heat the cylinder, the eccentric rod being at the time disengaged from the shaft. This done, the *gab* of the eccentric rod is laid upon the arm of the wiper-shaft; and, if the crank is in a horizontal position, the engine may start off without assistance; but, if it does not move, the fly-wheel is to be pushed round a few feet, or until the crank has once passed the *centres*, when it will move on freely. If no resistance is upon the engine, the throttle-valve should be put nearly shut, but so soon as the resistance comes,—the commencement of thrashing, for example,—the throttle-valve lever is to be connected to the vertical rod, and the work will proceed regularly.

1705. In *stopping*, where there is a stop-cock, the shutting of it puts a stop to further motion, except what the momentum of the parts may continue to give out for a few seconds; where there is no stop-cock, the first step is to disengage the throttle-valve lever, and close the valve, and immediately after disengaging the eccentric rod from the wiper-shaft, the engine will stop. It is advisable to keep this rod disengaged at all times when the engine is standing.

1706. As the engine-house is seldom accessible directly from the barn, there ought always to be means established for communicating a signal between the two places; and this should proceed from the chief of the operation,—the person who feeds the machine. As there can be but two propositions to make—to set on and to stop—one signal is sufficient, and a *bell* seems to be the most convenient medium of communication.

1707. *The boiler.*—Of all the parts of the steam-engine, the boiler, though by far the simplest in its construction, is the most important. In it is generated the agent of power, while all the other parts are merely the accessories and media through which the effects of the mighty agent are developed. It has constantly, while in action, to resist this imprisoned and powerful agent, and that merely by the strength of its parts; hence the necessity for having boilers made of the best possible materials, and those connected in the best possible manner.

1708. The form now most generally adopted for the boilers of farm-engines, and it is undoubtedly the best, is the plain cylindrical boiler, with hemispherical ends. The Staffordshire plate is considered the best for the purpose; and they are generally bent to the circle in the cold state, by the aid of a machine. The joinings are all effected by riveting with short bolts, the plates being previously punched by a machine for the reception of the rivets. The rivet-bolts are inserted and riveted down in the red-hot state, so that, besides the effect of the riveting to draw the contiguous surfaces of the plates into close contact, there is the powerful contraction of the iron while cooling, to produce still more perfect contact. To insure perfect tightness in the joinings or *landings*, technically so called, the whole of the joints, after they are all riveted up, undergo a process of caulking, which is simply the stamping up of the edges of the plates into intimate contact with the adjoining surface, by means of flat-edged chisels, struck with a hammer.

1709. Various rules are given for the dimensions of boilers, corresponding with any given power of engine; but the most natural are those founded upon the extent of surface exposed to the flame of the fire, and the flame and heated air of the flues, taken along with the cubical contents of the boiler. From researches into the relations of the fire-surface and contents, we can form a very correct value of the power of boilers from their capacity alone. According to these, a cylindrical boiler for high-pressure steam should have, in its entire capacity, 12 cubic feet of space for each cubic foot of water boiled off per hour. Now it has just been shown (1703) that a 6-horse power cylinder of 10 inches diameter will consume the steam of 9 cubic feet of water per hour, and $9 \times 12 = 108$ cubic feet for the capacity of boiler; and taking its diameter at 3 feet 4 inches, which gives a sectional area of 8·6 feet; and dividing the cubical capacity of the boiler by this last number, we have $\frac{108}{8 \cdot 6} = 12 \cdot 5$ feet for the length of a cylinder that will yield the capacity required. But as it will have hemispherical ends, the extreme length will be $13\frac{1}{2}$ feet nearly, which agrees very well with practice.

1710. The position in which the boiler is to be set down, should be as near as possible to the engine, so that the pipe conveying the steam should be as short as possible, to prevent all unnecessary condensation of steam.

1711. The *furnace* of the boiler has undergone many changes, both in form and dimensions, and in the means of supplying it with air for the consumption of the smoke. The latter property, though always desirable, is not of weighty importance in farm-engines, but it is essential that, in every case, the furnace be so constructed as to produce the requisite supply of steam with certainty and despatch. To effect these objects, it is required to expose as much as possible of the bottom of the boiler to the action of the fire, without reducing that portion of the surface which falls to receive the heat from the flame and smoke passing along the flues. In cylindrical boilers, this is effected by making the width of the furnace equal to three-fifths of the diameter of the boiler, the covering of the side flues rising to within 2 inches of the level of the centre of the boiler, that being the line to which the sinking of the water should be restricted, so that the fire or heated air shall never impinge on any part of the surface that is not covered internally with water. The area of fire-grate commonly allowed is one superficial foot to each horse power; or, if the furnace is 2 feet wide, the grate-bars should be 3 feet in length. This is too small unless coal of the very best quality is burned; and, to insure abundance of fire, the bars should be of such length as to give $1\frac{1}{2}$ square foot to the horse power nearly, and should be laid with a slope of 1 inch on the foot of length. In front of the bars, a breadth of from 15 to 18 inches is occupied by the dumb-plate or dead-plate, upon which the fresh fuel should always be laid down on its first introduction to the furnace. The mouth of the furnace is closed by a door and frame of cast-iron, leaving the opening of the ash-pit about 3 feet in height.

1712. The *chimney* for the steam-engine is an object of some importance. Upon its height and area depends much of the future effects of the engine; and very numerous are the views taken of these by engineers. The following points may, however, be taken as data not easily controverted. The height should not be less than 50 feet; and, if it is desirable to avoid the nuisance arising from smoke, the height should greatly exceed this. The internal sectional area should be as large as may be consistent with economy in the expense, but should never be under 80 square inches for each horse power. Thus a chimney for a 6-horse engine should have its area at the top $80 \times 6 = 480$ square inches, and $\sqrt{480} = 22$ inches nearly, the side of the square of the chimney internally; and if circular, the diameter should be 25 inches nearly. The height of the chimney being determined, and also the side of its square externally, the square of its base is found by adding to the length of the side at top the amount of increase arising from the slope given to the sides. The usual slope or battre is $\frac{3}{8}$ inch to a foot; with a height, therefore, of 50 feet, the increase at bottom will be $18\frac{3}{4}$ inches on each side; and the walls being one brick, or 5 inches thick, the side of the square at top will be $22 + (5 \times 2) = 32$ inches, and this added to $18\frac{3}{4} \times 2 = 39\frac{1}{2} + 32 = 5$ feet $11\frac{1}{2}$ inches, the sides of the square at the bottom.

1713. The regular supply of water to the boiler of a steam-engine is a matter of great importance, as is also the proper method of water-gauge; and it is also of great importance that the water sent into the boiler should have its temperature raised as high as possible before entering. This is effected in a very simple manner, and to a temperature of about 140° by the apparatus; but as the description of all the apparatus by which all these ends are best effected would involve the relation of much minutiæ, it is unnecessary for me to enter into them.

1714. The *fuel* for the steam-engine is always coal, where it can be procured; but either wood or peat may be used. In the neighbourhood of coal-works, the refuse or culm is always procurable at a low price, and is quite sufficient in point of quality for an engine furnace; 1 cwt. of this culm will, on an average, be required per hour that the furnace is burning, for a 6-horse engine. Where the locality involves a distant carriage, it is then better to use the large coal, of which, with due care, $\frac{3}{4}$ cwt. will suffice for an hour. In stoking, the coal should always be laid down on the dead-plate, pushing it forward before putting in a fresh supply. The fire should be kept clear, and always free of the clinkers that may be formed in the bars. On all occasions of stopping, the damper should be let down and the furnace-doors opened, to prevent unnecessary waste of fuel; but at all times, while working, the furnace-doors must be kept shut, unless the supply of steam is found to be too great.

1715. *The Horse-wheel.*—Until of late years the thrashing-machine was in most cases impelled by horses moving in a circular course; and as this power continues to be employed on the smaller class of farms, it is still of that importance to demand being here brought under notice. Horse-wheels are of various construction, as *under-foot* and *over-head;* the former being chiefly used where small powers are required, and the latter where four horses and upwards are employed. In general, in the under-foot wheel, the horses draw by means of trace-chains and swing-tree. In the over-head wheel, of old construction, we also find occasionally the same method of yoking practised; but in all modern over-head wheels the horses draw by a *yoke* descending over their back, from a horizontal beam placed over-head. Custom seems, as usual, to have produced a preference for this mode of yoking, though there appears good reason for calling its propriety in question, especially if the course has a diameter of 22 feet or upwards. The argument in support of the over-head draught is, that the horse exerts his force in the direction of a tangent, or very nearly so, to the curve in which he walks, or at right angles to the beam by which he draws; while, in the swing-tree draught, his shoulders being considerably more in advance of the point of attachment, his exertions must necessarily tend in a direction that will form an angle more acute than a right angle, but which will vary with the radius of the course. It is quite true that this is the case, and that the horse will draw at a disadvantage, to a certain extent, but the amount of this disadvantage is small. In a 26-feet course, which is a good medium, giving the over-head draught the full advantage of the right-angle—90°—the other will draw at an angle of about 72° with the radius or beam; and it is easy to show that the amount of disadvantage arising from this is as 21 to 20. If the draught of a horse in a wheel amounts to 170 lbs. under the favourable position, it will require an exertion of 178½ lbs. from the same horse, when yoked unfavourably, that is, by a swing-tree. With this disadvantage, which is but small, if we compare the freedom of action and uniformity of the resistance in the case of the swing-tree draught, with the constrained action and jolting effects which the horse undergoes in the over-head yoke; and to these, if we add the chances of disadvantage to horses of low stature, being constrained to draw at an unfavourable vertical angle, we shall soon find an amount of disadvantage greater than in the former case. The question is not now of that importance that it once possessed, in consequence of the extensive application of steam; but it appears still to be deserving of consideration.

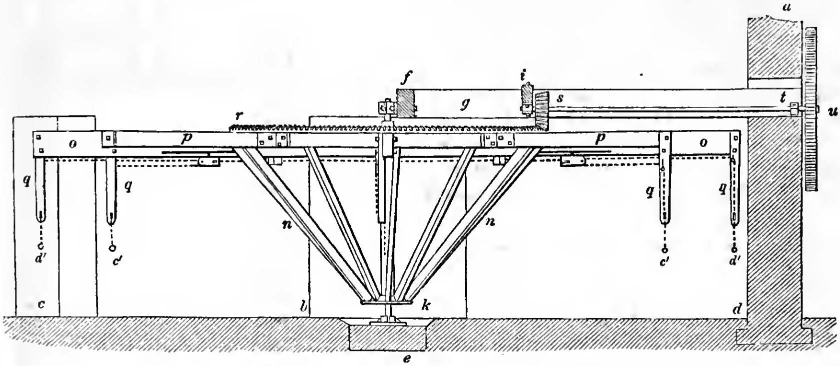
1716. In the construction of the horse-wheel, also, a question arises as to the *diameter of the actual wheel*, whether it should be equal in diameter to the entire horse-walk, and work as a spur-wheel, or have a diameter considerably under the former, and be applied as a face or bevelled wheel. It appears to me that the *large spur-wheel*, of 25 or 30 feet in diameter, has been conceived under a false impression, and that, on principle, its application is erroneous. It is also probable, that a consideration of the overshot water-wheel, which, from its construction, and the nature of the element employed, requires that its power should be given off at or near the extremity of its arms, may have given rise to this formation; but the causes that combine to render this not only advisable, but imperative, in the water-wheel, if every thing is duly considered, do not apply to horse power. When the horse-wheel has a diameter larger than the mean diameter of the horse-path, it gives the first motion a higher velocity than that of the moving power, by its more extended radius; and if any inequality occurs in the moving power, it will sensibly affect the succeeding motions. Horses do not exert a perfectly uniform force when yoked in a wheel—the very act of stepping forth, by removing the exertion from one shoulder to the other, produces small increments and decrements alternately to the power, and these must be communicated to the wheel which extends beyond that point of the lever by which the horse draws. Besides this effect on the machine, it must have an equally bad effect upon the horses; for, in consequence of the construction of the large wheel, and from the yoke being applied to a point where all elasticity is removed, the draught becomes what is termed *dead*,—that is to say, there are no elastic or yielding parts betwixt the power and the first impulse, that might tend to soften the sudden strains that come upon the horses, unless other means are resorted to to produce that result. Wheels of this construction will, therefore, be found more fatiguing to the horses than those of smaller diameter.

1717. Of horse-wheels with a *small circle of teeth*, the diameter best suited for all purposes, and which might produce a maximum effect, has not yet been defined; but from analogy, and taking into view the properties of the centre of percussion, we may infer that the radius of the segments forming the toothed wheel should be two-thirds of the radius of the beam, measuring to the centre of draught, which may be taken at 11 feet when the course is 26 feet diameter, giving to the toothed segments a diameter of 14 feet 3 inches. The diameter thus found is subject to modification, arising from considerations of strength, and the too great obliquity of the diagonal braces of the wheel, that would follow upon a large diameter. Such considerations will induce a reduction of diameter to 12½ or 13 feet, as a good medium size of wheel. The projection of the horse-beams beyond the point of action of the toothed segments, produce that degree of elasticity pointed out in 1716 the absence of which forms a defect in wheels of large diameter.

1718. The horse-wheel represented in fig. 138, is constructed on data derived from the foregoing considerations, and is an *elevation* of the wheel. It is constructed for four horses,—the course is 26 feet diameter within the pillars, and the wheel is

13 feet diameter, with a hollow cast-iron central shaft, having a flange at top and bottom, to which the arms and stays of the wheel are bolted. The position of the horse-wheel must be always adjoining to the barn; it may or may not be on the

Fig. 138.



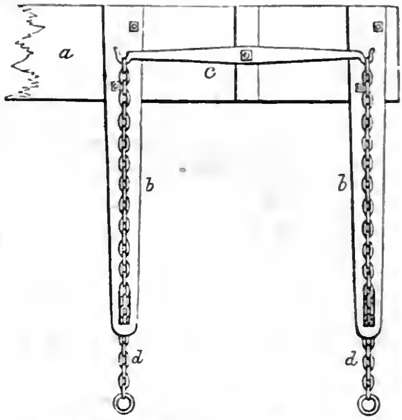
THE HORSE-WHEEL FOR A THRASHING-MACHINE.

side towards the stack-yard, but generally the former. In the figure, the barn-wall is marked *a*, and of the two main pillars, which support the main collar-beam, one is marked *b*; of the two minor pillars, erected solely for completing the bearings of the roof, one only is seen at *c*, and *d* is the floor or horse-walk. The footstep of the horse-wheel is supported on the stone block *e*, the step being adjustable by four screws, to bring the wheel to the true level; and *f* is the collar-beam, which is laid upon and bolted to the main pillars, and carries the plummer-block for the head of the central shaft. The sheers *g* are framed into the collar-beam, and resting on the wall *a*; and these have two diagonal braces, not seen in the figure, to resist the shake from the action of the wheel upon the pinion of the lying shaft; and the cast-iron bridge *i* is bolted down upon the sheers carrying the end of the lying shaft. The flanges of the central shaft *k*, and the one at the top not seen, form the foundation of the wheel; to the latter are bolted the horizontal arms, as well as the horse-beams *o*, and these are supported by the diagonals *n n*, seated in and draw-bolted to the flange *k*. The horizontal braces *p p*, of the horse-beams are framed into the ends of the horizontal arms, and secured with cast-iron knee-plates at their junction with the wheel and with the horse-beams. The yoke-bars *q q*, are made of hard wood, tapering towards the lower end, strongly bolted to the horse-beams, and are each mounted with an iron pulley near the lower end, over which the draught-chain passes, the height of which from the horse-path should be 3 feet 6 inches, liable to slight variation, arising from the stature of the horse that is to be yoked into it. The wheel *r* is now always made of cast-iron, in segments, and, when the wheel is very carefully made, are fitted and bolted to a bed-plate of the same material, previously bolted to the arms and horse-beams, and is 13 feet diameter. The horse-wheel pinion *s* is mounted on the lying shaft *s t*, whose inward bearing is upon the barn wall, in an opening formed for the purpose, and this shaft carries the spur-wheel *u* inside the barn. The calculations of this machine would stand thus:—The horses will walk the course three times in a minute, being at the rate nearly of $2\frac{1}{4}$ miles per hour, the lying shaft *s t* will make 11 revolutions for one of the wheel, or 33 per minute, and if the drum pinion, which is driven by the wheel *u*, is made 8·6 inches diameter, the wheel being 7 feet, would give the drum 320 revolutions per minute; a fair average velocity for a 4-horse machine, which can be increased by a quicker step of the horses, say to $2\frac{1}{2}$ miles per hour, which would give 340 revolutions per minute to the drum.

1719. Some horses, when yoked in a wheel, are observed, after a short practice, to take advantage of lagging back, and allowing those who are more willing to take the heavy end of the work. To counteract this, methods have been adopted to make the horses draw by chains, so arranged as to make them work against each other in pairs; or make any number of them draw from a ring-chain common to the whole. Another method was to make each horse draw against a certain weight suspended over pulleys; but all these have their imperfections in one way or another. A new and more perfect arrangement of the ring-chain was introduced by Mr Christie, Rhynd, Fifeshire, which received the approbation of the Highland and Agricultural Society of Scotland.* This arrangement is exhibited in the figure by the doted lines under the horse-beams; but I do not enter into the details of the arrangement. Suffice it for me to say that the principle of the arrangement is, *that the ring-chain forms a figure of so many equal sides or angles as there are horses in the wheel, and that the angles always remain equal.* The defects of any other method of this kind which has been tried being, that the angles vary according to the sluggish or active temper of the horses.

1720. A method of equalising the resistance to the shoulders of each individual horse has been long practised, and which, from its simplicity as well as its beneficial effects upon the horses, is deserving of general adoption. The apparatus consists of an iron lever with equal arms, which is suspended upon a bolt by a perforation through the centre of the lever forming the fulcrum, and the ends are formed into hooks to which the draught-chains are attached. Fig. 139 represents the application of this to the horse-beam, wherein *a* is a part of the beam, and *b b* the yoke-trees; *c* is the lever above described, suspended upon the back of the horse-beam; *d d* the draught-chains, hooked to the lever, and passed under the pulleys of the yoke-trees, beyond which the horse is yoked to the extremity of the chains. The advantages of this mode of yoking will at once be obvious; for suppose that, from inadvertence, the horse may have been unequally yoked, whenever he exerts his force, the chain that had been yoked short—suppose it to be the left shoulder—will immediately pull down the end of the lever to which it is hooked, and so bring the longer chain to bear with equal resistance upon the right shoulder. It will be found, also, that the lever will vibrate at every step taken by the horse, as his efforts are changed at every step from the one shoulder to the other; the lever will therefore tend to equalise his exertions in respect to his muscular economy, and to the motion of the machine.

Fig. 139.



THE LEVER FOR EQUALISING DRAUGHT IN THE THRASHING-MACHINE.

1721. *The Water-wheel.*—Water, when it can be commanded, is the cheapest and most uniform of all powers; and on many farms it might be commanded by carefully collecting and storing in a dam. Water-wheels have been commonly treated as of two kinds; but, with great deference, I conceive they may be classed under two heads. The *under-shot*, or *open float-board* wheel, which can only be advantageously employed where the supply of water is considerable and the fall low; it can therefore rarely answer for farm purposes, and need not be discussed. The second is the *bucket*-wheel, which may be *over-shot* or *breast*, according to the height of the fall. It is this wheel that is adopted in all cases where water is scarce or valuable, and the fall amounting to 6 or 7 feet or more, though it is sometimes employed with even less fall than 6 feet. It is the most effective mode of employing water, except where the fall is excessively high, or ex-

* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 264.

ceeding 50 feet, when, in such cases, it is applied to motive machines that will rarely be employed for agricultural purposes, such as Barker's mill, &c.

1722. When it is proposed to employ a stream of water for the purpose of power, the first step is to determine the *quantity delivered by the stream in a given time;* this, if the stream is not large, is easily accomplished by an actual measurement of the discharge, and is done by damming up the stream to a small height, say 1 or 2 feet, giving time to collect, so as to send the full discharge through a shoot, from which it is received into a vessel of any known capacity, the precise time that is required to fill it being carefully noted. This will give a correct measure of the water that could be delivered constantly for any purpose; if in too small a quantity to be serviceable at all times, the result may found a calculation of the time required to fill a dam of such dimensions as might serve to drive a thrashing-machine for any required number of hours. If the discharge of the stream is more than could be received into any moderately-sized vessel, a near approximation may be made to the amount of discharge by the following method: Select a part of its course, where the bottom and sides are tolerably even, for a distance of 50 or 100 feet; ascertain the velocity with which it runs through this space, or any measured portion of it, by floating light substances on its surface, noting the time required for the substance to pass over the length of the space. A section of the stream is then to be taken, to determine the number of superficial feet or inches of sectional area that is flowing along the channel, and this, multiplied into five-sixths of the velocity of the stream, will give a tolerable approximation to the true quantity of discharge—five-sixths of the surface velocity, at the middle of the stream, being very nearly the mean velocity of the entire section. Suppose the substance floated upon the surface of the stream passed over a distance of 100 feet in 20 seconds, and that the stream is 3 feet broad, with an average depth of 4 inches—here the area of the section is exactly 1 foot, and the velocity being 100 feet in 20 seconds, gives 300 feet per minute, less one-sixth = 250 feet, and this multiplied by the sectional area in feet, or 1 foot, is 250 cubic feet per minute for the discharge. It is to be kept in mind that this is only an approximation, but it is simple, and from repeated experiments I have found it to come near the truth. For those who wish to enter more elaborately into the subject, I may here state a formula derived from those of Sir John Leslie, for finding the mean velocity, and, having also the transverse section, to find the discharge of a stream or river.

Multiply the *constant* 1·6 into the hydraulic depth, and into the slope of the surface of the water per mile, the square root of the product will give the *mean velocity* of the stream in feet, per second; and the root, multiplied by the section of the stream in square feet, is the discharge per second. The *hydraulic depth* is the transverse section of the stream in square feet, divided by the periphery of the stream, less the surface breadth.

Example.—If the surface breadth be 3 feet, the bottom breadth $2\frac{1}{2}$ feet, and the slope of the sides each 9 inches, a transverse section of these dimensions will contain 2 square feet nearly, which, divided by the periphery, which is

$3 + \cdot75 + \cdot75 + 2\cdot5 = 7$, the periphery,
then the area of the section = 2 feet;
and $2 \div (7 - 3) = \cdot5$ foot, or = 6 inches, the hydraulic depth.

And suppose the slope at the place of section to be $1\frac{1}{2}$ inch on 100 feet, or 6·5 feet per mile, apply the formula—

$\sqrt{1\cdot6 \times \cdot5 \times 6\cdot5} = 2\cdot3$ feet, the velocity per second nearly, and the delivery will be $2\cdot3 \times 2 = 4\cdot6$ cubic feet per second, which, multiplied by 60, gives 276 cubic feet per minute.

1723. The next step is to ascertain, by levelling, from the most convenient point at which the stream can be taken off, to the site where the water-wheel can be set down, and to that point in the continuation of the stream where the water can be discharged from the wheel, or what is called the outfall of the tail-race. If the water has to be conveyed to any considerable distance from the point where it is diverted from the stream to the wheel, a lade must be formed for it, which should have a fall of not less than $1\frac{1}{2}$ inches in 100 feet, and this is to be deducted from the entire fall. Suppose, after this deduction, the clear fall be 12 feet, and that the water is to be received on a bucket-wheel whose power shall be equal to 4 horses.—

The rule for finding the quantity of water required per minute to produce 4 horses' power is to multiply the *constant* 44,000 by the horse-power, and divide the product by the product obtained by multiplying the *constant*,—the weight of water per cubic foot by the height of the fall.

Example.—Multiply the *constant* . . .		44,000	
By the horse-power, ...		4	
Which divide by the		)176000(234	cubic feet, the quantity
weight of water per cubic foot, .	62·5	1500	of water required per
Multiplied by the height of the fall, .	12		minute to produce 4
		2,600	horses' power.
	750·0	2,250	
		3,500	
		3,000	

The formula is this— . $\frac{44{,}000 \times 4}{62·5 \times 12} = 234$ cubic feet.

The rule for finding the horse-power of any ascertained discharge of water will be found in (117.)

1724. If the stream does not produce this quantity, a dam must be formed by embanking or otherwise, to contain such quantity as will supply the wheel for three or six hours, or such period as may be thought necessary. The quantity required for the wheel here supposed, for three hours, would be 42,120 cubic feet; but suppose the stream to supply one-fourth part of this, the remainder, or 31,590 feet must be provided for in a dam, which, to contain this, at a depth not exceeding 4 feet, would be 88 feet square. But the constant supply of water is often much smaller than here supposed, and in such cases the dam must be proportionally larger.

1725. The *dam* may be formed either upon the course of the stream, by a stone-weir thrown across it, and proper sluices formed at one side to lead off the water when required; or, what is much better, the stream may be diverted from its course by a low weir into an intermediate dam, which may be formed by digging and embankments of earth, furnished with sluice and waste-weir, and from this the lade to the wheel should be formed. The small weir on the stream, while it served to divert the water, when required, through a sluice to the dam, would, in time of floods, pass the water over the weir, the regulating sluice being shut to prevent the flooding of the dam. This last method of forming the dam is generally the most economical and convenient, besides avoiding the risk which attends a heavy weir upon a stream that may be subject to floods. When water is collected from drains or springs, it is received into a dam formed in any convenient situation, and which must also be furnished with a waste-weir, to pass off flood waters, besides the ordinary sluice.

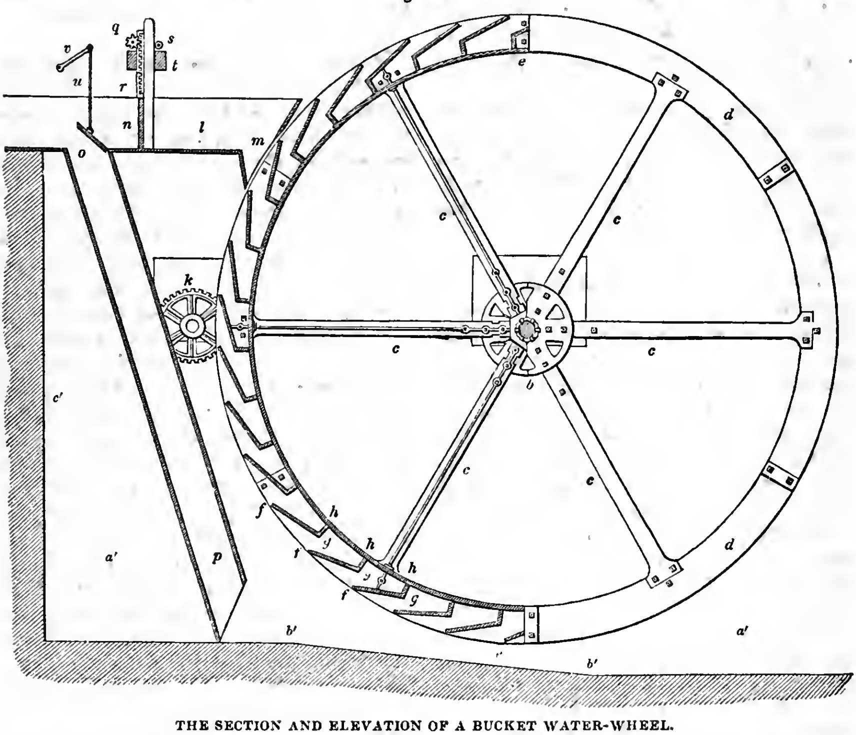
1726. The position of the sluice in the dam should be so studied as to prevent the *wrack* floating on the surface of the water finding its way into the sluice, and thence to the water-wheel. To avoid this inconvenience, the sluice should not be placed at the lowest point of the dam, where it most commonly is, but at one side, at which the water will pass into the lade, while the rubbish will float past to the lowest point.

1727. The water-wheel should be on the *bucket* principle, and, for a fall such as we have supposed, should not be less than 14 feet diameter; the water, therefore, would be received on the breast of the wheel. Its circumference, with a diameter of 14 feet, will be 3·1416 × 14=44 feet; its velocity, at 5 feet per second, is 44 × 5 = 220 feet a minute; and 234 cubic feet, per minute (1723,) of water spread over this, gives a sectional area for the water laid upon the wheel of $\frac{234}{220}=1·06$ feet; but as the bucket should not be more than half filled, this area is to be doubled = 2·12 feet; and as the breadth of the wheel may be restricted to 3 feet, then $\frac{2·12}{3}=·704$ foot, the depth of the shrouding, equal to 8½ inches nearly; and if the wheel is to have wooden soleing, 1 inch should be added to this depth already found, making 9½ inches.

1728. The *arc* in which the wheel is to be placed must have a width sufficient to receive the wheel with the toothed segments attached to the side of the shrouding. For a bucket-wheel it is not necessary that it be built in the arc of a circle, but simply a square chamber—one side of it being formed by the wall of the barn, the other by a wall of solid masonry, at least 2½ feet thick: one end also is built up solid, while the opposite end, towards the tail-race, is either left entirely open, or, if the water is to be carried away by a tunnel, the water-way is arched over and the space above levelled in with earth. It is requisite that the walls of the wheel-arc here described, should be built of square-dressed stone, having a breadth of bed not less than 12 inches, laid flush in mortar, and pointed with Roman cement.

1729. Fig. 140 is a *sectional elevation* of the wheel; *a′ a′* is the barn-wall, *b′ b′*

Fig. 140.



THE SECTION AND ELEVATION OF A BUCKET WATER-WHEEL.

is the sole of the arc or chamber, formed of solid ashler, having an increased slope immediately under the wheel, to clear it speedily of water. The shaft, the arms, and shrouding, are all of cast-iron, the buckets and sole being of wood; and, to prevent risk of fracture, the arms are cast separate from the shrouding. The width of the wheel being 3 feet, the toothed segments 4 inches broad, and they being 1 inch clear of the shrouding, gives a breadth over all of 3 feet 5 inches, and, when in the arc, there should be at least 1 inch of clear space on each side, free of the wall. The shaft is not required to be longer than just to pass through the bearings; for, in wheels of this kind, it is improper to take any motion directly from the shaft. The eye-flanges *b*, 2 feet diameter, are separate castings, to which the arms *c* are bolted; the flanges being first keyed firmly upon the shaft. The shrouding *d d* is cast in segments, and bolted to the arms and to each other at their joinings. On the inside of the shroud-plates are formed the grooves for securing the ends of the buckets and of the sole-boarding, in the form as shown in the section from *e* to *e*. The form of the buckets should be such as to afford the greatest possible space for water at the greatest possible distance from the centre of the wheel, with sufficient space for the entrance of the water and displacement of the air. In discharging the water from the wheel also, the buckets should retain the water to the lowest possible point. These conditions are attained by making the pitch *f f* of the buckets, or their distance from lip to lip, $1\frac{1}{5}$ times the depth of the shrouding; the depth of the front of the bucket *f g* inside, equal to the pitch; and the breadth of the bottom *g h* as great as can be attained consistently with free access of the water to the bucket immediately preceding; this breadth, inside, should not exceed two-fifths of the depth of the shrouding. The figure represents one-half of the shrouding-plates removed, in order the better to exhibit the position of the buckets.

1730. The *shrouding-plates* are bolted upon the buckets and soling by bolts passing from side to side; and, in order to prevent resilience in the wheel, the arms are supported with diagonal braces. The toothed segments which operate on the pinion *k*, are bolted to the side of the shrouding through palms cast upon them for that purpose, and the true position of these segments requires that their pitch-lines should coincide with the circle of gyration of the wheel: when so placed, the resistance to the wheel's action is made to bear upon its parts, without any undue tendency to cross strains. For that reason, it is improper to place the pitch-line beyond the circle of gyration, which is frequently done, even upon the periphery of the water-wheel. The determination of the true place of the circle of gyration is too abstruse to be introduced here, nor is it necessary to be so minute in the small wheels, to which our attention is chiefly directed; suffice it to say, that the pitch-line of the segment wheel should fall between one-half and two-fifths of the breadth of the shrouding, from the extreme edge of the wheel.

1731. Another important point is that *where the power is taken off from the wheel*, that is, the placing of the pinion *k*. The most advantageous part for placing this pinion is in a line horizontal to the axis of the water-wheel: here the whole weight of the water acts in impelling the pinion, while no strain is brought on the shaft beyond the natural weight of the wheel. In every position *above* this, unnecessary strains are brought upon the shaft and other parts of the wheel, and these increase with the distance from the first point *k*, till, if placed at the opposite point horizontal to the axis, the load upon the shaft would be *double* the weight of all the water upon the wheel, over and above the weight of the wheel itself.

1732. *Laying the water upon the wheel* is another point of some consequence; but whether it be delivered over the crown of the wheel, or at any point below that, the water should be allowed to fall through such a space as will give it a velocity equal to that of the periphery of the wheel when in full work. Thus, if the wheel move at the rate of 5 feet per second, the water must fall upon it through a space of not less than ·4 foot; for, by the laws of falling bodies, the velocities acquired are as the times and whole spaces fallen through, to the squares of the time. Thus the velocity acquired in 1″ being 32 feet, a velocity of 5 feet will be acquired by falling .156″; for 32 : 1″ :: 5 : .156″, and 1″^{2} : 16 :: .156″^{2} : .4 foot, the fall to produce a velocity of 5 feet. But this being the minimum, the fall from the trough to the wheel may be made double this result, or about 10 inches. The trough which delivers the water upon the wheel should be at least 6 inches less in breadth than the wheel, to give space for the air escaping from the buckets, and to prevent the water dashing over at the sides; *l*, fig. 140, is the trough and *m* the spout that conveys the water to the wheel. It is convenient to have a regulating sluice *n*, that serves to give more or less water to the wheel; and this is worked by a small shaft passing to the inside of the barn. The shaft carries a pinion *q*, working the rack of the sluice-stem *r*, a small friction-roller *s* being placed in proper bearings on the crosshead *t* of the sluice-frame; and this apparatus is worked inside the barn by means of a lever handle upon the shaft of the pinion *q*. As a waste-sluice, the most convenient and simple, in a mill of this kind, is the trap-sluice *o*, which is simply a board hinged in the sole of the trough, and opening from the wheel; it is made to shut close down to the level of the sole, and, when so shut, the water passes freely over it to the wheel. The lifting of this sluice is effected by means of the connecting-rod *u* and crank-lever *v*, the latter being fixed upon another small shaft, which passes through the wall to the interior of the barn, where it is worked in the same manner as the former. When it is found necessary to stop the wheel, the trap is lifted, and the whole supply of water falls through the shoot *o p*, leading it to the bottom of the wheel-arc *b′b′*, by which it runs off, until the sluice at the dam can be shut, which stops further supply. The wheel here described, if it moves at the rate of 5 feet per second, will make $6\frac{3}{4}$ revolutions per minute. The pinion-shaft of *k* will carry a spur-wheel by which all the other parts of the machine can be put in motion. The rate of the spur-wheel depends on the relation of the water-wheel and its pinion. In the present case they are in the proportion of 8 to 1, and, as the water-wheel makes $6\frac{3}{4}$ revolutions per minute, this, multiplied by 8, will give 54 to the spur-wheel.

1733. There is a diminutive form of thrashing-machine that merits notice,—a *one-horse machine*. In some of our pastoral districts, where the proportion of arable land is so small as not to warrant the expense of a large thrashing-machine, these have been very successfully adopted. They are constructed with a small horse-wheel, generally over-head; and the motion is carried into the barn in the usual form, where a spur-wheel drives the drum-pinion at a velocity of 250 turns per minute. The drum strikes downward, and has a pair of feeding-rollers. There is neither shaker or fan attached to the machine, and four people are required to carry on the process, the dressing being an after operation. With this little machine 12 bushels of oats can be thrashed in an hour; and the whole cost of it is about £20.

1734. There remains to be noticed one more member of this family of machines,—the English *portable thrashing-machine*. It is now most extensively employed in the southern parts of the kingdom, and apparently to good purpose. But while this may be granted to the machine, I demur to the practice which involves out-of-door thrashing, and a system of half performed work. But it is to the machine, and to one member of it alone, that I wish to direct attention, namely, the *drum*. It appears to me, in regard to this member, that the English and the Scotch machines operate on different principles. In the latter, as is well known, the thrashing is performed by a process of beating, and the instrument acts over but a short space, upon the grain undergoing the process—that is, while it is under the drum-cover, or about one-fourth the circumference of the drum-case; and even during a part of this progress, the cover is so distant from the beaters—about 3 inches—that little effect is produced upon the straw beyond a few inches from the feeding-rollers. There can be no doubt that, owing to this peculiar construction, when a stray ear of corn, or a sheaf-band, happens to enter root foremost, they are very likely to pass unthrashed, for the rollers have no hold of them; and they are so lightly pressed upon the beaters that we cannot be surprised at their passing in an imperfectly thrashed state. It has come under observation, also, that, taking our machines as usually worked, and applying them to the thrashing of corn cut by the scythe, the work, from the same cause, is often imperfectly performed, mainly in consequence of many of the ears entering by the reverse end. Of late years, many attempts have been made to improve our thrashing-machines, by improving the shaking apparatus, apparently forgetting that the shaker should have nothing to do beyond separating loose grains from the straw. The duty of the shaker is not to thrash; and when foul thrashing appears, it is the drum, not the shakers, that are in fault.

1735. Let us turn to the English machine, which has nothing, it is true, beyond a drum and feeding-rollers, and they even—the rollers—can be left out. The drum, or, as it might be called, the *rubber*, though armed with what may be termed beaters, does not, in fact, thrash by beating, but by rubbing the grain against a wire grating; and in this lies its best qualities. The drum of this machine is a skeleton formed of two rings of cast-iron, fixed upon an axle, and to these rings are fixed six beaters, lying parallel to the axle, forming a skeleton cylinder. It revolves within a concave, which embraces nearly three-fourths of its circumference, and is nowhere more distant from the beaters than $1\frac{1}{4}$ inch. The concave is nearly throughout an open trellis or grating, composed of plates and rods of iron and wire; and to complete all, this drum makes from 700 to 900 revolutions per minute. In an apparatus of this kind, it is impossible that an ear of corn, enter how it may, can escape unthrashed, or rather rubbed; for it is evident, that the machine operates by a process of *rubbing* out the grain; and with all the defects attending these machines, it must be granted that they thrash clean.

1736. Contrasting these machines, we see the Scotch one operating with a very heavy, and, from its general construction, sluggish cylinder, its beaters moving with a velocity of less than 3000 feet a minute, and the grain subjected to its influence over a space not exceeding $1\frac{1}{2}$ foot; and when worked by 4 horses, thrashing at the rate of 26 bushels of wheat per hour, dressing included. In the English machine is to be seen a small and extremely light skeleton cylinder, which, from its structure, must be easily moved, though its beaters move with a velocity of 4000 feet per minute, and the grain subjected to its influence over a space of about 4 feet, and, when worked by 4 horses, thrashing at the rate of 36 bushels of wheat per hour, but not dressed, though in general very clean thrashed. The straw is perhaps a little more broken, which is sometimes unimportant.

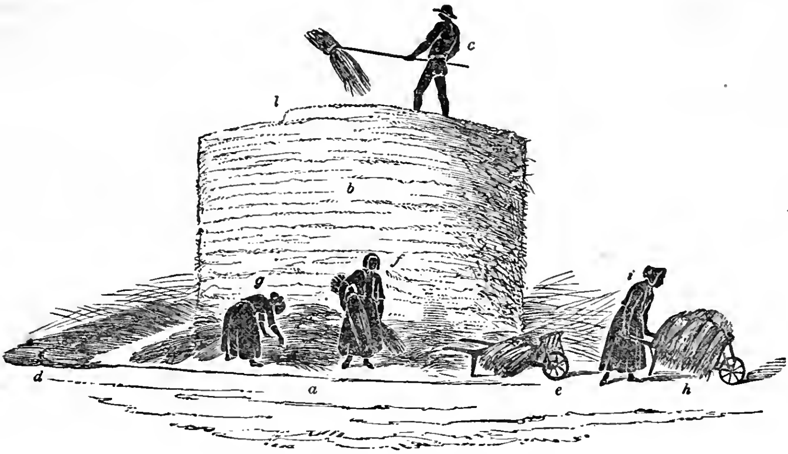
1737. "I cannot view these two machines," well observes Mr Slight, "without feeling impressed with a conviction that both countries would soon feel the advantage of an amalgamation between the two forms of the machine. The drum of the Scotch thrashing-machine would most certainly be improved by a transfusion from the principles of the English machine; and the latter might be equally improved by the adoption of the manufacturing-like arrangements, and general economy of the Scotch system of thrashing. That such interchange will ere long take place, I am convinced; and as I am alike satisfied that the advantages would be mutual, it is to be hoped that these views will not stand alone. It has not been lost sight of, that each machine may be said to be suited to the system to which it belongs, and that here, where the corn is cut by the sickle, the machine is adapted to that; while the same may be said of the other, where cutting by the scythe is so much practised. Notwithstanding all this, there appears to be good properties in both that either seems to stand in need of, and it is not improbable but that the grain in Scotland will ere long be entirely cut down by the scythe."

ON THE THRASHING AND WINNOWING OF GRAIN.

1738. The first preparation for *thrashing* corn — that is, separating the grain from the straw by the thrashing-machine or the flail—is taking in the stack to be thrashed, and mowing it in the upper or thrashing-barn. The person appointed to superintend the barn-work, is the one who forks down the stack to be conveyed into the barn. This is generally the steward, where there is one; and where there is none, the person who superintends the field-workers usually takes this charge. In some cases the hedger does it, when there is not much field-work in winter. Suppose, then, that the steward undertakes the duty,—he is assisted in it by 4 field-workers.

1739. When about to take in a stack, he provides himself with a ladder to reach its eaves, and a long small fork, usually employed to pitch sheaves at leading-time to the builder of stacks. He also provides himself with a stout clasp-knife, which most farm-servants carry. Standing on the ladder, he, in the first place, cuts away with the knife all the tyings of the straw-ropes at the eaves of the stack. On gaining the top, the ladder is taken away, and he cuts away as much of the ropes as he thinks will allow him to remove the covering with the fork. The covering is then pushed down to the ground, until the top of the stack is completely bared. On the side of the stack nearest the barn, a little of the covering is spread upon the ground by the field-workers, to keep the barn-sheet off the ground, and they spread the sheet over the spread straw, close to the bottom of the stack. The sheaves first thrown down from the top of the stack upon the sheet are taken by the women, and placed side by side, with the corn end upon the edge of the sheet, along both its sides, to keep them down from being blown up by the wind, or turned up by the feet. The sheet is seen spread out at *a*, fig. 141,

Fig. 141.



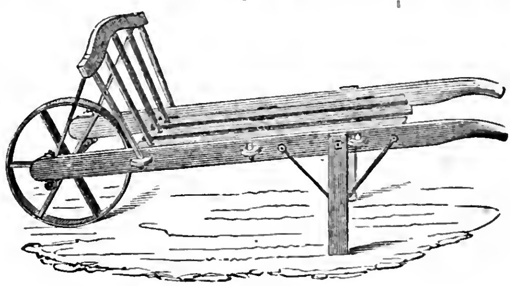
CASTING DOWN A STACK TO BE THRASHED.

from the base of the stack *b*, which is in the act of being thrown or cast down by the steward *c*, and the sheaves, keeping down one side of the sheet, are seen lying in a row as at *d*. One barrow *e*, is in the act of being loaded by the field-worker *f*, whilst another worker *g* assists in loading every barrow as it returns empty; and another barrow *h* is seen fully loaded, and in the act of being wheeled away by the third field-worker *i* to the barn. Each barrow-load, as it arrives at the upper barn, is tilted upon the floor, and emptied at once, instead of the sheaves being lifted out of it one by one. Two barrows, if the distance from the barn is not great, will bring in a stack of ordinary size in a moderate time, say in 3 hours. The fourth worker remains in the upper barn, to pile up the sheaves as they are brought in into what are called *mows*—that is, the sheaves are placed in rows, parallel to each other, to a considerable height, with their butt ends outwards, the first row being piled against the wall, as seen at *a*, fig. 145. In casting the stack, the steward takes up the sheaves in the reverse order in which the builder had laid them at harvest-time, beginning with those in the centre first, and then removing those around the circumference one by one. The fork thrust into the band will generally hit the centre of gravity of the sheaves, where they are most easily lifted, and swung towards the sheet. The sheaf *k* is about the position it assumes on being pitched by a fork, the corn end always having a tendency to drop downwards, and it is supposed to have been lifted from its bed at *l*. When all the sheaves of the stack have been wheeled in, the steward takes a rake and clears the ground of all loose straws of corn that may have been scattered from the stack to the barn, and puts them into the sheet, the four corners of which are then doubled in towards the middle, including within them the grain that may have been shaken out by the shock received by the sheaves on being thrown down; and the sheet, with its contents, are carried by all the women into the barn, and its contents emptied on the floor, near the feeding-in board of the thrashing-machine. The sheet is then shaken, and spread out upon the stack-yard wall, or other airy place, to dry before being folded up to be ready for use on a similar occasion. The covering of the stack is then carried away by the women, to such parts of the courts and hammels as are considered by the cattle-man to require littering, before it becomes wetted with rain, and the ground raked clean. The straw-ropes, which bound down the covering of the stack, should be cut by the steward *into short lengths* before being carried away in the litter, as *long* ropes are found very troublesome to the men when filling their carts with the dung on clearing out the courts. Stacks should be carried into the barn in dry weather, though a drizzling or muggy day will do little harm to the straw. Damp straw passes through the thrashing-mill not only with difficulty, but is apt to mould and contract a disagreeable smell in the straw-barn. A stack may remain in the barn until the straw is required; or it may be thrashed the first wet day; or it may be required to be thrashed on the subsequent part of the day in which it is carried; or it may be requisite to thrash it as brought in, in which case additional hands are required to bring it in, while the usual barn-workers are employed at the mill. The steward having to feed in, the hedger, or engine-man, or one of the men, should field-operations not be pressing, or even a woman, in a case of emergency, can cast the stack, provided the covering is taken off for her, which the steward will do ere the mill is set on. Two barrows actively worked will keep the mill going, if the distance from the stack to the barn is short.

1740. The *barn-sheet* is made of thin canvass, and should be about 12 feet square. It is useful not only for this, but many other purposes of the farm, of which notice shall be taken as the occasion suits.

1741. A very convenient means of conveying the sheaves from the stack to the barn is the *corn-barrow*, fig. 142, the construction of which is so obvious that a specified description seems unnecessary, farther than that it is about 6 feet in length, and stands $2\frac{1}{2}$ feet in height to the top of the bracket. The sheaves are laid *across* the barrow in rows, with the corn and butt ends alternately, and they are kept from sliding off in the act of being wheeled, by the slanting bracket which is supported by stays. In this way, from 10 to 15 sheaves, according to their bulk, may be wheeled away at once by a woman.

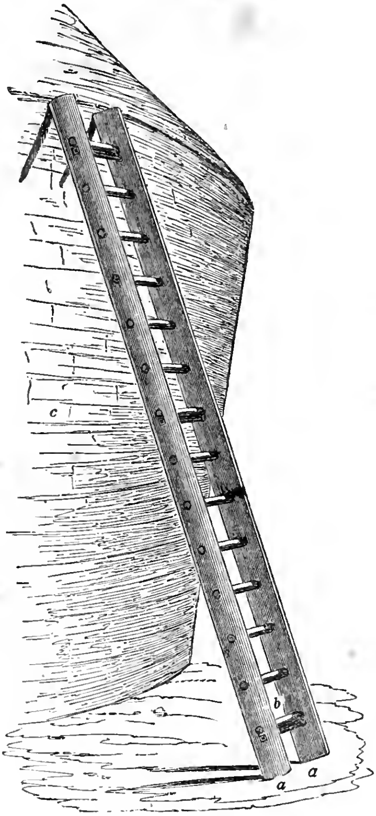
Fig. 142.



THE CORN-BARROW.

1742. Ladders are most useful implements about a farm-steading. They are best formed of tapering Norway pine spars, sawn up the middle. A useful form of ladder for farm purposes is shown in fig. 143, where the rounded form of the Norway spar, divided in two, is placed outmost, though it is as often placed inmost. These spars *a a*, are connected together by steps *b* of clean ash, pushed through auger-made holes in the spars, and rendered firm by means of wedges driven into the outside ends of the steps. The steps are 9 inches apart, and 16 inches long at the bottom, and 13 inches at the top, in a ladder of 15 feet in length, which is the most useful size for the use of a stack-yard. To prevent the ladder from falling to pieces, in consequence of the shrinking of the round steps, a small rod of iron is placed under the upper, middle, and lower steps, where one of its ends is passed through each spar, and held firmly there by means of a shoulder on the inside, and a nut and screw on the outside of each end of the rods. When properly finished and painted, such a ladder will last many years.

Fig. 143.



THE LADDER.

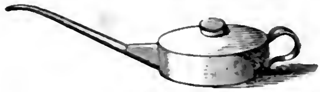
1743. A couple of 10 feet, a couple of 15 feet, and one of 24 feet ladders, will suffice for all the purposes of a farm, as also for the repairs of the steading and houses.

1744. Some dexterity is required to set a long ladder on end, as also to carry it from one place to another. To place it in a perpendicular position, its lower or heavy end should be shoved against any object capable of resisting its slipping upon the ground; and on its light end being elevated arm's-length above the head, the position is kept good by another person taking a step between the prongs of a fork, by means of which that end of the ladder is still more elevated, while it is still increased by the first person pushing arm's-length, simultaneously, against one step after another, till the perpendicular position is gained. A long ladder is carried from one place to another in this way, provided the distance to be carried is short. Set the perpendicular edge of the ladder against the right shoulder, and then take hold of a step with the right hand, and raise the ladder steadily by it a little from the ground, while, to retain the perpendicular position, grasp a step above the head firmly with the left hand, and then walk steadily forward. Some can carry it steadily by grasping one step with both hands, with the edge leaning against the shoulder; and some even are so powerful in the arms, as to carry a ladder by the steps at arm's-length before them, with one arm above, and another below the head. A ladder may be moved on the ground a short distance, while standing in a perpendicular position, by holding a spar in each hand at arm's-length, and then moving first one foot of the ladder in advance, and then the other, till the spot is gained. This sort of motion, when applied to moving a large stone, is technically named by masons *cutting*. A long ladder is brought down from the perpendicular to the horizontal position, by placing it against a stack, as against *c*, fig. 143, or any other object which will resist its foot slipping on the ground, and allowing it to come to the inclined position against the arms, with the hands stretched above the head, and the ladder will approach the horizontal position the farther you recede from its lower end, the upper end being supported by another person with a long fork. When not in use, ladders should be laid on the ground along the side of a stack, or the stack-yard wall; when left standing they are apt to twist. Ladders are more frequently destroyed by being brought to the ground in a careless manner, and by being blown down by the wind while resting against a stack, than by fair use.

1745. Another mode of taking in a stack into the upper barn is with a horse and cart, when the sheaves are mowed up by one woman, and carried from the door by another. When this plan is adopted as a fixed one, there is no gangway to the upper barn, the cart being set alongside the wall, and the sheaves forked into the door upon the floor, from whence they are carried to the mow. This plan also requires the stack-yard to be constructed so as a cart may pass and turn between every two rows of stacks, thereby causing it to occupy a large space of ground. It has also the effect of laying a plough idle when a stack is taking in, unless there be an odd horse, worked by a lad, employed over and above the ordinary number of draughts. If a plough is laid idle upon every stack being taken in, greater loss is incurred by employing the horses in this way, than in paying 4 women and having 2 barrows; and, after all, the women will be required to work in the barn when the mill is set on. When a horse is employed, 2 men are required at the taking in of the stack; one to cast the stack, and the other to drive the horse, unless, indeed, a woman is employed to cast the stack, which she may occasionally do, but cannot be depended on to possess the requisite strength to do the work throughout the season. On taking in with a horse, one barn-sheet is required at the stack and another at the barn-wall. The cart-wheels are apt to cut up the stack-yard in wet weather, unless the roads through it are metalled with stones, which incurs expense; and in time of snow, a complete road must be cut for the passage of the cart. Roads through a stack-yard, to admit carts every where, and give freedom to go to the barn from any part, lays the stack-yard open to people and stock. I confess I like the gangway and barrows, as being a neater and quieter mode of proceeding with the work, especially as women are obliged to be employed in the barn; but even with a gangway, a cart or carts may be occasionally employed in taking in a stack while the mill is going, by the sheaves being forked from the cart, across the head of the gangway, into the upper barn, and thence taken to the mow or feeding-in table.

1746. Before setting on the thrashing-mill, its several parts require to be *oiled*. Fine sweet oil should be employed for this purpose, though too often a coarse dirty oil is used. It should be put for use into a small tin-flask, having a long narrow spout, fig. 144, to reach any gudgeon behind a wheel. The gudgeons which require oiling are those of the drum, the spur-wheel, the shakers, and the fanners; and, with horse-power, that of the pinion of the lying-shaft, as also the step of the bone-wheel; and in the case of water-power, those of the wheel, and the lying and upright shafts. It is the duty of the steward to oil the machine.

Fig. 144.



THE OIL-CAN.

1747. When steam is employed as the moving power, the fire should be kindled by the engine-man in time to get up the steam by the moment it is wanted. From half an hour to an hour may be required for this purpose, according to the state of the atmosphere. When water is the power, the sluice of the supply dam should be drawn up to the proper height, to allow the water time to reach the mill-wheel sluice when it is wanted. When the power is of horses, the horses are yoked in the wheel by their respective drivers, immediately after leaving the stable at the appointed hour of yoking; and while one of the men is left in charge of driving the horses, the others go to the straw-barn to take away the straw from the screen of the mill with straw-forks, figs. 110, 111, and fork it in mows across the breadth of the barn.

1748. The steward undertakes the feeding-in of the corn, and has the sole control of the mill. Two women are appointed to the upper barn above—one to bring forward the sheaves, the other to loosen their bands and place them, as required, upon the table of the feeding-in board. Other two women are appointed in the corn-barn below, one to take away the corn as it comes from the spout, and riddle it with a riddle appropriate to the sort of corn, in a bin in one corner or side of the barn. The other takes away the roughs, or coarse corn, from the other spout, and riddles it with an appropriate riddle in a heap by itself, throwing the skimmings of the riddlings in a chaff-sheet, which she carries to the upper barn, to be again put through the mill. Where elevators are in use, one woman is sufficient in the corn-barn to riddle the corn as it comes from the clean spout, and the other woman, in this case, tramps the straw-mow in the straw-barn. It is the duty of one of the women in the corn-barn to see that the chaff does not accumulate upon the end of the mill-fanners, and fall down into the rough spout. To ascertain the state of the chaff easily, a small sliding shut should be made in the wooden partition between the corn-barn and chaff-house, on opening and looking through which, the state of the chaff will at once be seen. When water or steam is employed, women either take away the straw from the machine, independent of those in the barns, or men do it, such as the hedger or cattle-man, and at times the shepherd. In all cases, a woman should spread the straw and tramp it in mows in the straw-barn, as it comes from the mill, and form one mow after another.

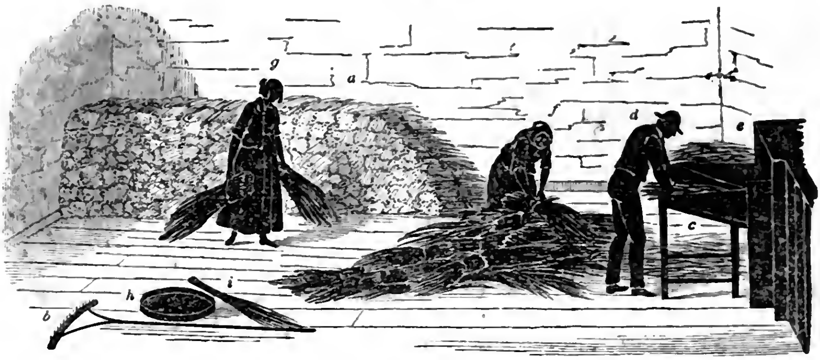
1749. A *chaff-sheet* for carrying oat-chaff or riddlings, or other refuse from the barns, consists of thin sacking or cotton bagging—and there should at least be two of them in the corn-barn. From 5 to 5½ feet square makes a convenient size of chaff-sheet.

1750. Every thing being thus prepared, (and every preparation ought to be completed before the mill is moved,) the mill is ordered by the steward to be set a-going by the engine-man or driver—and which is best done by means of ringing a bell, hung in the engine-room or horse-course,—when the power is steam or horses, and he himself lets on the water to the wheel when the power is water. The power should be applied gently at first, and no corn should be presented until the mill has acquired its proper momentum—the *thrashing-motion*, as it is termed. When this has been attained, in a very few seconds, and which a little experience will teach the ear to recognise instantly, the steward—the feeder-in—takes a portion of a sheaf in both his hands, and, letting its corn end fall before him on the feeding-in board, spreads it with a shaking and disengaging motion across the width of the board. His great care is, that no more is fed in than the mill can thrash cleverly; that none of the corn is presented sideways, or with the straw end foremost. He thus proceeds with a small quantity of corn for a few minutes, until he ascertains the capacity of the mill for work at the particular time, which is much affected by many circumstances, and then the requisite quantity is fed in; but on no account should the feed exceed one sheaf at a time, however fast they may have to be supplied in succession.

1751. The ascertainment of the capacity of the mill is necessary every time the mill is used; for however well acquainted the feeder-in may be with it generally, and whatever power may be employed, it is not alike effective under all circumstances. For example, the water may flow quicker or slower; the horses move slower and duller or brisker; and the steam be more or less easily raised, and retain its elasticity longer or shorter one day than in another. If water is flowing *freely into* the supply-dam while the thrashing is going on, it will come more quickly towards the wheel, and consequently maintain the thrashing pace of the mill for a longer time than when it flows from a full dam until it is emptied, when the power becomes less by degrees. So with horses: the state of the weather will oppress them one day, and they will work with languor and irregularity, do what the driver can to induce them; while in another day, they will work with an active pace throughout the yoking. I presume less of this variation will be felt with steam than with any of the other powers, but still the state of the atmosphere must have *some* effect on its elasticity. The direction and strength of the wind affects the progress of thrashing. When it blows in the direction of the straws passing through the mill, the thrashing will proceed briskly. So powerfully have I seen this exemplified, that the upper barn door had to be kept shut, to moderate the effect of the wind. On the other hand, when the wind blows against the straw through the mill, the thrashing may proceed so slowly as that the doors of the straw-barn are obliged to be closed—and then some of the corn will pass along with the straw.

1752. Acquainted with all these promotive and retarding circumstances, suppose that the feeder-in *d*, fig. 145, is ready to proceed. He takes the sheaves from the feeder-in board *e*, supplied by the woman stationed beside it *f*, whose duty it is to loosen the bands of the sheaves; but he should not allow her to put on more than one sheaf at a time on the table, as is the propensity to do, much to his annoyance in separating the sheaves; while the other woman *g*, brings forward the sheaves from the mow *a*, and places them in a convenient position before the other woman *f*, and even loosens a band occasionally in assistance.

Fig. 145.



FEEDING IN CORN INTO THE THRASHING-MACHINE IN THE UPPER BARN.

1753. There are certain circumstances which greatly affect the action of the mill in the cleanness of its thrashing. One depends on the *driving of the horses*, in which a considerable difference is felt by the feeder-in when one man keeps the horses at a regular pace, whilst another drives them by fits and starts. The regular motion is attained by the driver walking round the course in *the contrary direction to the horses*, in which he meets every horse at least twice in the course of a revolution, and which keeps all the horses upon their mettle, every horse expecting to be spoken to when he meets the driver. The irregular motion is produced by his walking in the *same direction* with the horses, when the horse next him makes the greatest exertion until he outstrips the man, when he slackens his pace; and then the horse following him, on coming up to the man, exerts himself until he also passes him; and so on in succession, one horse after another. The man always walks slower than the horses; and when he gives a crack of the whip the horses give a start, and strain the machine; but immediately after this they relapse into the irregular motion, caused as above described. In such a style of driving a willing horse is sure to get more to do, and a lazy one less than he should, as horse-wheels are usually constructed. The gangway, which is sometimes made for the driver to walk in within the stays of the wheel, serves only to encourage his indolence. I have seen a fellow fast asleep while leaning against one of these stays, on being carried round on the gangway. The horses receive a breathing of 15 or 20 minutes at mid-yoking in the mill.

1754. Another cause of foul thrashing is cutting the bands of the sheaves with a knife, instead of loosening the band and corn-knot. The cutting is a quick mode of assisting the woman who hands the sheaves to the feeder-in, but the knot, in passing sideways with the sheaf, almost escapes the drum. Every band should be loosened, its corn-knot untied, and laid along the sheaf to which it belongs, when it will have the chance of being thrashed clean. If one woman is unable to loosen the bands fast enough, on account of the shortness of the sheaves, the other woman should assist her by laying loosened sheaves before her; but if a third woman is found requisite for the work, let her be engaged rather than the straw be not thrashed clean.

1755. Too slow or too fast a motion of the mill, and the permission of portions of sheaves going broadside on, or butt end foremost, to the feeding-rollers, will cause foul thrashing, and consequent loss of corn.

1756. There are several incidental inconveniences attending the act of thrashing under particular circumstances—as, when the sheaves are very long, the feeding-rollers take a long time to pass them through, even after the fast motion has been given them. In a very quick motion, the beaters of the drum are apt to chop the straw in pieces. On the other hand, very short sheaves are taken in so quickly as almost to elude the drum, even when the feeding-rollers are put on the slow motion. It is a laborious task to feed in short sheaves of any sort, and especially of oats, so as to keep the mill steadily thrashing; and it is loss both of time and power to allow the feeding-rollers to be idle, even for a moment. I was once very hard worked, as were the women who loosened the sheaves and riddled the corn, in feeding-in a stack of ordinary dimensions of Blainslie oats of very short straw, when the sheaves disappeared through the feeding-rollers in an instant, though on the slowest motion. The stack took about 6½ hours to thrash with horses, and during this time 64 bolls, or 384 bushels, of clean corn passed through the mill—nearly 10 bolls or 60 bushels an hour. Another cause besides short straw may cause great labour in feeding-in,—namely, inordinate application of the moving power. Wind is the power which is most likely to elude the control of man. I remember of a windmill which ran off, and could not be stopped by the brake, in consequence of a sudden gale pressing more forcibly upon the sails than it was in the power of the apparatus to furl them; and such a velocity did the mill attain that two men were required to feed in, and horses and men to bring in corn to the machinery, until the wind should abate a little—which it did not at all until three large stacks of oats had been thrashed, at the rate of 16 bolls, or 96 bushels, per hour. When the straw is long and supple, it is apt to wind round the upper feeding-roller—and, when it does, no more corn should be fed in, as it will be drawn in instantly by the drum. In some mills a reverse motion is given to the feeding-rollers, to obviate the accident by unwinding the straw; but it does not always serve the purpose intended. Indeed, I never saw a good instance of unwinding by the rollers. A much better plan is, to cut the straw with a stout knife, while the rollers are moving in their usual course. The most convenient form of knife is that of a razor set dead in a stout wooden handle. It should be always at hand within a leathern strap nailed on the inside of the post of the drum-framing, near the right hand of the feeder-in. Long oat-straw is liable to warp at all times, especially when damp, and brought direct from the field. Some mills are closed in with boarding above the drum-cover, to conceal the first rake from view; but in close muggy weather, or with the straw not completely dry, the straw is apt to linger about the rake—and, to notice this inconvenience, the board has to be raised up very often. Such a board is useful when wheat is thrashing, when its grains, striking against the surface of the rake, are thrown back with great force upon the face of the feeder-in. So painfully have I felt the pellets of wheat strike my face, in the absence of such a board, that a sack had to be nailed up to ward off the grain. The inconvenience of the straw collecting in front of the first shaker I have seen most frequently occur when seed-wheat was thrashing in autumn, before the straw was completely won; and wheat-straw, in that state, will even wind round the rollers.

1757. When the sheaves are about all thrashed, one of the women takes the rake *b*, fig. 145, and pushes with its inverted head all the loose corn along the floor, as about *c*, that has come out from the straw, into a heap at the feeding-in board, upon which it is placed by the other woman with the wecht *h*. While the feeder-in is putting this loose corn towards the rollers with a stout stick, kept in the barn for the purpose, the woman who had raked it in now sweeps the entire floor towards the board, with the besom *i*. The mill is then stopped for a few minutes, until all the corn, chaff, and straw belonging to the particular stack thrashed are swept away from the drum-gudgeons, and elsewhere, and placed on the feeding-in board, that no remains of the corn in hand may be left to mingle with perhaps a very different sort of grain in the stack that will be thrashed next. While all this is proceeding, the women in the corn-barn are not idle. One has riddled the tail of the corn-bin, and shovelled the bin close against a convenient part of the barn-wall; while the other has taken up to the upper barn the remaining refuse, to be passed again through the mill, and swept the barn floor clean, and hung up the riddles against the walls, and put the other implements into their proper places.

1758. When barley is thrashed, the roughs are not riddled as it comes from the spout, but reserved to be put through the mill after the sheaves have all been thrashed. The hatchway *a*, fig. 127, forms a convenient means of communication betwixt the corn and upper barns, and through it the roughs are handed up in weehts, and placed on the feeding-in board, from which the feeder-in supplies the mill in small quantities with the stick, so as the roughs may have time to be thoroughly beaten by the drum; for, with the exception of the fanners to blow away the awny refuse into the chaff-house, the rest of the machinery of the mill is of little value in this operation. The use of the stick for this and the operation mentioned above, is to save the hands of the feeder-in being seized by the feeding-rollers, when feeding in so short a substance as roughs. Few mills have elevators, and therefore the barley-roughs are usually treated as now described.

1759. Any portion of the straw that happens to be damp, which it is very likely to be immediately after harvest, will probably not be thrashed clean, and it is advisable to put it again through the mill. The opening in the wall at *b*, fig. 137, betwixt the upper and straw barns, permits the damp straw to be forked up from the straw-barn into the upper barn.

1760. After the mill has been used for every purpose, the sluice of the dam is immediately let down, the horses taken out of the mill-course, or the steam let off, the hatchway and opening are closed, and the door of the upper barn is locked.

1761. The feeding-in of oats is similar to that of wheat, but only the straw is not so easily separated in the sheaf.

1762. The bean being easily separated from its pod, the fast motion of the thrashing-machine should be put on when it is thrashed; but, the straw being brittle, the best plan to avoid its being much broken with the fast motion is to feed the sheaves thin *sideways*, instead of lengthways, into the feeding-rollers. The pods being covered with down, it becomes black on the crop being won, which the thrashing throws off like a thick black impalpable dust, which, on entering the mouth and nostrils, and blackening the clothes, makes the thrashing of beans a disagreeable process; and the noise occasioned by their impinging against the iron lining of the drum-case, is most deafening, and overpowers the human voice. In thrashing peas, the feeding-rollers are put on the fast motion, and the sheaf is allowed to be taken in by them, while the feeder holds on by the sheaf, and pulls it thinner and thinner. Peas are as easily thrashed out as beans; but the process does not create so offensive a dust, though the noise attending it is very great. Peas are riddled with the oat riddle, the refuse generally being small clods of earth and shrivelled grains, which are left in the riddle, and given to the pigeons.

1763. I have said that the straw, as it is thrashed, is mowed up in the straw-barn, and it is done in this manner:—Two persons are required to take away the straw when the thrashing-mill is in motion. The straw is received, as it falls continuously down the straw-screen *o′*, fig. 136, upon the strongly boarded part of the floor of the straw-barn below it, and is thence taken up in forkfuls, with a large straw fork, fig. 110, and carried to the part of the straw-barn where it is intended to be mowed up, and where a field-worker is ready to receive it and mow it up. The mowing consists of spreading the straw in a line, across the end or along one side of the straw-barn, in breadths or mows of 5 or 6 feet, and trampling it firmly with the feet; and, when one mow has reached such a height as the roofing of the barn will easily allow, another one is made upon the floor beside it, and so on in succession, one mow after another, in parallel order, until the stack is thrashed or the barn filled. The advantage of putting up straw in the barn in mows, in preference to building it over a large portion of the barn-floor, is—that a mow receives the straw in forkfuls, which require to be only spread a very little before being tramped firm; whereas over a broad space the forkfuls would have to be carried to the farthest end and sides—a task which no single field-worker could do as fast as the men fork it. And when the straw is taken away, each mow is easily removed by force of the arms alone, whereas straw is very difficult to be pulled asunder when built up and tramped in broad spaces.

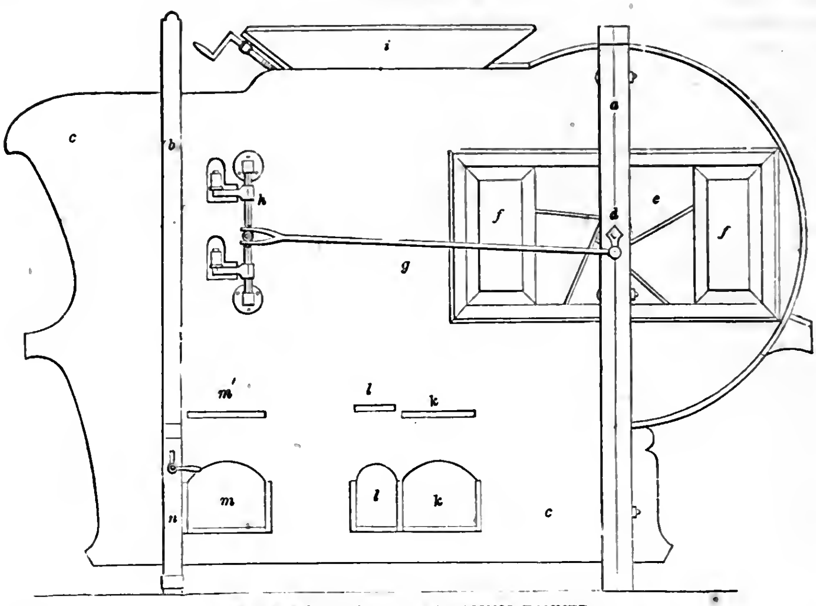
1764. When a stack of litter straw is being thrashed, the cattle-man may be saved a good deal of trouble in carrying the litter to the courts and hammels, should they require to be littered. To effect this, the straw is carried in back-loads from the straw-screen in short ropes, one end of which is hooked on to the bottom of the screen, and the other end is held in one hand of the person who is to carry the load, while the other hand guides the straw into the rope. Those who carry assist each other on with the load in the barn. The carriers litter one court after another methodically, and not at random, in which they are assisted and directed by the cattle-man, and by the field-worker who would have had to mow the straw in the barn.

1765. For the convenience of this process, as well as for many others, it is better to have the end of the straw-screen cut off about $3\frac{1}{2}$ feet above the floor of the straw-barn, instead of allowing it to slope down to the floor, because, when it is so prolonged, its end is in the way upon the floor, and very apt to become injured by the prongs of the large forks striking against it when removing the straw; and it much interferes with the convenience of bundling straw directly from the mill, either for the purpose of litter, fodder, or thatching stacks. In some mills there is no straw-screen at all, the straw falling on the floor direct from the apron of the second shaker. Besides the inconvenience of the straw thus falling directly upon the persons taking it away, the want of a screen prevents the stray grains of corn being separated from the straw, and are therefore carried away in it.

1766. The next process in connexion with corn is the *winnowing*—that is, making it clean for the market—and this process is conducted in the corn-barn. The first thing to be done towards preparing the thrashed heap of corn for the market, is passing the roughs of wheat or oats through the blower. This machine is set with its tail at the barn-door, that the chaff may be blown away from it. The steward drives the fanners, one woman fills the hopper with the roughs; and as they do not pass easily through the hopper, another woman stands upon the stool belonging to the barn, fig. 164, and pushes them with her hand towards the feeding-roller; while the other two women riddle the corn upon the new-thrashed heap. The riddlings of the roughs, and all the light corn, may be put past for the fowls.

1767. Before proceeding to describe particularly the winnowing of corn, it is necessary to give you some idea of the machines by which the corn is made clean for market, such as the winnowing machines, or *fanners*—so named in the latter sense because they blow away the filth from the corn by means of fans. When cleaning fanners are fixed to one spot, and are connected with elevators, they are generally of large dimensions, and of more complicated construction than when made to be moved about in the barn. Fig. 146 is the *elevation* of the fixed fanner, which is in dimensions 6 feet 9 inches in length, 4 feet 9 inches in height, and 1 foot 9 inches in breadth, and where *a* is the fore framing, made in halves, and bolted together, for the convenience of removing the outward half of the fan-case; *b* is the back frame made single; *c c* is the side boarding; *d* is a crank on the end of the spindle of the fan, the arms of which are seen traversing the spaces *e*, which are the air-ports by which the air finds access to the fans, and upon which are placed sliding panels *f f*, by which the admission of the air, and ultimately the force of the blast, can be regulated; the crank *d* is attached to the connecting rod *g*, which communicates motion to the double or bell-crank spindle *h*, whose office it is to move the riddle-frame. The hopper *i* receives the undressed grain, and the spouts *k l m* deliver respectively the first, second, and light grain, after separation in the machine; but, as it would be inconvenient to deliver all these at one side, there are corresponding sliders, *k′ l′ m′*; and each side being provided with

Fig. 146.

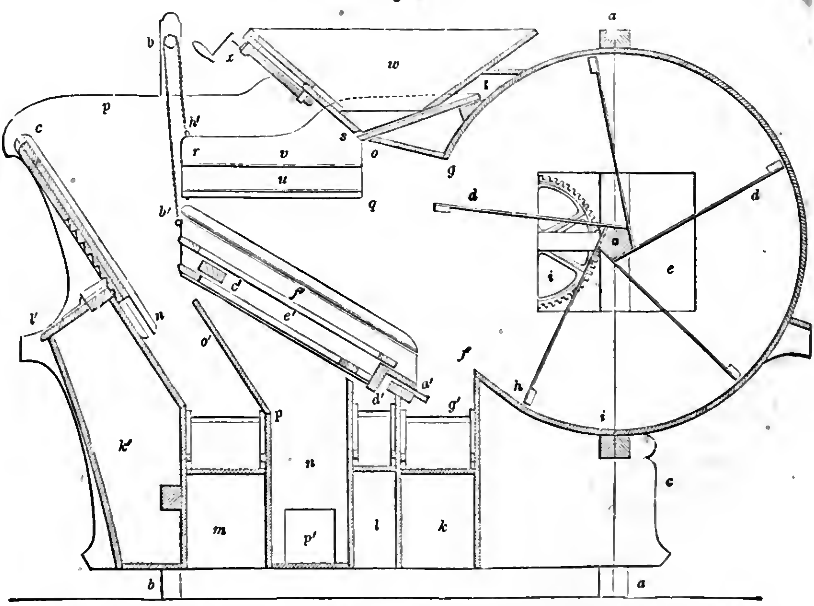


THE ELEVATION OF THE DRESSING FANNER.

spouts and sliders, the latter are shifted so as to cause the three qualities to be delivered—two on one side, and the third in the opposite. The slot-bar *n* is for the purpose of adjusting the length of the fourth foot of the machine to any inequalities of the barn-floor.

1768. Fig. 147 is a *longitudinal section* of the same fanner, the letters of which

Fig. 147.



THE LONGITUDINAL SECTION OF THE DRESSING FANNER, WITH RIDDLES AND SIEVES.

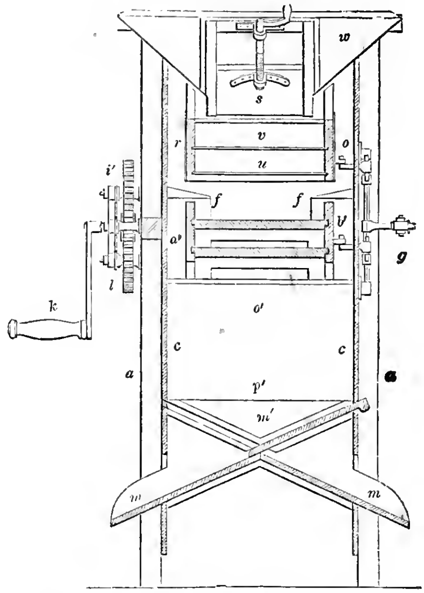
partly correspond with those in fig. 146. The fans revolve within the circular case *f g h*, the space *f g* being open for the discharge of the air, *g o* being the funnel-board; *s t* is the shoe; *q r s* is the riddle-frame, which receives the two riddles *u* and *v*, slid in grooves and movable; *w* is the hopper, on the front of which is the sluice *s*, moved by the screw-winch *x*, to regulate the feed. The sieve frame is *a' b'*, which receives two sieves into the grooves *e'* and *f'*. The frames of both riddles and sieves are supported by the chains *b'* and *h'*, attached to the stretcher-rod *b*. The toothed wheel *i*, seen through the air-port, is turned by a winch-handle, and acts upon a pinion fixed upon the axle of the fan. The proportion of the wheel and pinion are 4½ to 1, the fan making from 212 to 220 revolutions per minute. The spare riddles are kept in the locker *k'*, *l'* being the lid opening into it; *c n'* is a slider that can be raised or depressed to catch the light grain, while it allows the chaff to pass over.

1769. The full complement of riddles for the riddle-frame is 6, of which 2 only can be employed at one time. Their meshes are—for wheat 5 in the inch, for barley 4 in the inch, and for oats 3 in the inch. The slap-riddles are three quarter inch, and 1 inch in the meshes. The sieves are made of wire-cloth: the upper one has 9 meshes in the inch, the lower 7 meshes.

1770. Fig. 148 is a *transverse section* of the same fanner: *a a* are the frames, *c c* the side-boardings, *m m* the light spouts, *m'* the sliders, to change the direction of the discharge; and *o' p'* is the sloping division *o' p* of fig. 147. The sieve-frame, with its 2 sieves, are contained between *a'* and *b'*; and *f f* are 2 flaunch-boards, sloping over the sieve-frame, to direct the grain upon the sieve. The riddle-frame, with its riddles *u* and *v*, are contained between *r* and *o*; and *w* is the hopper, with its sluice *s*. The end of the connecting-rod *g*, fig 146, is seen at *g*, as jointed to the bell-cranks that shake the riddles and sieves by their attachment at *b'* and *o*; *i'* is the toothed wheel, with its winch-handle *k*, and framework *l*, by which the fan is impelled.

1771. When this fanner is in operation, the blast is sent through the funnel *f g o b'*, fig. 147. Its chief force is directed

Fig. 148.

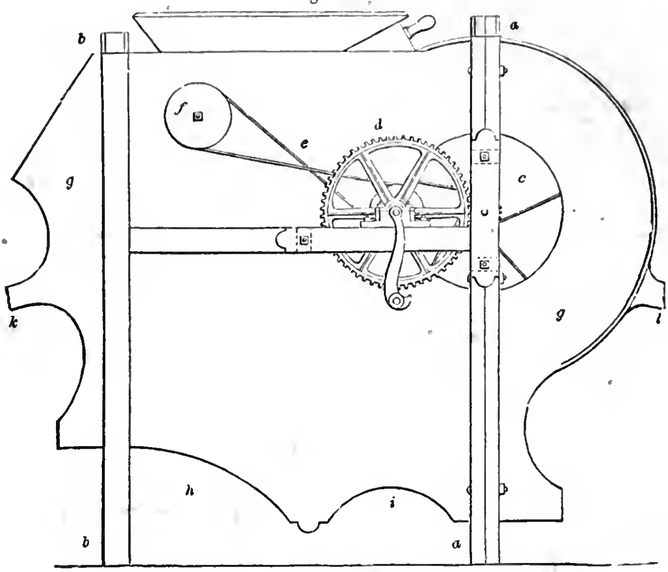


THE TRANSVERSE SECTION OF THE DRESSING FANNER.

upon that end of the riddles *q o*; and as the grain falls from the hopper upon that end of the riddles, the lighter chaff is immediately blown off beyond the point *c*. The remainder, with the grain, will be passing through the riddles towards the sieve; and during this stage, any remains of chaff are blown off and the light grain and seeds are blown beyond *b'*. The blast not having power to carry them over *c*, they fall down between *c* and *b'*, and are discharged at the *lights* spout *m*; at the same time, the heavy grain and seeds fall upon the upper sieve *f'*, when all the plump full-sized grains roll down over this sieve, and are delivered at the *firsts* spout *k*. These grains, together with other seeds whose specific gravity exceeds the *lights*, but whose bulk is under that which the upper sieve is intended to pass, consequently fall through the meshes, and are received upon the lower sieve *e'*; upon this the grain so received rolls down and is delivered through a small opening at the foot of the sieve *e'* into the chamber of the *seconds* spout *l*. The smaller seeds, such as those of *sinapis* and others, being too small to be retained even upon this sieve, fall through it, and are received into the chamber *n*, from which they are removed at convenience through the aperture *p'*, which is closed by a sliding shutter. The usual price of this fanner, with its riddles and sieves, is £9, 9s.

1772. *The finishing fanner or duster.*—This is a fanner of simpler construction than fig. 146. As regards the blast, it is constructed on the same principle as the former. Fig. 149 is an *elevation*, in which the framework is similar to the last, but its

Fig. 149.



THE ELEVATION OF THE FINISHING FANNER OR DUSTER.

over-all dimensions are smaller, the extreme length being 5 feet 8 inches, the height 4 feet 8 inches, and the width, as before, 1 foot 9 inches. The main frame *a a* is again made in halves, and the back frame *b* is also single; *c* is the air-port. The wheel *d*, and its pinion on the axle of the fan, are in the same proportion as before; but on the axle of the wheel, a pulley is mounted, which, by means of a cross-belt *e*, drives the pulley *f*, of the same diameter, and which is placed upon the axle of a feeding-roller. The sideboarding *g g*, is formed to the taste of the maker, except in that part which forms the fan-case, and in the parts *h* and *i*, which are cut away to afford more ready access to the *light corn*, and to the small seed that may have been separated: *k* and *l* are handles by which it may be lifted from one place of the barn to another.

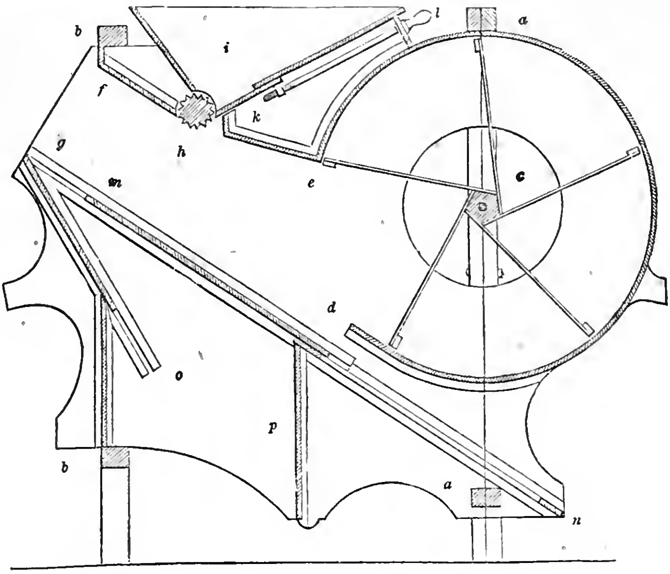
1773. Fig. 150 is the *longitudinal section*, where *a a* and *b b* are the cross rails of the frames, and *c* the air-port. In this machine, the blast is sent directly through an open funnel, *d e f g*; the latter part, *f g* being continued outward from the feeding roller *h*, which is so placed as not to offer any obstruction to the current. The hopper *i* is furnished with a slider *k*, which is adjusted to the requisite feed by the screw *l*; and the sole of the funnel, from *m* to *d*, is a solid board, while the shoot from *d* to *n*—the point of discharge for the *best corn*—is a wire sieve. That part of the sole *m d*, and the board *g o*, are both fitted to slide up or down to temper the division of the *light corn*, should any of them remain; and *p* is a division, separating the light corn from the small seeds.

1774. Fig. 151 is the *transverse section; a a* are the frames, *b* is the winch-handle, *c* the wheel-framing, and *d* the wheel; *f* is the pulley of the feeding-roller, *h* the roller, and *i* the hopper. Of the interior parts, *p* is the division under the sole, *m* is the sole as seen below, and *d d* are the vanes of the fan, *e e* being its axle.

1775. In operating with this fanner,

the grain is taken from the hopper by the revolution of the feeding-roller; and as it falls perpendicularly in a thin sheet, is intercepted by the blast under the most

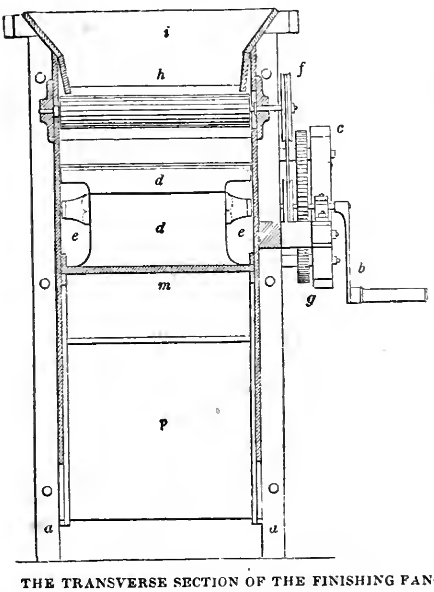
Fig. 150.



THE LONGITUDINAL SECTION OF THE FINISHING FANNER OR DUSTER.

favourable circumstances. All such chaff and dust as yet remain amongst it, is blown over the back-board *g*, fig. 150; the light grain that may have remained is separated also, and falls between *g* and *m*, down the spout *g o*; the remainder runs down the sole *m d*, and in passing from *d* to *n*, should any small seeds yet remain, they are intercepted, and fall through the screen *d n*, while the best corn passes on, and is delivered at *n*. The price of this fanner is £6, 15s.

Fig. 151.



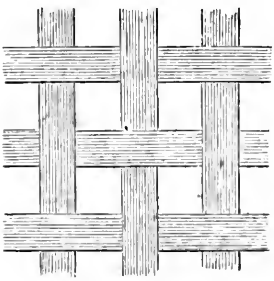
THE TRANSVERSE SECTION OF THE FINISHING FANNER OR DUSTER.

1776. The *thrashing-machine fanner* differs little in its essentials from the first described. Its position *p* is seen in figs. 135 and 136, immediately under the great hopper *o*. The width for a 6-horse power machine ought to be considerably more than the common fanners, not under 24 inches, nor is it requisite that it should exceed 30 inches. The fan is of the same diameter, and the *firsts* spout stands in the same relation as described in fig. 146. There is no spout corresponding to the *seconds* of that figure; but the foul spout takes the place of the light corn. The riddles and sieves of fig. 147 are entirely left out, and in their place a simple shoe, with a sheet-iron bottom, which is perforated all over in 1-inch holes at five-eighth inch apart. This is placed under the great hopper, and is agitated by a connecting rod from a crank on the fan-axle, in the same manner as exhibited in fig. 146 at *g*. The extreme length of the machine fanners should be 8 feet, and their height 4 feet 10 inches.

1777. *Riddles.*—The most complete implements for separating heavy articles from corn of any kind are *riddles.* They are formed either entirely of wood, or partly of wood and wire. Wood riddles have long been in use, though I believe, in the hands of a skilful riddler, the wire riddle makes the best work. The wood are made of fir or willow, but American elm is the best. The wire riddles have hitherto been made of iron wire, on account, perhaps, of its cheapness; but I should suppose that copper wire would make a better and more durable riddle. A riddle, whether of wood or wire, consists of a bottom of open mesh-work, and of a cylindrical rim of wood, the diameter of which is usually 23 or 24 inches, and its depth 3 inches. Rims are made either of fir, or oak, or beech, the last being most used. In fir rims, the wooden withes of the bottom are passed through slits, thereby endangering the splitting of the rim itself all round, which they not unfrequently do; but in the oak rim the withes are passed through bored holes, which never cause splitting. There is little danger of wire splitting the rims of any sort of wood. The following figures of riddles are portions only of the bottom of each kind, but the meshes are at full sizes.

1778. Fig. 152 is a wheat riddle of wood, the meshes of which are a quarter of an inch square, the breadth of the wood splits three-sixteenths of an inch, and its price is 3s. 6d. with an oak rim.

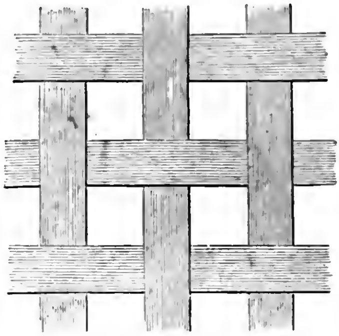
Fig. 152.



THE WOODEN WHEAT RIDDLE.

1779. Fig. 153 is a wooden barley riddle having a mesh of five-sixteenths of an inch square, the breadth of the withes being a quarter of an inch. The price is 3s. with an oak rim.

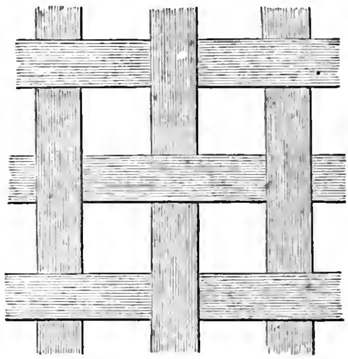
Fig. 153.



THE WOODEN BARLEY RIDDLE.

1780. Fig. 154 is a wooden riddle for oats, with three-eighths of an inch square of mesh, and the breadth of the withes a quarter of an inch. The price is 2s. 4d. with an oak rim.

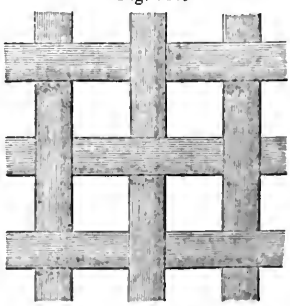
Fig. 154.



THE WOODEN OAT RIDDLE.

1781. Fig. 155 is a wooden riddle for beans, having five-sixteenths of an inch square in the mesh, with withes of three-sixteenths of an inch in width. The price is 3s. 6d. with an oak rim.

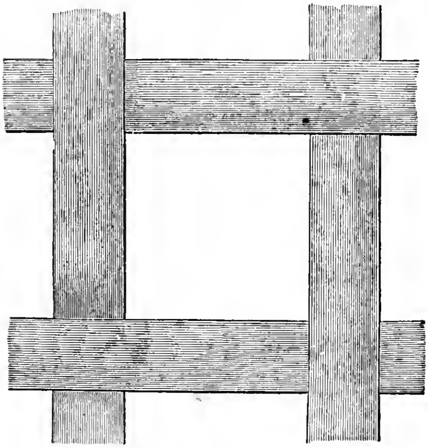
Fig. 155.



THE WOODEN BEAN RIDDLE.

1782. For riddling the roughs of wheat and oats, the roughs of barley not being riddled, a wooden riddle, fig. 156, has

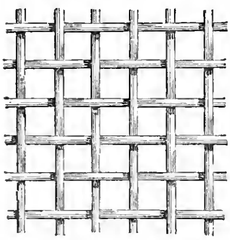
Fig. 156.



THE WOODEN RIDDLE FOR THE ROUGHS OF WHEAT AND OATS.

meshes of one inch square, and the breadth of the withes three-eighths of an inch. The price is 2s., with an oak rim.

Fig. 157.

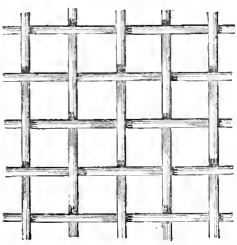


THE IRON-WIRE WHEAT RIDDLE.

1783. Fig. 157 is an iron-wire riddle for wheat, having 25 meshes in the square inch, including the thickness of the wires. The price is 5s., with a beech rim.

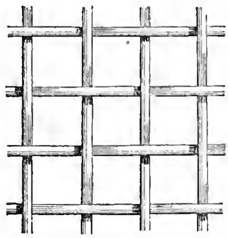
1784. Fig. 158 is an iron-wire riddle for barley, having 16 meshes to the square inch, including the thickness of the wire. The price is 4s., with a beech rim. A barley wire riddle answers for riddling beans, but an opposite process is performed,—the small and shrivelled beans and other refuse pass through the meshes, while the good grain is left in the riddle; together with any lumps of clay and stones that may have accompanied the good grain, and which must be removed by the hand.

Fig. 158.



THE IRON WIRE BARLEY RIDDLE.

Fig. 159.

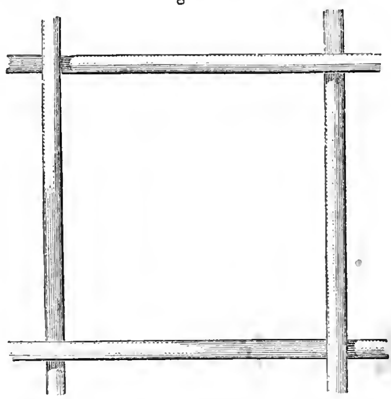


THE IRON-WIRE OAT RIDDLE.

1785. Fig. 159 is an iron-wire riddle for oats, having 12 meshes to the square inch, including the thickness of the wire. The price is 3s. 6d., with a beech rim.

1786. Fig. 160 is a wire riddle for roughs, having the meshes $1\frac{1}{2}$ inch square.

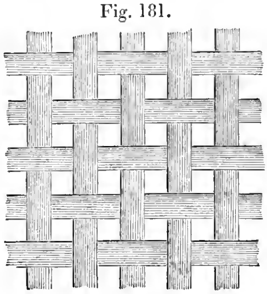
Fig. 160.



THE IRON-WIRE RIDDLE FOR ROUGHS.

The price is 2s. 6d., with a beech rim. Riddles for roughs are also called *slap-riddles*. When elevators are used in a thrashing machine, no slap-riddles are required.

Fig. 181.



THE WOODEN SIEVE.

1787. *Sieves.*—Fig. 161 is a wooden sieve for sifting out dust, earth, and small seeds, from corn, having meshes of one-eighth of an inch square, and the breadth of the withes also one-eighth of an inch. The price is 3s. 6d., with an oak rim.

Fig. 162.

THE IRON-WIRE SIEVE.

1788. Fig. 162 is an iron-wire sieve, having 64 meshes to the square inch, including the thickness of the wire. The size is 22 inches diameter, called No. 8, and, with a beech rim, is sold for 5s. 6d.

1789. These are all the sizes and varieties of riddles and sieves required on a farm. Of slap-riddles and sieves, only one of each size is used; but of the riddles for wheat, barley, oats, and beans, two of each kind are required, whether of wood or wire. I have tried both kinds, and prefer the wire, as making better work, though I am aware they require more dexterous riddlers, to use them with advantage, than the wooden riddles.

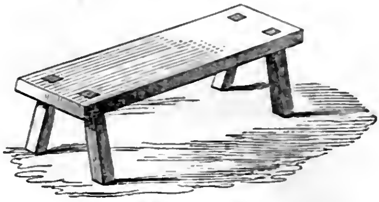
1790. *Wechts* or *maunds* for taking up corn from the bin or floor, of the form of *h*, fig. 145, are made either of withes or of skin, attached to a rim of wood. One of fir withes, with a rim of oak, costs 2s. 6d. A young calf's skin with the hair on, or sheep's skin without the wool, tacked to the rim in a wet state, after becoming dry and hard, makes a better and more durable wecht than wood. Wechts should be made of different sizes; two as large as two fulls shall fill the bushel with ease, and others of smaller diameter, and less depth of rim, to take up the corn from the fanner, to give to the riddlers. Baskets of close and beautiful wicker-work, such as fig. 163, are used in barns in parts of England instead of wechts.

Fig. 163.

THE CORN-BASKET OF WICKER-WORK.

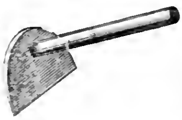
1791. A stout four-legged *stool*, $2\frac{1}{2}$ feet long, 9 inches broad, and 9 inches high, fig. 164, made of ash, is useful in a barn, to allow the women to reach the hopper of the fanner easily. For want of a stool the inverted bushel is taken to stand upon, much to its injury.

Fig. 164.



THE BARN STOOL.

Fig. 165.

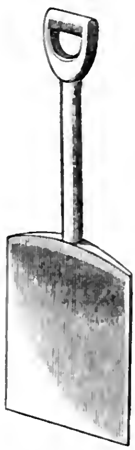


THE BARN WOODEN HOE

1792. A *wooden hoe*, fig. 165, 7 inches long, and 4 inches deep in the blade, fixed to a shaft 9 inches long, made of plane-tree, is easier than the hands to fill wechts with corn from the floor.

1793. A couple of wooden *scoops*, such as fig. 166, to shovel up the corn in heaps, are indispensable implements in a corn-barn. The scoop is 3 feet 3 inches in height, with a head like a common spade; a helve 18 inches in length, and the blade 14 inches wide and 16 inches long. The blade, helve, and handle, are all of one piece of wood, of plane-tree, the belly of the scoop being a little hollowed out, and its back thinned away to the sides and face. This is a convenient size of scoop for women's use, and who have most occasion to use it, and it is also light. In the granaries in towns, scoops are made longer, with a handle of a separate piece of ash, and are clumsy implements when made of more than one piece of wood. A wooden scoop does not injure a floor so much as an iron spade, and better retains the corn upon its face, in the act of shovelling.

Fig. 166.



THE CORN SCOOP.

1794. Brooms are useful implements in a steading, to sweep the different sorts of floors, and they are formed of materials suited best to clean the particular sort of floor. For sweeping the floors of causewayed or paved stables and byres, the twigs of the birch tree form the most elastic and durable brooms. They are tied together with stout twine in bundles of about 6 inches in diameter at the tied end, and 2 feet in length. A wooden handle of about 3 feet in length is driven into the tied end, and is kept in its place by a pin passed through it and the twigs. The sweeping end receives such a trimming with the knife as to give it a flattened face to the ground, sloped away to a point. Fresh twigs make the best brooms, and after they have become perfectly dry, they are very brittle. Brooms for the corn-barn and granaries are best made of stems of the broom plant, (*Genista scoparia*,) and I presume the instrument derived its name from the plant being so used, which is simply tied together with twine at one end, about 3 feet in length, and used without a handle. The broom is also in the best state when fresh, and becomes very brittle on being dried. When long straight stems of the common ling (*Calluna vulgaris*) can be procured, they make both good and durable brooms. The harder birch is required to clear the dirt from between the stones of a causeway, and the softer broom answers best to keep the barn-floor. Hair brooms do not answer, as bristles have not strength to clear away the heavier dust often encountered in barns. Perhaps brooms of whalebone would answer better than broom, but I have seen none of them as yet tried in the country.

1795. Nails should be driven at convenient places in the walls and partitions of the barn, to hang the riddles, wechts, and sieves upon.

1796. The necessary implements being described, the heap of grain, suppose it to be wheat, is next to be winnowed. For this purpose, the blower, fig. 149, is placed alongside the heap, with its tail away from the direction in which it is proposed to place the new riddled heap of grain with its offside, that is, its side farthest from the driver, next the heap. The steward adjusts the component parts of the blower to suit the nature of the grain to be winnowed—namely, the tail-board, *g o*, fig. 150, should be no higher up than to allow the chaff to escape over it, while it retains the lightest even of the grain; the slide, *m d*, in the interior, should only be so far up as to permit the light grain to be blown over it, while it retains all the heaviest, which pours down *d n* to the floor. What falls from this slide is the light corn, and it drops nearest the chaff. The wire-screen below this slide on *d n* permits dust and small seeds of wild plants to pass through, and deposits them between the light and heavy corn. The opening of the sluice at the feeding-roller *k* and *h* is so adjusted as that the grain shall fall as fast, but no faster, than the wind shall have power to blow away the chaff and light corn from amongst the heavy. All these adjustments of parts may not be made the most perfect at once, but a little trial will soon direct him what requires to be rectified, and experience of the machine will enable him to hit near the mark at once. The blower should be made to stand firmly and steadily on the floor when used.

1797. The arrangement of the persons who winnow the corn, so as to proceed with regularity and despatch, is this:—The steward drives the blower. One woman fills the hopper with corn with a large wecht, or the basket, fig. 163, from the heap, on the opposite side from the driver. Her duty is to keep the hopper as nearly full as she can, as then the issue of corn from it is most regular, and she is assisted in doing this the more easily by the use of the barn-stool, fig. 164. Another woman, with a smaller wecht, takes up the good grain as it slides down upon the floor, with the wooden hoe, fig. 165, and divides the wechtful between the other two women, who each stand with a riddle, fig. 152 or 157, in her hand at the place where the new heap is to be made. The heap is made in one corner, or against any part of a wall of the barn, to take up as little room as possible. When the two women have received the grain into their riddles, they riddle it, bringing the last part of each riddling towards the edge of the heap, and casting what is left as the scum in the riddles into the bushel, as a receiver, placed conveniently to receive it. The riddlings consist of capes, large grains, sprouted grains, small stones, the larger class of seed of weeds, that could not pass through the wire-screen in the blower, clods of earth, bits of straw too heavy to be blown away, and such like. By the time the women have riddled the quantity given them, the other woman has taken up as much from the floor at the blower as to supply them with a fresh quantity. When the corn begins to accumulate amongst the riddlers' feet, one of them takes the wooden scoop, fig. 166, and drawing with it the tail or edge of the heap into a small heap, gives it up in portions to the other riddler, who puts the remains of the riddlings into the bushel; after which the large heap is shovelled up against the wall, while the scattered grain on the floor is swept towards it with a broom *i*, fig. 145, by one of the riddlers, or the woman who gives up the corn from the blower, as the case may be. While the unwinnowed heap is becoming less, as the riddled one increases in bulk, the woman who has charge of it shovels it also up at times, and sweeps in its edge, that no scattered grains may be permitted to lie upon the floor to get crushed with her shoes. All the women should endeavour to do their respective parts in a neat and cleanly way. There is much difference in the mode of working evinced by different women in the barn, some constantly spilling grain on the floor, when they have occasion to lift it with a wecht, evincing the slattern; but it is the duty of the steward to correct every instance of carelessness; whilst others keep the floor clean, and handle all the instruments they use with skill and neatness.

1798. The thrashed heap of corn being thus passed through the blower, and riddled in the manner described into another heap, the chaffy matter blown upon the floor is then carried away to the dunghill, and the light corn subjected to examination, as well as the riddlings in the bushel. When the grain is of fine quality, there will be no good grain, and little bulk in the light corn heap, which may all be put past for hen's meat; but, in other circumstances, the light corn, together with what is in the bushel, should again be put through the fanners, and all the grain taken out of it that would not injure the clean corn, when mixed with it. When the light corn has thus been disposed of, and the seeds and dust from the screen carried out and placed on a bare piece of ground for the pigeons, fowls, or wild birds to pick up, and *not* thrown upon the dunghill to render it foul with the seeds of wild plants, the heap should be shovelled up, the fanner thoroughly cleaned and placed aside, and the floor swept.

1799. When corn is dressed clean, there should nothing be seen but good grains,—no shrivelled grains, no seeds of other plants, no clods of earth, no straw, no chaffed grains. It is highly probable that the dressing described above will be sufficient to clean the corn; but should any earth or small seeds be still detected amongst it, and the blower cannot separate these, the corn should be sifted through a sieve, fig. 161 or 162. Should light substances be still detected along with shrivelled grain, the whole should again be put through the fanner, and riddled as before described. Should light substances only be found, these may be blown away by the fanner, and the corn will not again be required to be riddled, but measured into the bushel, and put into sacks from the fanner. Good grain will be sufficiently dressed by one passage through the fanners, but that of inferior quality will require twice putting through; or should a superior class of fanner be used, such as fig. 146, grain of even very inferior quality may be made sufficiently clean by one winnowing. In general, oats are made clean by one winnowing, but wheat and barley require two thorough winnowings, that is, twice through the fanner, and twice riddled.

1800. Suppose, then, that the corn has been treated as last described, and lies in a heap to be measured into sacks, the arrangements for doing this is seen in fig. 167, where *a* is the steward with the strike in his right hand, ready to strike the corn in the bushel *b*, which is in the act of being filled by the two women *c c*, who are pouring a wechtful each into it at the same time, and in such quantity, as to fill it at once. Other two women *d d* are holding the mouth of the sack *e* ready for the bushel to be emptied into it. The first two bushelfuls are emptied into the sack from the floor, and the last two are emptied by first placing the edge of the bushel upon the half-filled sack by the steward and one of the women lifting it by its handles, and when there, the women slip the mouth of the sack under the handle

Fig. 167.

THE MEASURING UP OF GRAIN IN THE CORN BARN.

nearest them, and while they raise the bushel a little by means of the sack, the steward turns the bushel over from him, pouring the grain completely out of it into the elevated mouth of the sack; and thence sustaining the weight of the empty bushel with both hands, he sets it down by the handle beside the heap of corn, with one handle towards the heap and the other towards the sack, ready again to be filled. Four bushels, or half a quarter of grain, are put into one sack. The sack, when full, is wheeled away by the steward with the sack-barrow *f* amongst the other sacks at *g*; and while the steward is doing this, one of the women *d* brings forward an empty sack from the heap *h*, which had been laid neatly down by the steward, in sufficient number to contain all the corn in the heap, or what portion of it may be desired to be measured up at the time. As the heap *i* diminishes, one of the women *c* shovels it into smaller space with the scoop *k*, and sweeps the floor clean towards the heap with the broom *l*, and then the whole party advance nearer the heap. It is customary for the two sets of women *c c* and *d d* to take the filling of the bushel by turns every four sacks filled, as the holding of the sacks is attended with little fatigue, compared to filling the bushel.

1801. There are some particulars regarding the measuring up of grain which require attention. In the first place, the bushel should be filled at once, because it will hold more corn when filled with two separate wechtfuls than with two at once, the first wechtful getting time to subside before the other is poured above it.

1802. In the next place, the wechtfuls should not be poured into the bushel from a great height, as the higher fall compresses more grains into the bushel. The women, *c c* in fig. 167, are purposely shown pouring the corn from too great a height into the bushel.

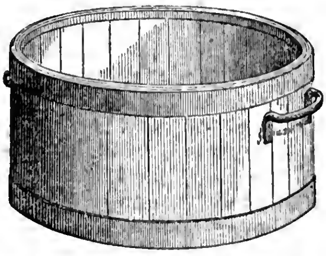
1803. Another consideration is, that the bushel be striked immediately after it is filled. To do it quickly, the corn raised in the centre of the bushel by the pouring should be levelled with a wave of the fingers of the left hand, in the lightest manner, so as to make it spread around towards, and not lower than, the edge of the bushel farthest from the heap, and this part of the edge is sweeped with the side of the same hand, to clear it of every grain of corn, and make it ready for the strike to be applied, which should always be drawn towards the heap, in order to make the superfluous grain striked off fall as near it as practicable. As a proof how much grain sinks in a bushel in a very short time after it has been striked, a space in the inside of the rim will be seen all the way round, the moment that the bushel is touched to be emptied; but a more obvious proof is obtained on striking the mouth of the bushel with a smart stroke of the strike, and the grain will immediately subside a considerable space.

1804. Another matter is, that the grain be well shaken down into the sack while it is measured, so as to fill up the corners, and make the whole sack firm. It is much easier for men to carry a well filled sack to a distance, and especially up several stairs to a granary, than one that is loosely filled in. The filled sack can be commanded like a pack of goods; in a slack one, the grain is apt to shift its berthage, to use a nautical phrase, and to change the centre of gravity of the load.

1805. The corn is measured up direct from the fanners in this way:—The steward drives the fans, one woman fills the hopper, another puts the winnowed grain into a large weeht, and fills the bushel at once, strikes the bushel and empties it, while the other two women hold the sacks, one of whom wheels them away with the sack-barrow as filled. There is one objection to this mode of filling the bushel, that the tremor of the floor, occasioned by the working of the fanner, is apt to shake down the corn in it more than in the way described above. In measuring up corn for horses, or seed-corn of any kind, or the corn to be given to the men as part of their wages, it may be measured up in any circumstances; and as only oats can be measured after one winnowing—it is only that species of grain which is measured up direct from the fanner.

1806. Corn is now invariably measured by the imperial bushel, fig. 168. It is of

Fig. 168.



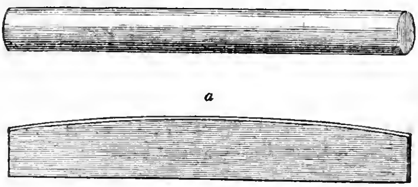
THE IMPERIAL BUSHEL OF A CONVENIENT FORM.

cooper-work, made of oak and hooped with iron; and, according to the Weights and Measures Act, must be stamped by competent authority before it can be legally used; and, having been declared the standard measure of capacity in the country for dry measure, it forms the basis of all contracts dependent on measures of capacity when otherwise indefinitely expressed (5th Geo. IV., c. 74, sec. 15.) The bushel must contain just 2150.42 cubic inches, though its form may vary. The form represented in the figure I consider most convenient, being somewhat broader at the base than at the top, and furnished with 2 fixed handles. It is not too broad for the mouth of an ordinary half-quarter sack, nor too deep to compress the grain too much; and its 2 handles are placed pretty high, so that it may be carried full without the risk of capsizing. Some bushels are made inconveniently broad for a sack, for the sake of being shallow, that the corn may not be compressed in them. I have seen others spread out so much in the mouth as to render them unsteady. Some have no handles at all, and are obliged to be lifted by the arms; whilst others have only one handle for the person who overturns the bushel to lay hold of, and that sometimes a jointed one, and there being no handle on the other side for the sack to pass under, the sack is apt to slip over the mouth of the bushel while it is being emptied; and others have the handles too low to be of any service to the sack to pass under in the act of the bushel being emptied. These different structures of bushels become essential conveniences or inconveniences when much corn has to be measured up in a short time; and when convenience is studied in them, they contribute much to ease labour. I felt this forcibly one short day in winter, when I had to measure up 125 bolls of oats, equal to 750 bushels, with the old firlot of $1\frac{1}{2}$ bushel, of a convenient form, overturning it 500 times, and wheeling away every boll with a sack-barrow to different parts of the barn.

1807. In connexion with the bushel is the *strike* for sweeping off the superfluous corn above the edge of the bushel. It is usually made of two forms; the one a flat piece of wood, like *a* in fig. 169; the other of the form of a roller, like *b*. The Weights and Measures Act prescribes that the strike shall be of a round form, of a piece of light wood, 2 inches in diameter; but he who put the notion into the heads of those who drew up the act, that this is the best form of strike, must have had little experience of using one. If the object is to separate one stratum of grains of corn from another—and this is the only object of using a strike—the *sharp* edge of

Fig. 169.

b



a

THE FLAT AND CYLINDER CORN-STRIKES.

the flat strike is evidently best fitted for the purpose. A cylinder, when passed with a uniform motion over a bushel, though not rolling, must push down some of the grain that is in front of it, under it; and, if it is *rolled* across the bushel, it must press down still more grain, in the manner of a roller passing over friable land, and, of course, *make* the bushel hold more grain than it would naturally do. I would advise all sellers of grain to use the flat strike, whatever purchasers may wish them to do. On striking wheat, the strike is drawn straight across the bushel, the grains being nearly round, and yielding easily to the forward motion of the strike; but in the case of barley and oats, pease and beans, the strike should be moved across the bushel in a zig-zag manner, because, those grains being long or rough, a straight motion is apt to tear away some of them even to be below the level of the edge of the bushel. The strike should be made of wood in the best seasoned state, and of that kind which is least likely to lose its straightness of edge, while it should be light to carry in the hand, and hard to resist blows. Perhaps plane-tree may afford the nearest approach to all these properties.

1808. Wheat and oats require no other dressing than what may be given by the fanner; but it is otherwise, at times, with barley. When barley has not been thoroughly ripened, the awns are apt to be broken off at too great a distance from the grain, by the thrashing-machine; and as the part left must be got rid of before the grain can be said to be dressed, means are used for that purpose by the *hummeller*, which may be driven by the same power as the thrashing-machine, or used by the hand.

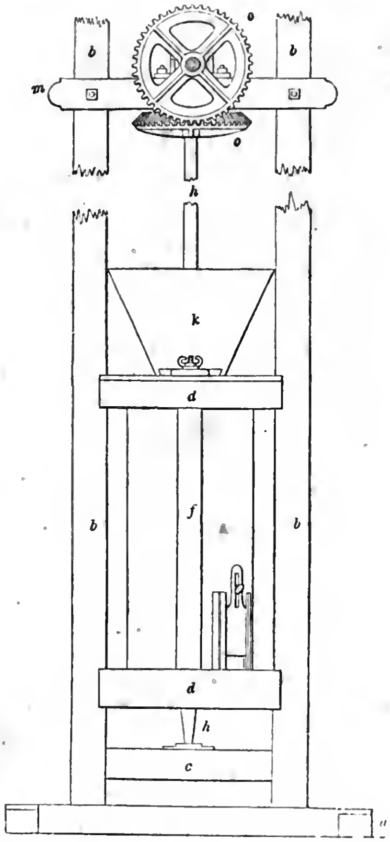
1809. The hummelling of barley is a process that, in many cases, is essential to the marketable condition of that grain, and it is effected in many different ways. In some cases the thrashing-machine itself is made the hummeller, by employing an iron fluted cover to the drum; in others, without this addition, the barley is shut up in the drum-case for a few minutes while the drum is revolving, as recommended by the late Rev. Dr Farquharson, Alford.* Another method is with a conical receiver, within which a spindle, carrying a number of cross arms, is made to revolve, and the grain passes through this machine, lying nearly in a horizontal position, before entering the fanner. This form of the hummeller was made public by Messrs Grant, Grantown, Banffshire,† and, with some modifications,—which are, however, very important ones, and give a new character to the machine,—a hummeller similar to it is now the most approved form, the case being made cylindrical, and its position vertical. Instead, also, of the grain passing loosely through the cylinder, an essential characteristic of the improved machine is, that the cylinder shall be always full of grain.

1810. The *cylinder hummeller* consists of a cylindrical case of wire-cloth, having an upright iron spindle revolving within it, armed with a number of flat thin blades of iron, kept in revolution at a high velocity. The grain is admitted through a hopper at top, keeping the cylinder always full, and is discharged through a small orifice at bottom, the degree of hummelling depending upon the area of this orifice. Fig. 170 is an elevation of this hummeller. The sole frame *a a* rests on the floor of the corn-barn (see *k* fig. 130;) *b b* are two strong posts rising from the former, and secured to the beams of the floor above; *c* is a bridge-tree which supports the foot of the spindle *h*; two rings of wood *d d*, are supported by the uprights *f*. It is lined with wire-cloth, of 10 or 12 meshes in the inch, and placed

* *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 66. † *Ibid.*

between the posts *b b*, and is furnished with a bottom, which just admits the spindle *h* to pass through, and having a

Fig. 170.

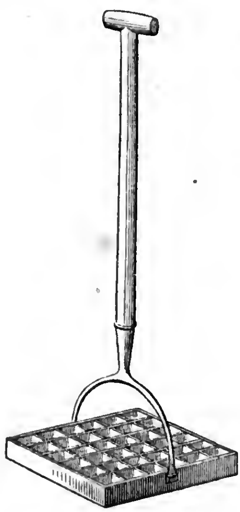


THE ELEVATION OF THE CYLINDER HUMMELLER.

thin shield on the spindle, over the opening. The spindle supports the blades, which are in 2 rows, 5 and 4 in a row, riveted into the spindle; or the blades may be cruciform, with an eye in the centre, through which the shaft passes. The hopper *k* may be either formed round the spindle, or it may stand at one side; and it may be furnished with a slider to regulate the feed, though this is virtually done by the contraction or enlargement of the orifice below. To save space, fig. 170 is represented broken off; but *m* is a bridge-piece bolted upon the posts *b*, to support the head of the spindle, and also the end of the horizontal shaft; the spindle *h* and shaft carry the mitre-wheels *o* that give motion to the spindle. The spindle requires to have a velocity of 300 to 400 per minute, and the motion may be conveyed in various ways, suited to the general arrangements of the machinery. In the present case, it is brought at once from the great spur-wheel by a pinion of the same size as that of the drum; and its shaft is supported on a bracket at the one end, while the other has a bearing in the wall that separates the barn from the engine-house.

1811. *The Hand-hummeller.*—In the smaller class of farms, hand-hummellers are pretty generally used, and are of various forms, but all retaining one principle of construction and of effect. They are round, square, and oblong; but in all three forms, they consist of a number of parallel bars of iron, placed in a frame of one of the forms above-named. Fig. 171 is a square hummeller in perspective. It consists of a square frame of iron, 12 inches each way, 2 inches in depth, and $\frac{1}{8}$ inch thick. Bars of similar dimensions are riveted into the sides of the frame, and crossing each other, forming compartments of from $1\frac{1}{2}$ to 2 inches square. A branched iron stem is riveted to the frame below and at top, and forms a socket into which a wooden helve is fixed, having a crosshead by which it is held in the hand. Such hummellers are frequently made with parallel bars only, in which case they are less expensive but much less effective. It is used with a mincing motion on a thin layer of barley on the floor.

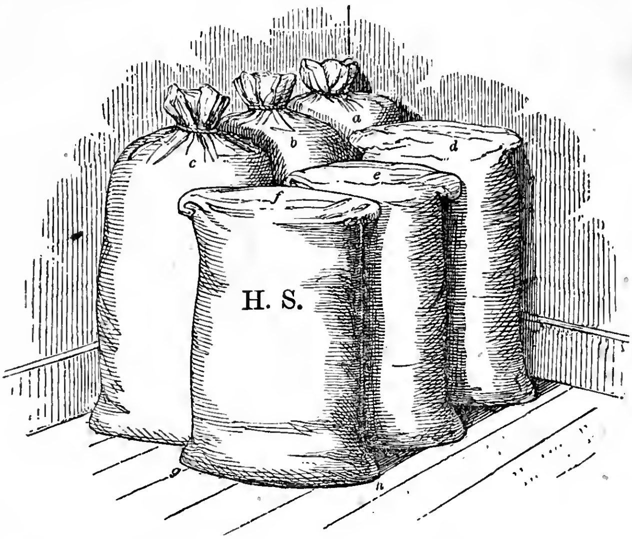
Fig. 171.



THE HAND-HUMMELLER.

1812. To make sacks stand so as each may be taken away with ease from a number, they should be set, the first one in a corner, with one shoulder against one wall, and the other shoulder against the other wall, as seen at *a*, fig. 172; and every other sack in the same row, as *b* and *c*, will stand with the left shoulder against the wall, and the right

Fig. 172.



FILLED SACKS AS THEY SHOULD BE PLACED ON THE BARN FLOOR.

shoulder against the side of the sack set down before it. In the succeeding row, the first sack, as *d*, will have its right shoulder against the wall, and its left shoulder against the side of the first sack *a* that was set up in the corner; and the succeeding sacks, *e* and *f*, will have their left shoulders in the hollows between the sacks, *b* and *c*, in the first row, and their right shoulders against the sides of the sacks that were set down just before each of them: and so on, row after row. In short, the sacks stand shoulder to shoulder, instead of side to side. Now, the utility of this arrangement is, that the sacks, in the first place, are as closely set together as they can possibly be; for the left shoulders of *d* and *e*, as may be seen, fill up the hollows between the right shoulders of *a b* and *b c*. In the next place, as each sack is removed in the reversed order in which they were placed, it presents its broad side either to the barrow to be wheeled away, without the slightest entanglement with any other sack, or to be lifted at once as it stands upon the man's back, without the usual trouble of having to be kneed forward to a more convenient spot. Thus, look upon *f*, the last placed sack, and the first to be removed. It is obvious that its side is presented in the most proper position for the barrow; and its corners *g* and *h* are quite ready for the hands of the persons who are to assist in raising it to a man's back. The figures show also the difference between tight and slovenly sacking up of corn; *f* shows a slackness of putting the first bushel into it, where there are creases between *g* and *h*, and the corners at *g* and *h* project too much out, because the corn above them is too slack. On the other hand, *d* shows a well-filled sack. When filled sacks are wheeled aside, their mouths should be folded in and closed up, as represented in the outer row *d e f*. On tying sacks, which they must be when intended to be sent away by cart, the tie should be made as near the corn as possible, to keep the whole sack firm, as seen in *a*, *b*, and *c*.

1813. There are three modes of lifting a sack to a man's back. One is, for the person who is to carry the load to bow his head down in front of the sack, placing his back to its broad side, and bending his left arm behind his own back, across his loins, and his right hand upon his right knee, to await in this position the assistance that is to be given him. Two people assist in raising the sack, by standing face to face, one on each side of it, bowing down so as to clasp hands across the sack near its bottom, as from *g* to *h*, below the carrier's head, and thrusting the fingers of the other hands into the corners *g* and *h*, which yield and go inwards, and thereby afford a firm hold. Each lifter then presses his shoulder against the edge of the sack, and with a combined exertion upwards, which the carrier seconds by raising his body up, the bottom of the sack is raised uppermost, and the tied mouth downmost, resting against the back of the carrier. The lifters now leaving hold, the carrier keeps the sack steady on his back, with his left arm across its mouth. Another plan is, for the carrier to lay hold of the top of the shoulder of the sack with both his hands, his arms crossing each other. His two assistants do as directed before; and while they lift the sack between them, the carrier quickly turns his back round to the sack and receives it there, retaining a firm hold of the parts he had at first. A third plan is for the assistants to raise the sack upon another one, and then the carrier brings his back down against the side of the sack, laying hold of its shoulders over his own shoulders, and rising up straight with it on his back. The last plan requires most strength from the carrier, he having to rise up with the load; the second most from the lifters, they having to lift the load up; and in the first both parties are nearly equally concerned.

1814. The more upright a man walks with a loaded sack on his back, with a short firm step, the less will the load feel oppressive to him.

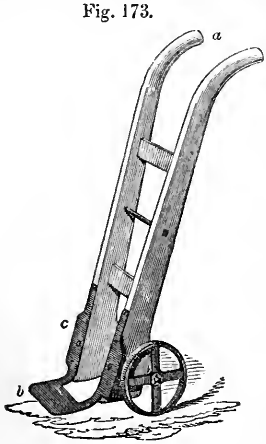
1815. A filled sack is kneed forward by placing both knees against the side of the sack, and, while embracing it with both arms, and grasping hold of it with both hands, lifting it from the ground, and pushing it forward a space with the knees, and thus from space to space, or around a pivot.

1816. In regard to loading a cart with filled sacks, the general principle is to place all the mouths of the sacks within the body of the cart, so that should any of the tyings give way, the corn will not be spilled upon the ground. One mode of loading a cart, a double-horse load, is represented in Plate III., which is supposed to be a loaded cart on its way to a market town. Two sacks are laid flat on the bottom of the cart, with the mouths next the horse. Two are placed on the front, with their bottoms outwards. Two are placed on the tail-board with their bottoms outwards, and the mouths of all the four are within the cart. These last four sacks are placed on their edges, with the corners just over the edge of the front and back of the cart. Other two sacks are placed together on edge above these four, and one behind, flat, with all their mouths pointing inwards. Nine or ten old bolls, that is, 54 or 60 bushels, used to be carried by two horses, according to the distance to be travelled; but now that half-quarter sacks are in use, and the single-horse cart is most generally employed, the loads have assumed a different form, according to the length of the journey, and as the horses are to be loaded or return empty from the market town. About 36 bushels of wheat, 40 of barley, and 56 of oats, each quantity making about 1 ton weight, is considered a good load for a double cart in the country; and a single one will take a proportionate quantity of these numbers, according to the circumstances in which the farm is situated in reference to the place where the grain is to be delivered; but 15 cwts. make a good load for a single horse. The carters in towns take much heavier loads of corn than those in the country. I may mention that the sacks, as represented in the cart in Plate III., seem too large and full for corn; they rather have the appearance of being filled with rye-grass seed.

1817. The *sacks* for corn require to be attended to, to keep them in serviceable condition. They are usually made of a sort of canvass, called sacking, and according to the quality of the tow of which the sacking is made, and the mode in which it is manufactured, whether tweeled or plain, the price of sacks varies from 1s. 3d. to 2s. 6d. each. Every sackful of corn, before it is put into the cart, is tied at the mouth with a piece of cord, a soft cord answering the purpose best. The ties are either attached to the seam of the sack itself, or are carried in the ploughman's pocket. Every sack should be marked with the initials of its owner's name, or with the name of the farm. The letters may either be painted on with a brush, or formed by painting upon open letters cut through a plate of zinc. In either case, red lead is used. The initials are put on, and appear as those on sack *f*, fig. 172. When sacks become wetted with rain, they should be shaken and hung up in the air to dry; and if they get besmeared with mud, they should be washed and dried. If the air cannot dry them in time to prevent mouldiness, they should be dried before a fire. Where steam is used for thrashing, sacks may be dried in the boiler-house. An airy place to keep sacks is across the granary, over ropes, suspended between the legs of the couples. Holes will break through sacks, by wear, by tear, or by mice, which will almost invariably find their way into sacks of corn that have stood a considerable time on the barn floor. The best thread for darning even canvass sacks, is strong worsted; and if well darned, the mended parts become the strongest parts of the sack. When a considerable accident occurs to a sack, probably the best way of using the torn sack is, to keep it for cutting up to mend others. The person who has the charge of thrashing and cleaning the corn, has the charge of the sacks, and must be accountable for their number.

1818. Sacks, when filled, are most conveniently wheeled to any part of the barn, in a barrow made for the purpose. A good form of a sack-barrow may be seen in fig. 173. To be convenient, it should stand upright of itself, as seen in the figure. There are two modes of using it; one when the sacks stand *upright* when filled, and the other when the sacks stand as in fig. 172.

Fig. 173.



THE SACK-BARROW.

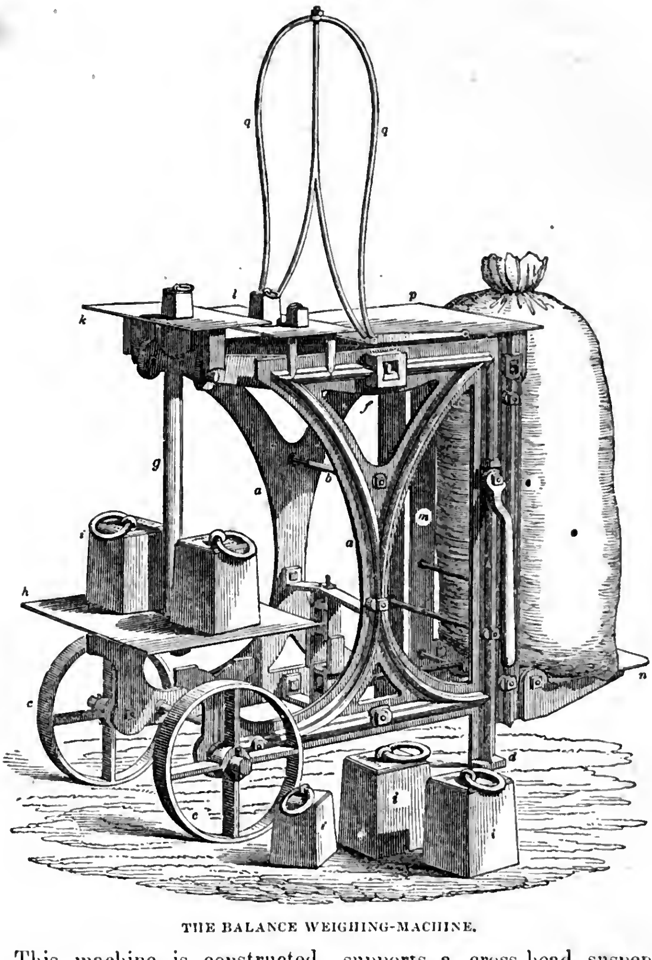
On standing behind the wheels, in the first case, and on taking a hold of the handle *a* with the right hand, and the mouth of the sack with the left, and, pushing it off, insert the iron scoop *b* of the barrow between the sack and the floor; and on pulling the sack towards you, push the wheels forward by the right foot on the axle, and the sack is placed on the scoop, ready for removal. In the other case, push the scoop of the barrow below the sack *f*, which is lying a little from you; and on pulling the sack towards you, it becomes ready for removal. The iron shields *c* over the wheels save their rubbing against the sacks. The height of the barrow should be 3½ feet, its breadth, over the wheels, 1½ foot, and the frame made of ash, and painted. The load is most easily wheeled with the barrow held in a nearly upright position.

1819. A frame of iron, to hold the sack in filling, has lately been introduced into England; but as I consider it better adapted for the potato-field than the corn-barn, I shall defer describing it at present. The objection to using it in a corn-barn is, that the spikes of the legs injure a floor.

1820. *The Weighing-machine* is an important article of the barn furniture, and various forms of it are resorted to. The common beam and scales is the most correct of all the instruments of the class; but it is defective, as being less convenient for the purposes of the barn than several others that are partially employed. Steelyards of various forms are also used; but in all steelyards there are grounds for doubting their accuracy, in consequence of the operator not seeing the true counterpoise of the substance weighed, but only its representative, bearing an actual weight greatly smaller than the substance, but in the inverse proportion to it that the longer arm of the steelyard on which it is appended bears to the shorter arm. Many of these steelyards, from their compactness, are, however, greatly to be commended; and, when well constructed, and properly adjusted, will be found to answer the purpose of weighing such bulky articles as grain with sufficient accuracy. Their cheapness also, when compared with some other instruments on the beam and scale principle, holds out a great inducement for their adoption.

1821. *A weighing-machine*, on the balance principle, which combines every convenience for the setting on and removal of the bags of grain, with accuracy and neatness of construction, is exhibited in

Fig. 174.



THE BALANCE WEIGHING-MACHINE.

fig. 174. This machine is constructed chiefly of cast-iron, the framework *a* is connected by cross-stretcher bolts *b*, and is supported in front on the wheels *c c*, while the back parts are supported on the feet *d*. The folding handles *e*, one on each side, turn on a joint pin at *e*, and become levers by which the machine can be moved about like a wheelbarrow. The beam, parts of which are seen at *f f*, is double, and also formed of cast-iron, with steel centres, the two bars forming the beam-stand, and are connected by a diagonal truss. The one end of the double beam supports a cross-head suspended on the end centres of the beam, and to which is attached the pillar *g*, to the lower end of which is attached the shelf-plate or scale *h*, upon which the principal weights *i i* are placed. The cross-head carries also the top shelf or scale *k*, upon which the smaller weights are placed, and a dead plate *l* is fixed on the framework on which the small weights stand ready for use. The opposite ends of the beam carry a frame *m*, only partially seen, to the lower end of which the shelf *n* is jointed, and upon this shelf the bag *o*, about to be weighed, is

shown in the figure. To the upper end of the frame *m* there is also attached, by a strong bracket not seen in the figure, the shelf or scale *p*, and upon this scale the bag may be placed and weighed with equal accuracy, while it is supported by the light frame *q q*. The object of the top and bottom weighing shelves is to suit the placement, or the removal of the bag, either from or to a man's back by the top shelf, or from or to the corn-barrow by the lower shelf. When the machine is not in use, the lower shelf *n* is folded up against the back of the frame, and the light frame or back *q q* folds down over the folded-up lower shelf *n*, reducing the machine to a very compact state. In weighing with this machine, from its being on the principle of the balance, the amount of weights required is equal to the absolute weight of the body that is being weighed, and the true weight is determined when the scales or shelves *k* and *p* coincide in one level line with the dead-plate *l*. In constructing this machine, the bottom of the pillar *g*, and of the frame *m*, are provided with a horizontal connecting-rod, which preserves their parallelism, and, consequently, the correct indications of the beam. Weighing-machines are constructed, on the same principle, with wooden frame-work, which renders them lighter and cheaper; but from the changeable nature of the material, as affected by moisture and dryness, they are liable to derangement. The price of the machine, as exhibited in the figure, is £8, 10s.; and when constructed in wood the price is £5 or £6.

1822. *Riddling.*—The riddling of corn is a complicated and difficult operation. I have never found a person who could describe it in words; and as it is the only species of farm labour I never could perform to my own satisfaction, I feel that I cannot describe it so as to be of service to those who would desire to learn it. I may say, generally, that riddling consists of holding the bottom of the riddle a little inclined from you, and of giving the corn in it a circular motion, always from right to left, accompanied with an upward jerk of the left hand, which seems to loosen and shake the mass of corn, and has the effect of bringing up all the lighter impurities in it to the surface, while the rotatory motion seems to draw these to the centre of the riddle into a heap, and the same jerk causes, at the same time, the heavy corn to descend equally through the meshes of the riddle. Very few people, who profess to riddle, can do it well. I have never seen a man do it well, though I have several women. A good criterion of the ability to riddle is this:—Place a man's hat with a flat crown in the centre of the riddle, and if you can make the hat start up on any point of the edge of its crown, and by the motion of the riddle cause it to revolve on that point, in the centre of the riddle, as long as you please, and with what velocity you may, you will certainly be able to riddle corn well. The usual way of riddling is to swing the riddle from side to side in an elliptical course, and make the corn fall through the meshes quickly, all which may easily be done by any novice; but such a motion sends much of the impurities along with the corn, instead of collecting them in the centre. Corn passes more quickly through a wire than a wooden riddle, and it requires a skilful hand, with a quick circular motion, to prevent it passing too quickly. The withes of the wooden riddle retarding the passage of the corn through the meshes, an indifferent riddler will make better work with a wooden than a wire riddle. Before all the corn has been passed through the riddle, the impurities, collected in the centre, are brought in a heap to the left-hand side of the riddle, the riddle being inclined to that side for the purpose, while the rotatory motion is continued to the last. The impurities are then thrown into any vessel placed for their reception, such as a wecht, and the bushel is so used when the corn is not measuring up.

1823. *Sifting.*—Sifting is performed with the sieve, and its object is to separate small heavy objects from corn, while, at the same time, whatever impurities lighter than corn are also brought to the surface. It is performed precisely in the same manner as riddling, when it is well done, but the circular motion is made to revolve much quicker. Corn is only subjected to sifting, after it has been winnowed and riddled as clean as these operations can make it; and yet, with a thorough sifting, it is surprising what impurities may be discovered amongst it, both in the scum of light matter brought to the surface, as well as the heavy stuff, which descends through the small meshes, leaving the good grains behind on the sieve. All seed-corn should be sifted; and I believe there is no way of doing it so effectually as with the hand. Sifting-machines have been contrived for the purpose, with more or less success, and are now generally adopted in meal-mills, and, no doubt, save much manual labour, though I am doubtful of their sifting so well as the hand; for I consider meal-sifting by the hand as the perfection of riddling, and in doing it, the meal is not only moved in precisely the same manner as corn when well riddled, but the sieve itself is made to revolve gently and regularly, with a slight jerk, from the right hand to the left, making the whole process such a complication of motion as would be difficult to imitate with machinery. Reeing-machines have been invented for cleansing corn, but with what success, compared to riddling by the hand, I cannot say. They are successful, however, in cleansing rye-grass seed.

1824. *Carts.*—The common cart being so intimately connected with the produce of barn-work, this seems a very befitting time to say a few words on its construction and use. Agricultural carriages are either four-wheeled waggons or two-wheeled carts; and as the Scotch practice, which I profess chiefly to follow, admits, with very few exceptions, the two-wheeled cart only, the following observations are chiefly confined to that implement.

1825. Though the cart, in general, is a vehicle very much diversified in structure to suit the numerous purposes to which, in a commercial country, it is applied, yet for the purposes of the farm its varieties lie within narrow limits, and may be classed under two principal kinds, the *tilt* or *coup* close-bodied cart, and the close-bodied dormant cart; but these, again, vary as to size, forming *single* and *double horse* carts, which are merely varieties of the first. A third and less important kind, is the corn or hay cart, used chiefly in the seasons of corn and hay harvest; and there are others not required on every farm, but are important to some, such as the cage cart, for carrying lambs and other live-stock to market, and the water and liquid-manure cart.

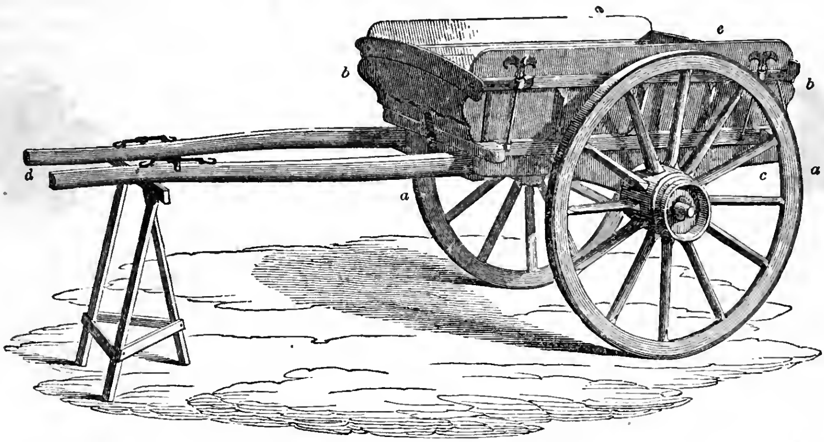
1826. *The tilt cart* is the most important vehicle of transport on the farm, and is employed for nine-tenths of all the purposes of carriage required in the multifarious operations throughout the year. It is employed to convey manure of all kinds; to convey stone and other materials for draining and other operations; leading home turnips and potatoes; and for carrying produce of all kinds to market. For some of these operations the tilt cart is pre-eminently adapted, such as carrying and distributing of manures, or other matters that can be safely discharged by tilting. The dormant cart, on the other hand, is sufficiently commodious when substances have to be carried that require to be discharged from the cart by lifting, such as grain in bags, and many other articles requiring to be conveyed to and from the farm.

1827. Fig. 175 is a view in perspective of the common one-horse tilt or coup cart, of a simple and much approved construction, and consists of the following parts. The wheels *a a*, which are of the usual height, 4 feet 6 inches, are of the dished construction, with cylindrical tread or sole, and are inclined from the vertical to bring them to the standard gauge below. The axle, which is of the bent order, with 2½ inch arms, is only seen as it protrudes through the nave. The body of the cart, *b b*, with its bolsters, one of which is seen at *c*, by which it rests upon the axle, and to which the shafts are jointed by means of a joint-rod that passes through the bolsters and the ends of the shafts. The shafts *d* are secured to the body by means of the lock seen in the figure in front; and they are here represented resting upon a tresste to keep the cart upon a level; and, lastly, the top-sides *e e*, which are fitted to ship and unship as occasion may require.

1828. The double-horse agricultural cart differs only from the one-horse tilt, fig. 175, and its details, in being of larger dimensions, but especially in depth; the length is also increased a few inches, while the width remains nearly the same, and the limbers are stronger; but all the dimensions are variable, according to the tastes and objects of the owners. This cart is represented at work in Plate III.

1829. In all carts of the descriptions here noticed, the cladding or boarding of the floor and sides is an important point: very fine and straight grained deal should be avoided, because of its liability to split. Of the woods best adapted for the purpose, I may name the common saugh or willow, the larch, the common Scots fir, and others of the pine tribe; and the more they abound in sound knots, so much the better are they adapted to the purpose, not only preventing the splitting of the boards, but adding to the durability of the material.

Fig. 175.



THE SINGLE-HORSE TILT CART.

1830. The nails used for fixing the boarding should always be the common *cart nail*, which is distinguished from other common nails by its diminished length, increased thickness, and being chisel-pointed, qualities that adapt it for being driven into hard wood, while its thickness gives it the requisite strength to resist the rough usage that such machines are always liable to.

1831. It is always of importance to husband well the energies of the horse; and in no case is it more necessary than in the cart horse. To facilitate the arrangement of the load in the two-wheeled cart here described, the practice has been to place the cart upon the axle, in a position that places four-sevenths of the body before the axle, and three-sevenths of it behind. Whether this has been deduced from calculation or experiment, cannot now be determined; but one thing is certain, that the above proportion seems to suit all purposes, and what is more, it yields, by calculation and experiment, a result which loads the horse in the shafts with a fair degree of pressure, and such as he is quite capable of supporting through a moderate journey. The amount of this load on the back of the horse has frequently been very much overrated; and few practical people have a clear conception of its amount. When the cart is properly loaded, there will be a preponderance of one-seventh of the load before the axle on which the cart body rests.

1832. The method of yoking the horses into the cart may be seen in Plate III., where the horse in the shafts is yoked as it would be in a single-horse cart, and where both the horses are yoked, as in the double-horse cart, with all the necessary harness. In addition to the collar and bridle required for yoking the horse to the plough, as already described in (676,) and (680,) the horses require the following harness in the cart:—

The Shaft-horse.

Saddle and girth,	22 lbs. weight, worth	£1	2	0
Breeching,	10 „	„	1	0	0
	32		2	2	0
Collar,	15 „	„	1	0	0
Haims,	7 „	„	0	5	6
Bridle,	4½	„	0	10	0
	58½ lbs.		£3	17	6

The Trace-horse.

Two back-bands and girth, 8 lbs. weight, worth			£0 16 0
Cart chains,	14	@ 7d. per lb.	0 8 2
Stretcher,	1½	— —	0 3 0
	23½		1 7 2
Collar,	15	— —	1 0 0
Haims,	7	— —	0 5 6
Bridle,	4½	— —	0 10 0
	50 lbs.		£3 2 8

1833. In Forfarshire the trace-horse is harnessed differently from that shown in the plate. A broad strap is hooked to the upper part of the back of the collar, and terminates at the other end in a crupper, through which the tail is made to pass, and a haunch strap goes down each side from the top of the quarter to support the trace-chains and stretcher. This plan supports the stretcher well, and completely prevents it striking the hocks of the horse when turning and halting, but it confines the action of the horse very much, and, when the bearing-rein of the bridle is passed over the top of the haims, the horse's head is pulled up to an inconvenient degree. The yoking seen in the plate is better therefore than this mode.

1834. A set of cart and plough harness was exhibited by Mr David Scott, saddler, Glasgow, at the Highland and Agricultural Society's Show at Edinburgh, in 1848, the component parts of which were fastened together by means of spring-hooks, instead of the common buckle, which seems to me to deserve the attention of farmers. The parts are easily put together and separated. Connected with the same contrivance of spring-hooks was a collar, which being kept together with a spring-hook, may be easily disengaged and expanded, and removed from the neck of the horse in case of the horse falling, and any other part of the harness can be as easily disengaged in case of accident. The price of this form of harness complete is £6, 8s.

1835. I may also mention that, at the same Show, Messrs Waldie and Hunter, saddlers, Kelso, exhibited a cart-saddle, the boards and panels of which, being movable, adjust themselves to any form of the horse's back, like a pad. The price of this saddle is £1, 1s.

1836. Harness leather is best for farm purposes in the long run, though highest priced at first.

1837. Hemp and Manilla reins are the best, and cost 5½ per lb. They should always be used double with the cart, whether the horse be yoked double or single. The double reins are wound up with a tie and loop, to hang on any hook or slip below any part of the harness, as shown below the haunch-strap of the breeching in Plate III. The *shaft-horse* requires bridle, collar, haims, saddle, and breeching, to be fully equipped. The bridle, collar, and haims, constitute the harness common to both plough and cart. The breeching is buckled to the back part of the wooden tree of the saddle, at such length of strap as suits the length of the horse's quarter. The saddle—as saddle and breeching together are commonly called—is placed on the horse's back immediately behind the shoulder, and strapped firmly on, in case of slipping off in the yoke, with the belly-band, which can scarcely be seen in the plate; the breeching being put over the horse's hind-quarter. Time was when a crupper was a general appendage to the breeching—the effect of which was to place an undue pressure upon the root of the horse's tail, when the saddle was pressed forward by the back-chain, on the cart descending a declination. Now that the comfort of animals is better attended to, by the removal of annoyances to the work-horse, the crupper has been generally removed. The back-chain is fastened to the back-chain hooks of the shafts of the cart, and gets leave to remain there constantly. In yoking, the shafts are held up with their points elevated; the horse is *told* to turn and back under them, which he does very obediently, and even willingly; they are then brought down on each side of the horse; the back-chain is then adjusted along the groove of the saddle, to such length as that the draught-chains, when extended, shall be in a straight line to the axle; the shoulder-slings, or draught-chains, are linked to the draught-hook of the cart, at such length as to be an extension of the above line; the breeching-chains are linked to the breeching-hooks, of such length as to allow the breeching to hang easily upon the hams of the horse—

not to chafe the hair—in his motion forward upon level ground, but as tight as before the back-chain hooks slip as far back as they can upon the runner-staples of the shafts, the hams of the horse shall press against the band of the breeching sufficiently to keep the cart back, before the horse's rump shall touch the front of the body of the cart. The cart belly-band is then buckled round the near shaft under the runner-staple, just as tight as not to press against the horse's chest on level ground, and only when he goes up-hill. All these adjustments of parts are made in a short time, even with a new horse, cart, or harness, and they require no alteration afterwards.

1838. The harness of the *trace-horse* is simple beyond the collar, haims, and bridle, consisting only of 2 back-bands, belly-band, and trace-chains. The back-band is placed where the saddle should be, and is fastened to the trace-chains on either side with a triangular buckle having a long hooked tongue. The trace-chains are linked to the draught-hook *h*, fig. 11, of the haims at one end, and fastened by a hook at the other end to a staple in the under side of the shafts; the point of which hook is always placed in the inside, to put it out of the way of taking hold of any thing passing near the shafts of the cart. The trace-chains are usually divided in two pieces, one called the *short-ends*, which pass from the shafts to the stretcher, and the other part stretch from the stretcher to the haims. The short ends are usually left attached to the cart. A hook on each side of the stretcher attaches the short-ends to the other part of the trace-chains. The use of the stretcher is solely to expand the trace-chains beyond the hind-quarters of the trace-horse. The trace-chains being distended from the haims to the shafts, the back-band is hooked on to them, so as always to lie firmly on the horse's back; and the belly-band is also hooked in like manner to the same part of the chains, to keep both ends of the back-band firm. The rump-band is hooked on to the trace-chains, so as to lie easy on the rump when these are distended; and the position of this band may vary farther or nearer on the loins or rump, as it may best lie, its use being solely to keep the chain and stretcher from falling on the horse's hocks when he turns. The reins are then fastened on each side of both horses to the ring of the bridle, having been previously passed through rings on the haims and the back-band. The horses are now ready to start, in as far as the harness is concerned.

1839. To unyoke the horses is just to undo what has been done in yoking; the reins are first taken off and coiled up; the stretcher is unhooked from the chains, and it and the short-ends brought over the head of the shaft-horse and laid upon the shafts of the cart behind him, and the trace-horse is then free; the cart belly-band is then unbuckled; the draught-slings and breeching-chains are unhooked; and on the shafts being raised up, the shaft-horse is free; and on the bearing-reins being slipped over the top of the haims, both the horses' heads are free to take a drink of water, or shake themselves.

1840. The cart should always be under cover in a cart-shed when not in use, as, when not so accommodated, and being a machine composed of many parts, the weather soon has an injurious effect upon its upper works. When backed into the port of a cart-shed, the shafts are easily put up out of the way of the horse again being yoked, by hanging the back-chain upon a hook suspended by a chain from the balks of the roof, when the shed is not floored above, and, when it is floored, the hook to support the back-chain may be suspended from a joist of the flooring.

1841. The *grease* used for farm-carts is commonly a mixture, melted together in equal parts, of tallow or train-oil and common tar. It is kept in a deep narrow tub, and applied with a broad pointed stick. The tub should have a cover, but is usually without one, and subject to collect dust in the cart-shed. When a cart is to be greased, the linch-pin and washer are removed from the projecting point of the axle; the upper part of the wheel is then pulled towards you from the cart with such a jerk as to allow the lower edge of the wheel to remain on the same spot of ground it was, and the point of the axle-arm will then lean upon the edge of the bush at the back of the nave. The grease is then spread upon the upper side of the axle-arm with the stick, the wheel pushed back to its proper place, and the washer and linch-pin respectively restored to their proper places in the projecting point of the axle. The groove of the saddle is also greased, to lessen the friction of the back-chain when playing upon it. The grease used for railway carriages has sulphur in it, which is said to make it more durable, and might, no doubt, be used in farm carts, provided the cost were not exorbitant. It is, I believe, a patented article.

1842. Systematic writers on agriculture, when treating of the various plants cultivated on a farm, describe their characters in botanical phraseology; and though this seems a proper mode, when different genera of plants have to be distinguished from each other; yet when mere varieties of the same species, and especially when those varieties are numerous, require to be described, a more natural method of classifying them seems likewise desirable, that other people than botanists may easily distinguish them. Professor Low, when treating of wheat, enumerates 11 different subdivisions* which are cultivated, and which, doubtless, possess distinct botanical characteristics; but such distinctions are not likely to be appreciated by the majority of farmers. Mr Lawson has described 83 varieties of wheat;† Colonel le Couteur mentions having in his possession, in 1836, no fewer than 150 varieties‡; and the Museum of the Highland and Agricultural Society in Edinburgh possesses 141 varieties.§ To distinguish all these varieties by botanical terms would puzzle any farmer.

1843. For this reason, it has occurred to me, that a method should be established for easily recognising the different kinds of grain in use by the external characters of the ear and grain. Colonel le Couteur has given a classification of *wheat* involving this principle, and adduces a similar reason for attempting it, when he says,—"No one has done so, as a branch of agriculture, in those plain terms which may be intelligible, not to the botanist or scientific reader only, but to the great mass of farmers." And the principal object he considers should be held in view, in establishing such a classification, is the nature and qualities of each variety for making bread?

1844. In prosecuting this idea of a classification, Colonel le Couteur divides all the varieties of wheat into two classes, namely, *beardless* and *bearded*. In so far he imitates the modern botanist, who divides the cultivated varieties of wheat into the two divisions of *barbatum* and *imberbe*, signifying the above conditions. But, unfortunately for the stability of this classification, that distinction is not immutable, for some bearded wheat lose their beards on cultivation, and some beardless ones are apt to become bearded, when cultivated on poor soils and exposed situations. Some of the other grains indicate a tendency to similar sporting, for the potato-oat assumes a beard when sown a long time on the same ground in a poor state. He subdivides beardless wheat into white, red, yellow, and liver-coloured, smooth chaffed, and velvet chaffed; and the bearded he divides under the same colours. Some varieties of wheat are, no doubt, decidedly downy on the chaff, but others, again, are so very little so, that it is difficult to distinguish them from some of the roughest varieties of smooth chaffed; and it is known that the same wheat will be differently affected, in this respect, by the soil upon which it grows; for a sharp soil renders the chaff and straw smoother and harder than a deaf one, which has a tendency to produce soft and downy chaff and straw. Downiness is thus not a more permanent character than the beard for establishing the denominations of the great divisions of wheat. Conjoining the characters of the grain and ear of wheat, is, in my opinion, injudicious, inasmuch as the character of neither separately can positively indicate the state of the other, and both are not required to indicate the superior properties of any variety of wheat for making bread. A baker at once distinguishes the grain which will afford the best bread; and neither he, nor any farmer, could indicate such a property from the ear of any wheat. Colonel le Couteur assumes a liver-coloured wheat, as a distinctive colour, as well as others. I confess I cannot distinguish this colour; and I never remember to have seen a wheat of a liver-brown colour. I think all the colours of wheat may be classed under two of the primary colours, *yellow* and *red*—for even the whitest has a tinge of yellow—and the brownest is deeply tinged with red; and as *white* and *red* are the terms by which the colours of the wheat have been longest known, these should be retained; and the subtints of yellow and red found in wheat may be easily designated. The variety of wheat which should form the standard of each colour has never yet been indicated; but, judging from the collection of wheat in the Highland and Agricultural Society's Museum, I should say that the Hungarian white wheat indicates the purest white, and the blood-red wheat the purest red.

1845. Were I to attempt to classify both the wheat plant and grains of wheat, by *natural marks*, I would make two classifications, one by the ear and the other by the grain, so that each might be described by its own characteristics, and, if desirable, when describing the plant, reference could be made to the characteristics of the grain. In this way confusion would be avoided in describing the ear and the grain. The farmer who grows the wheat plant, and sells it in the grain, should be acquainted with both; but the baker, who is only acquainted with the grain, need know nothing of the ear. Were he, however, to receive an ear of each variety of grain he purchased, he would be best able to describe at once,

* Low's *Elements of Practical Agriculture*, p. 229.
† Lawson's *Agriculturist's Manual*, p.29.
‡ Le Couteur *On Wheat*, p. ii., Dedication; and p. 77.
§ *Catalogue of the Museum*, p. 63-6.

to the farmer, what particular variety afforded him the flour best suited to his purpose.

1846. *Wheat.*—On examining the *ears* of wheat that have come under my notice, I think they may be divided into three classes, as represented in fig. 176, which show the ears half the

Fig. 176.

CLASSIFICATION OF WHEAT BY THE EAR.

natural size, and which may be distinguished thus : *a* is a *close* or *compact* eared wheat, which is occasioned by the spikelets being set near each other on the rachis, and this position makes *the chaff short and broad.* This specimen of the close-eared wheat is Hickling's Prolific. The second class of ears is seen at *b*, the spikelets being of *medium* length and breadth, and placed just so close upon the rachis as to screen it from view. The ear is not so broad, but longer than *a*. The *chaff* is of *medium length and breadth.* This specimen is the well-known Hunter's white wheat. The third class is seen at *c*, the spikelets of which are set *open*, or so far asunder as to permit the rachis to be easily seen between them. The ear is about the same length as the last specimen, but is much narrower. *The chaff is long and narrow.* This is a specimen of Le Couteur's Bellevue Talavera white wheat.

1847. These three classes of varieties constitute the *Triticum sativum imberbe* of botanists,—that is, all the varieties of the beardless cultivated wheat. Formerly they were divided by botanists into *Triticum hybernum* or winter wheat, and *Triticum æstivum* or summer wheat ; but experience has proved that the summer wheat, so called, may be sown in winter, and the winter wheat sown in spring, and both come to perfection. Paxton says that Triticum is derived from "*tritum*, rubbed—in allusion to its being originally rubbed down to make it eatable."* It is of the natural order *Gramineæ* of Jussien, and of the third class *Triandria*, second order *Digynia*, and genus *Triticum*, of the Linnæan system. In the natural system of Lindley, wheat stands in class iv., *Endogens* ; alliance 1, *Glumales* ; order 29, *Graminaceæ* ; genus 11, *Hordeæ*.

1848. In *d*, fig. 176 is represented a bearded wheat, to show the difference of appearance which the beard gives to the ear. The bearded wheats are generally distinguished by the *long shape* of the *chaff* and the open position of the spikelets, and therefore fall under the third class *c*. But cultivation has not only the effect of decreasing the strength of the beard, but of setting the spikelets closer together, as in the specimen of the white Tuscany wheat, shown at *d* in the figure, which is considered the most compact eared and improved variety of bearded wheat. Bearded wheat constitutes the second division of cultivated wheat of the botanists, under the title of *Triticum sativum barbatum.* The term bearded is used synonymously with spring wheat, but erroneously, as beardless wheat is as fit for sowing in spring as bearded, and the bearded may be sown in winter.

1849. In regard to classifying wheat by the *grain*, on observing a great variety of forms, I think they, as well as the ears, may all be classed under three heads. The first class is shown in fig. 177, where all the grains are *short, round,* and *plump*, with the bosom distinctly marked, and well filled up. In the cut, the grain to the left is seen with the median line along its bosom ; another, below it, with the round or opposite side lying undermost ; and the third and fourth show the germ and radicle ends respectively. All fine *white* wheat belongs to this class, and is enclosed in *short, round,* and generally *white chaff*, which, when ripe, becomes so expanded as to endanger the falling out of the grain. Very few *red* wheat belongs to this class. In reference to the ear, this class is found in *short-chaffed* and broad spikelets, which are generally compact, as *a* fig. 176. The specimens here, of the grain, are of the Hungarian white wheat.

Fig. 177.

SHORT, ROUND, PLUMP FORM, AND SMALL SIZE OF WHEAT.

1850. The second class is represented by fig. 178, where the grains are *long and of medium size*, that is, longer and larger than the grains of fig. 177. The *chaff* is also *medium-sized.* In reference to the ear, it is of the *medium* standard,

* Paxton's *Botanical Dictionary*, Triticum. See also Hooker's *British Flora*, p. 20, edition of 1831.

in respect to breadth and closeness of spikelets, as *b*, fig. 176, though *medium-sized grain* is *not* confined to this sort of ear; and is found in the *compact* ear, as in Hickling's prolific white and red wheat, as well as in the *open* ear, such as the red Danzig creeping wheat. Most of *red* wheat belongs to this class of grain, though many of the *white medium-sized* — such as Hunter's white — also belongs to it. This specimen of grain is the Caucasian red wheat, whose ear is bearded, and belongs to the open-spiked class *c*, fig. 176. The left-hand grain shows the median line strongly marked, and the ends of all the grains are sharp.

Fig. 178.

RATHER LONG, MEDIUM-SIZED FORM OF WHEAT.

1851. Fig. 179 represents the third form of grain, which is *large and long* to a greater degree than the last class. Its *chaff* is *long*, and, in reference to the ear, the spikelets are generally open; though, in the case of this specimen, the Odessa long white wheat, the ear is medium-sized, and the chaff long as well as the grain. The median line of the uppermost grain is not so distinctly marked as in the two former cases. The ends of the grain are pointed but not sharp, and the skin seems rather coarse. The germ and radicle are boldly marked.

Fig. 179.

LARGE SIZE AND LONG FORM OF WHEAT.

1852. The three sorts of wheat in these figures, all placed in similar positions, are of the natural size, and indicate the forms of the principal varieties of wheat found in our markets.

1853. It will be seen from what has been stated, that no inevitable relation exists between the *ear* and the *grain*; that the compact ear does not always produce the round grain nor the white wheat; that in the medium ear is not always found the medium-sized grain; and that the open ear does not always produce the large long grain. Still, there exist coincidents which connect the *chaff* with the *grain*. For example, the *length* of the *chaff* indicates the *length* of the *grain*, upon whatever sort of ear it may be found; and, generally, the *colour* of the chaff determines *that* of the grain; and as the open spikelet bears long chaff, the long chaff covers grain of coarser quality than the chaff of the compact ear. On desiring, therefore, to determine the sort of *grain* any number of *ears* of different kinds of wheat contain, the *form* and *colour* of the *chaff* determine the point, and not whether the ear carries compact, medium, or open, bearded or beardless, woolly or smooth spikelets.

1854. But the classification of wheat is unimportant to the farmer, compared to the mode of *judging* it, to ascertain the external characters which best indicate the purposes to which it may be best employed, in the particular condition of the sample. The purposes are, for seed and the making of flour—whether the flour is to be employed in the manufacture of bread or of confections, or in some of the arts, as starch-making. In its *best* condition, all wheat, whether red or white, small or large, long or round, should appear plump within its skin, and not in the least shrivelled or shrunk. The skin should be fine and smooth, and not in the least scaly or uneven in surface. The colour, be it what tint it may, should be bright, lively, and uniform, and not in the least dull, bleached, or particoloured. The grains should all be of the same size and form, not short and long, round and long, small and large. The grains should be quite perfect; there should be no bruises, or holes, or dried rootlets hanging from one end, or woolly appendages protruding from the other. If perfect in all these respects, wheat is fitted for every purpose, and may be purchased by the general merchant. For particular purposes, particular properties must be sought for.

1855. When wheat is quite opaque, indicating not the least translucency, it is in the best state for yielding the finest flour—such flour as confectioners use for pastry; and in this state it will be eagerly purchased by them at a large price. Wheat in this state contains the largest proportion of fecula or starch, and is therefore best suited to the starch-maker, as well as the confectioner. On the other hand, when wheat is translucent, hard, and flinty, it is better suited to the common baker than the confectioner and starch manufacturer, as affording what is called *strong* flour, that rises boldly with yeast into a spongy dough. Bakers will, therefore, give more for good wheat in this state than in the opaque; but for bread of finest quality the flour should be fine as well as strong, and therefore a mixture of the two conditions of wheat is best suited for making the best quality of bread. Bakers, when they purchase their own wheat, are in the habit of mixing wheat which respectively possesses those qualities; and millers who are in the habit of supplying bakers with flour, mix different kinds of wheat, and grind them together for their use. Some sorts of wheat naturally possess *both* these properties, and on that account are great favourites with bakers, though not so with confectioners; and, I presume, to this mixed property is to be ascribed the great and lasting popularity which Hunter's white wheat has so long enjoyed. We hear also of "*high mixed*" Danzig wheat, which has been so mixed for the purpose, and is in high repute amongst bakers. Generally speaking, the purest coloured white wheat indicates most opacity, and, of course, yields the finest flour: and red wheat is most flinty, and therefore yields the strongest flour: a translucent red wheat will yield stronger flour than a translucent white wheat, and yet a red wheat never realises so high a price in the market as white—partly because it contains a larger proportion of refuse in the grinding, but chiefly because it yields less fine flour, that is, starch.

1856. The weight of wheat varies according to the state of the season from 59 lbs. to 68 lbs. per imperial bushel; the former being very light, and produced only in a wet late season, on inferior land, the latter being extraordinarily heavy, and produced only in a very clear hot season on the best soil. A good average weight for wheat is 63 lbs. per bushel, the finest samples from the best soils in the same circumstances being 65 lbs. Of Chidham white wheat, weighing 65 lbs per bushel, I found that 86 grains weighed one drachm. The bushel should contain 715,520 grains of wheat: at 63 lbs. to the bushel, and 87 grains to the drachm—the most common case—the bushel should contain 701,568 grains.

1857. For *seed*, the base from which the rootlets issue should be distinctly marked and rather prominent, and the end from which the blade springs should be covered with a slight hairiness. The protuberances of the rootlets and hairy end should on no account be rubbed off by sheeling, as that would render the grain unfit for seed, and deprive it of its vitality. Nor should the grain be kiln-dried, as that process also deprives it of vitality; but, indeed, wheat is never kiln-dried in this country.

1858. Kiln-drying makes wheat too hard for grinding, and imparts a smoky odour to it. Hardness, however, is not necessarily induced by kiln-drying, as some wheat becomes hard by ordinary drying; and in parts of the Continent, such as on the shores of the Mediterranean, some wheat is naturally so hard, that others are called soft merely to distinguish them. When no smokiness can be detected in the odour of foreign wheat, the surest test of its having retained its vitality is to germinate the grain near the fire, in a glass, amongst as much water as will swell it.

1859. *Damaged* wheat may be detected in various ways. If it has been in sea-water, although not enlarged by moisture, it never loses the saline taste; and even when washed in fresh water and dried in a kiln, the washing gives it a bleached appearance, and the kiln-drying may be detected by the smell or taste. Wheat which has been sheeled to make it look round and plump, may be detected by the ends being rubbed down. When heated in the stack, though not to the degree of affecting the colour, it tastes bitter. When long in the granary, it appears dull and dirty, though passed through the fanners; and, though not seriously injured, contracts a musty smell. Wheat is attacked by insects in the granary, which breed within its shell and eat the kernel, and the shells are then easily detected by their lightness, and the holes in them. Germinated, swollen, burst, bruised, smutted grains, as well as the presence of other kinds of grain and seeds, are easily detected by the eye.

1860. Difference of opinion exists in regard to the *best mode of preserving wheat in granaries.* The usual practice is to shovel the heap over from the bottom every few weeks, according to the dryness or dampness of the air, or heat or coldness of the atmosphere. In this mode of treatment, a free ventilation of air is requisite in the granary, and the worst state of the atmosphere for the grain is when it is *moist* and *warm.* Extreme heat or extreme cold are preservatives of grain. The practice of others is not to turn it over at all, but keep it in the dark in thick masses, reaching from the floor to the ceiling. No doubt, if air could be excluded from a granary, the grain would be preserved in it without trouble; and a good plan of excluding the air seems to be, to heap the grain as close together as possible. When kept long in heap without turning, it retains its colour with the fresh tint, which is secured by keeping it in the dark. The ancients used to preserve grain many years, to serve for food in years of famine. Joseph, in Egypt, preserved wheat for seven years in the stores; in Sicily, Spain, and the northern parts of Africa, pits were formed in the ground to preserve it; and the Romans took great pains in constructing granaries, which kept wheat for 50 and millet for 100 years.* As regards the farmer, the question of preserving wheat in granaries should little affect him, the best way of keeping wheat being in the straw in the stack; and when the stacks are thrashed, that the straw may be used, he should dispose of his wheat immediately, and take the current market-prices. During the currency of a lease, this is the safest practice for securing him an average price; and it saves much trouble in looking after the grain, much vexation when the grain becomes injured, and much disappointment when the price falls below its expected amount. Two friends of mine, large farmers, were both great losers by keeping wheat of their own growth. They each stored three years' crop, and though offered £6 a quarter for it, refused it, and were obliged at last to take 65s. Such is not unfrequently the fate of farmers who speculate in grain of their own growth; but when they become merchants, and involved in the intricacies of foreign trade, their ignorance of their new profession makes them feel the effects of their temerity in engaging in it.

1861. Wheat is prepared for the use of man by being ground into *flour*. The machinery used for grinding wheat is simple and effective. The first process is to put the wheat through the *sheeling cylinder*, which rubs off every extraneous matter adhering to the outer skin of the grain, and renders it plumper, brighter in colour, and free from every impurity. The quantity of black suffocating dust which flies off from the cylinder in this process, and the seeds and other substances separated from the grain and collected together, surprise every one, who has never previously witnessed the process, how such impurities can proceed from an *apparently clean sample.*

1862. After the sheeling, the wheat is put into a large hopper, which conveys it, by means of the shoe and clack, through the upper one of two millstones of French bhurr,† which grind it into

* Dickson's *Husbandry of the Ancients*, vol. ii. p. 426.
† See Ure's *Dictionary of the Arts*, art. *Millstone*, for an account of this remarkable substance.

a flour containing all the ingredients of the wheat. On leaving the stones, the flour has attained a high rise of temperature. In order to cool it, which should be done as quickly as possible, it is immediately carried, in small quantities on an endless web, to a well ventilated cooling-room, to be spread upon a wooden floor, and turned frequently over with a wooden shovel.

1863. After it is thoroughly cooled, it is made to descend from the cooling-room, by a hopper, into the *boulting or dressing cylinder*, in which it is separated into several parts, by being pushed by revolving brushes through wire-cloths of different size of mesh. These parts usually consist of *firsts*, or fine flour; of *seconds*, or second flour; of *thirds*, or sharps; of *broad* or coarse bran, and of *fine* bran.

1864. Sometimes the coarse bran only is taken out, when the flour is said to be *overhead*, and makes good coarse household bread. Sometimes both fine and coarse bran are taken out, and the flour makes a sweet coarse bread, but not so good as the overhead. When a small quantity of the firsts is taken out, to make the flour as fine as possible, it is used for pastry and fancy bread; and the seconds then become finer, and make the seconds loaf of superior quality. When a large proportion of the flour is made into firsts, it is not fine, and the seconds are thereby reduced in quantity and made coarser. The sharps, or thirds, which consist of the kernel of the grain, broken and escaped from between the millstones, are used by biscuit-bakers.

1865. The first or broad bran is used for bran-mashes, and mixing with horse-corn; and the fine bran is employed to feed poultry and pigs.

1866. In London the millers dress the flour into seven distinct sorts. From a quarter of wheat of 8 bushels, there are yielded of—

	Bushels.	Pecks.
Fine flour,	5	3
Seconds,	0	2
Fine middlings,	0	1
Coarse middlings,	0	0½
Bran,	3	0
Twenty-penny,	3	0
Pollard,	2	0
Total,	14	2½

1867. So that grinding increases the bulk of flour and bran in the proportion of 14½ to 8 of the bulk of wheat.

1868. Whether flour is properly *ground*, is judged of on being taken into the hand as it falls from the spout from the millstones. It is rubbed by the thumb along the side of the forefinger, and if it feel pleasantly smooth, without being greasy or rough, it is well. When the outer edge of the millstones are set too close, the flour feels greasy, and has been too much bruised—or *killed*, as it is termed—and it does not easily rise with yeast in the making of bread. When the stones are set too far asunder, the grain accumulates too much under the eye of the millstone, and is there *broken*, which prevents a part of the skin of the grain being separated from the kernel, so that the bran is thick, rough, and heavy, containing much waste of substance.

1869. When the large bran is inspected, and is found to be entirely skin, and no white substance of the wheat adhering to it, the shelling has been well executed; and bran in this state, on being thrown up, will fall lightly towards the ground in large thin flakes. The small bran has always a part of the substance of the wheat attached to it, being derived from the groove which forms the bosom or median line of the grain, and is produced after the large bran has been sloughed off, and a considerable portion of the grain ground down to the level of the groove.

1870. Whether flour is properly *dressed* is ascertained in the same way, by rubbing the fine flour with the thumb along the forefinger; and if it feel smooth and even, not in the least rough or gritty, or greasy, it is well. To judge still further whether the flour has been perfectly dressed, press a polished surface, such as the back of a silver spoon, upon it, and if the smooth pressed surface expose no minute brown spots of bran, it is clean dressed; and if none can be detected by a good magnifying-glass, it is as perfectly dressed as machinery can do it.

1871. There is no means of judging whether any parcel of flour will make good bread, the *flour* of the opaque and flinty wheat being undistinguishable from each other; and it is perhaps this difficulty which induces bakers to buy wheat, and have it mixed and made into flour on their own account—otherwise the simplest plan for them would be to buy the sort of flour they want. On account of this practice of the bakers being very general, most of the flour millers in Scotland grind only on hire.

1872. Flour is put up into *sacks* of 280 lbs., or 20 stones imperial. It is pressed by the bottom of the sack being beaten against the floor by means of a fork-lever, to which the sack is suspended, on being filled at the spout from the dressing-machine. Of wheat weighing 64 lbs. per bushel, 4½ or 5 bushels will be required to make a sack of fine flour. Of the fine crop of 1815, I remember of the late Mr Brown, Whitsome Hill, Berwickshire, selling to Mr Mackay of Clarabud Mill, in that county, 800 bolls, or 4800 bushels of red Danzig creeping wheat, weighing 27 stones per boll, or 63 lbs. per bushel, which yielded 24 stones of fine flour, and only 3 stones of refuse, which is only one-ninth of the entire weight.*

* As an instance of the great fluctuation in the price of wheat, occasioned by a difference in seasons, I may mention that part of this fine wheat was sold in 1815 for 32s. per boll of 6 bushels, or 5s. 4d. per bushel; and in August 1816, a very wet season, part was sold for 105s. per boll, or 17s. 6d. per bushel, being a rise in price of about 328 per cent in the course of a few months.

I find the fine white wheat used by the bakers of Edinburgh yield 13½ st. of 14 lbs. of flour from 4 bushels, weighing 18 st., 2 st. of odds, seconds, parings, sharps, and waste, and 2½ st. of bran.

1873. Many devices are practised to *adulterate flour*. I remember a miller in Cornwall being fined in very heavy penalties for adulterating his flour with washed felspar, obtained from the disintegration of the granite of his neighbourhood. Potato-flour and bean-flour are mixed with wheat-flour, and though not positively unwholesome, or perhaps unlawful, are frauds, inasmuch as they are articles of inferior value to the flour of wheat. Every kind of adulteration can be detected. "If potato-flour be added," says Dr Ure, "which is frequently done in France, since a vessel which contains 1 lb. of wheat-flour will contain 1½ lb. of potato-flour, the proportion of this adulteration may be easily estimated. If gypsum or ground bones be mixed with flour, they will not only increase its density still more, but they will remain after burning away the meal."—"Bean or pea flour may be detected by pouring boiling water upon it, which develops the peculiar smell of those two substances."—"Nitric acid has the property of colouring wheat-flour of a fine orange yellow, whereas it does not affect the colour of potato-flour."—"Pure muriatic acid colours good wheat-flour of a deep violet, but dissolves potato-fecula."—"As fecula absorbs less water than flour, this affords a ready means of detection."—"Alum may be detected in bread by treating the bread in water, and pouring a few drops of nitrate or muriate of barytes in it, when a heavy white precipitate will follow, indicating the presence of sulphuric acid."* "Guaiacum," says Dr Thomson, "is rendered *blue*, by various animal and vegetable substances. It becomes blue, according to Tadei, when rubbed in the state of powder with gluten of wheat, or with the farina which it contains."† If a little of this gum and water be put amongst flour, it is a very good and easy test of its soundness when the flour becomes *blue*. "It has been found so difficult to detect the adulteration of flour," remarks Mr Babbage, "and to measure its good qualities, that, contrary to the maxim that government can generally purchase any article at a cheaper rate than that at which they can manufacture it, it has been considered more economical to build extensive flour-mills, and to grind their own corn, than to verify each sack purchased, and to employ persons in continually devising methods of detecting the new modes of adulteration which might be resorted to."‡

1874. Any one may analyse flour in this way:—"A ductile paste is to be made with 1 lb. of flour and a sufficient quantity of water, and left at rest for an hour; then having laid across a bowl a piece of silken sieve stuff, a little below the surface of the water in the bowl, the paste is to be laid on the sieve, on a level with the water, and kneaded tenderly with the hand, so as merely to wash the starchy particles out of it. . . . . The water must be several times renewed, until it ceases to become milky. The gluten remains on the sieve."§

1875. The analysis of wheat and flour by the celebrated Vauquelin gave the following results. It may be observed, however, of the wheat and flour subjected to this analysis, that they were of foreign growth, and the results cannot be adopted for practical purposes in this country, as if they had been obtained from British wheat and flour. "In general," says Davy, "the wheat of warm climates abounds more in gluten, and in insoluble parts; and it is of greater specific gravity, harder, and more difficult to grind."‖

Components.	French wheat.	Odessa hard wheat.	Odessa soft wheat.	Ditto.	Flour of Paris bakers.	Ditto of good quality and in public establishments.	Ditto, inferior kind.
Starch, .	71·49	56·5	62·00	72·00	72·8	71·2	67·78
Gluten,	10·96	14·55	12·00	7·30	10·2	10·3	9·02
Sugar, . .	4·72	8·48	7·56	5·42	4·2	4·8	4·80
Gum, . .	3·32	4·90	5·80	3·30	2·8	3·6	4·60
Bran, . .	...	2·30	1·20	...	...	...	2·00
Water, .	10·00	12·00	10·00	12·00	10·0	8·0	12·00
	100·49	98·73	98·56	100·02	100·0	97·9	100·20 ¶

It seems that Odessa wheat contains more than double the quantity of sugar that French wheat does. The gluten mentioned here is a mixture of gluten and albumen. The gum has a brown colour, and contains azote.

1876. It is the gluten which gives to a mixture of flour and water its tenaciousness, ductility, and elasticity, and forms an important nourishing property of loaf-bread. Gluten has a great resemblance to animal tendon or membrane, containing no less than 14½ per cent of azote. When subjected to fermentation, which is of a peculiar character, and has thereby obtained the appella-

* Ure's *Dictionary of the Arts*, art. *Flour of Wheat.*
† Thomson's *Organic Chemistry,—Vegetables*, p. 535.
‡ Babbage *On the Economy of Machinery and Manufactures*, p. 102.
§ Ure's *Dictionary of the Arts*, art. *Bread.*
‖ Davy's *Lectures on Agricultural Chemistry*, p. 136, edition of 1839.
¶ Thomson's *Organic Chemistry,—Vegetables*, p. 876.

tion of *panary* fermentation, a considerable volume of carbonic acid gas is evolved, but which is retained in the mass of the dough by the tenacity of the gluten. Thus confined during its evolution, the gas expands the dough to nearly double its pristine volume, and gives it its vesicular texture ; and it is the infinite number of these cellules, filled with carbonic acid gas, and apparently lined with a glutinous membrane of a silky softness, that gives to the well-baked loaf that light, elastic, porous constitution, which *good* bread always possesses.

1877. Wheat-flour also contains oil, which possesses the general properties of the fatty oils, or of butter. The proportion of oil in the outer part of the grain of wheat is greater than in the inner part. This appears from the proportion of fat yielded by the several parts of a sample of grain grown in the neighbourhood of Durham. Thus,—

	Per cent.
The fine flour gave of oil, .	1·5
The boxings, . . .	2·36
The pollard or sharps, .	3·56
The bran, . . .	3·25

The more husk in it, therefore, the more oil a flour is likely to contain. Hence the agreeable flavour of coarse bread.

1878. Wheat when burned in the grain leaves ash, of which the following is the composition, according to various authorities :—

	Will and Frezenius. Giessen. Red.	White.	Hichon. Holland.	Thon. Kurhesse.	Boussingault. Bechelbronn.	Erdmann. Leipsic.	Mean of the Six Analyses.
Potash, . . .	21·87	33·84	6·43	24·17	30·12	25·90	23·72
Soda, . . .	15·75	...	27·79	10·34	...	0·44	9·05
Lime, . . .	1·93	3·09	3·91	3·01	3·00	1·92	2·81
Magnesia, . . .	9·60	13·54	12·98	13·57	16·26	6·27	12·03
Oxide of iron, . .	1·36	0·31	0·50	0·52	...	1·33	0·67
Phosphoric acid, . .	49·32	49·21	46·14	45·53	48·30	60·39	49·81
Sulphuric acid, . .	0·17	...	0·27	...	1·01	...	0·24
Silica, . . .	...	...	0·42	1·91	1·31	3·37	1·17
	100·00	99·99	98·44	99·05	100·00	99·62	99·50

"Of the differences of this table," observes Professor Johnston, "part, no doubt, are due to the variety of wheat examined, part also to soil, climate, season, mode of culture, degree of ripeness, and other circumstances, the effect of which we have as yet no means of ascertaining. For all practical purposes, the mean of six analyses may at present be regarded as affording a valuable approximation to the true composition of the ash of the grain."

1879. The saline and other inorganic matter of wheat resides chiefly in the husk, as may be seen by the relative quantities of ash left by the flour, bran, &c. of several samples of English and foreign wheat, as determined in Professor Johnston's laboratory:

Where grown.	Ash left per cent by dry Fine Flour.	Boxings.	Sharps.	Bran.
Sunderland Bridge, near Durham, .	1·24	4·0	5·8	6·9
Kimblesworth, do. .	1·15	3·8	4·9	6 7
Houghall, . do. .	0·96	3·0	5·6	7·1
Plawsworth, . do. .	0·93	2·7	5·5	7·6*

1880. The composition of bran is as follows:—

Water, ...	13·1
Gluten, ...	19·3
Oil, ...	4·7
Husk, and a little starch, . .	55·6
Saline matter, (ash,) . .	7·3
	100·0

1881. *Leaven* was at first used to produce the fermentation spoken of in dough. It is nothing more than a piece of dough kept in a warm place until it undergoes a process of fermentation, swelling, becoming spongy, or full of air-bubbles, at length disengaging an acidulo-spiritous vapour, and contracting a sour taste. A much better promoter of the panary fermentation is *yeast*, which is the viscid froth that rises on the surface of beer in the first stage of its fermentation.

1882. With good wheaten flour, the proportion given by the bakers to make bread is, three-fourth's weight of flour and one-fourth of yeast, water, and salt. The bread loses one-seventh of its weight in baking. With these proportions, a sack of flour of 280 lbs. yields 92 loaves of 4 lbs. each.

1883. It is not unusual for farmers to bake their household bread, and it may be done in this way: Take, say 24 lbs. of flour, whether fine or ground overhead, and put it in a hollow clay dish. Make a deep hollow in the middle of it, and sprinkle a handful of salt over it. Then take half a pint of thick, sweet, fresh, well washed yeast, about 5 quarts of milk-warm water, from 65° to 70° Fahr., and a pint of bran, and stir them together in a pitcher. Too hot water will stop, and too cold will prevent fermentation. Pour the water and yeast over the flour through a sieve, and, mixing all lightly together, set the mass before the fire, covering it with a cloth.

* Johnston's *Lectures on Agricultural Chemistry*, pp. 365 and 868-9, 2d edition.

Light the oven fire, and bring it to a due heat. In about an hour the sponge will have risen sufficiently, when it should be kneaded with considerable force for about 15 or 20 minutes. The dough should not be worked too stiff, though it requires to be a little stiffer when the loaves are fired on their own soles than when fired in pans. The kneaded dough is again set before the fire, and covered with a cloth as before, when a new fermentation ensues, which will have proceeded far enough when the dough increases half more in bulk, that is, in about an hour, when the dough is portioned out into the size of the loaves desired, and placed in the oven to be fired. If the oven is too hot, the dough will be encrusted on the surface too much and too soon, and, if too cold, the bread will be heavy, and not rise sufficiently in the firing. Experience must teach these particulars. This quantity will make 27 lbs. of bread.

1884. The danger of making the bread *sour* is incurred between the first and second processes of fermentation. In the first it is the vinous fermentation, which of itself is innocent, but if increased heat is applied, or the sponge allowed to stand too long, it is apt to run into the acetous fermentation. This tendency is checked during the first process by kneading the dough in time. If, however, the second fermentation is allowed to continue longer than it should be, the acetous fermentation will rapidly appear, and then the bread will inevitably be sour unless some counteracting expedient is adopted, such as an application of an alkali, as carbonate of soda, or of an alkaline earth, as magnesia or chalk. It is certainly better to employ these neutralising ingredients than to allow the batch of bread to become sour, but better still to use the means of making the batch into sweet bread, than to rectify that acidity in it which ought never to have overtaken it; and the means of avoiding acidity are, to make the sponge fresh in the morning, a short time before the bread is to be fired, and not to allow it to stand over night in the kitchen in a low temperature. I speak from experience, and can safely aver that, with these precautions, not a sour loaf was seen in my house for many years. I do not say that a sponge left over night *must* become sour, but only that it is *much more apt* to become so than when fresh made. When the second fermentation is allowed to proceed too far, both the lactic and acetic acids are formed; the former most sensibly affects the taste, and the latter the smell; and both combine to make bread sour.

1885. Brewer's barm makes the lightest and best *yeast* for family use, and what of it may not be used at one time, may be kept sweet for some weeks in the following manner: "As this substance works out of the barrels, it should be placed in deep pans, and left to settle for a day or two. The thin fluid should then be poured off, and the pan filled with cold fresh spring water, stirring the thick yeast well up. Every day this operation is to be repeated, and occasionally it ought to be strained through a sieve into another vessel. It will thus always be ready for use." Experience alone can tell whether the scent or appearance of yeast procured at a brewery are those the most desirable; but these hints may prove useful. "If it be fit for the purpose, it will smell rather fragrant; if stale, it will have a strong acid and slightly putrid scent. In this state we have known it to be recovered and rendered available by adding a tea spoonful of flour, the same of sugar, a salt spoonful of salt, and a tea cupful of warm water, to a half pint of yeast, and setting it near the fire to rise, having well stirred it. This should be done about an hour before it is intended to be mixed with the flour; for that time is required in order to watch whether the fermentative principle is strong enough to work the bread. In a quarter of an hour the mass will have nearly reached its height, and a fine head will have formed. This must be looked at carefully. If it continue up and appear opaque, it may be trusted; but if it 'go back,' that is, sink, look hollow and watery, and the bubbles break, it will infallibly spoil the batch; it must be thrown away. *Bran ought always to be used*, however fresh and good the ferment may be found. Bran contains an acid principle which tends to subdue the bitter taste of the hop, and it also possesses much fermentative matter that assists the action of the yeast." In this way, "we have ourselves baked bread that was made with the barm from our own home-brewed beer for six successive weeks; not from necessity, but in order to ascertain the extent of time to which yeast might be kept sweet."*

1886. On the propriety of fermenting bread, Dr Robert D. Thomson conceives that there are materials, the use of which in baking bread would be more economical than fermentation. "Bread," he observes, "may be made either by the usual process of fermentation, or by the action of hydrochloric acid upon sesquicarbonate of soda. In many respects the latter process deserves the preference, when we consider the chemical nature of the two methods. The vulgar idea, which yields the palm of superiority to the former, does not appear to be based on solid data; and it seems desirable that, in a case of so much importance in domestic economy, the arguments in favour of such an opinion should be subjected to a careful experimental examination. Judging *a priori*, it does not seem evident that flour should become more wholesome by the destruction of one of its important elements, or that the vesicular condition engendered by the evolution of carbonic acid from that source, should at once convert dough (if it were unwholesome) into wholesome bread.

1887. "When a piece of dough," continues Dr Thomson, "is taken in the hand, being adhesive, and closely pressed together, it feels heavy, and if swallowed in the raw condition, it would prove indigestible to the majority of individuals. This would occur from its compact nature, and from the absence of that disintegration of its particles, which is the primary step in

* *Quarterly Journal of Agriculture*, vol. ix. p. 290.

digestion. But, if the same dough were subjected to the elevated heat of a baker's oven, 450°, its relation to the digestive powers of the stomach would be changed, because the water to which it owed its tenacity would be expelled, and the only obstacle to its complete division, and consequent subserviency to the solvent powers of the animal system, would be removed. This view of the case is fully borne out by a reference to the form in which the flour of the various species of the *cerealia* is employed as an article of food by different nations. By the peasantry of Scotland, barley-bread, oat-cakes, pease-bread, or a mixture of peas and barley-bread, and also potato-bread mixed with flour, are all very generally employed in an unfermented form, with an effect the reverse of injurious to health. With such an experience under our daily observation, it seems almost unnecessary to remark, that the Jew does not labour under indigestion when he has substituted, during his Passover, unleavened cakes for his usually fermented bread; that biscuits are even employed when fermented bread is not considered sufficiently digestible for the sick; and that the inhabitants of the northern parts of India, and of Affghanistan, very generally make use of unfermented cakes, similar to what are called *scones* in Scotland. Such, then, being sufficient evidence in favour of wholesomeness of unfermented bread, it becomes important to discover in what respect it differs from fermented bread. Bread-making being a chemical process, it is from chemistry alone that we can expect a solution of this question."

1888. After describing the usual mode of baking loaf-bread, Dr Thomson proceeds to argue that "the result gained by this process may be considered to be merely the expansion of the particles of which the loaf is composed, so as to render the mass more readily divisible by the preparatory organs of digestion. But as this object is gained at a sacrifice of the integrity of the flour, it becomes a matter of interest to ascertain the amount of loss sustained in the process. To determine this point, I had comparative experiments made upon a large scale with fermented and unfermented bread. The latter was raised by means of carbonic acid, generated by chemical means in the dough. . . . . . The result of my experiments upon the bread produced by the action of hydrochloric acid upon carbonate of soda, has been, that in a sack of flour there was a difference in favour of the unfermented bread, to the amount of 30 lbs. 13 oz.; or, in round numbers, a sack of flour would produce 107 loaves of unfermented bread, and only 100 loaves of fermented bread of the same weight. Hence, it appears that in a sack of flour, by the common process of baking, 7 loaves, or 6½ per cent of the flour, are driven into the air and lost.

1889. "An important question now arises from the consideration of the result of this experiment. Does the loss arise entirely from the decomposition of sugar, or is any other element of the flour attracted? It appears from a mean of 8 analyses of wheat-flour from different parts of Europe by Vauquelin (1872) that the quantity of sugar contained in flour amounts to 5·61 per cent. But it is obvious that, as the quantity lost by baking exceeded this amount by nearly one per cent, the loss cannot be accounted for by the removal merely of the ready formed sugar of the flour. We must ascribe this entire loss to a conversion of a portion of the gum of the flour into sugar, and its decomposition by means of the ferment, which is highly probable; or we must attribute it to the action of the yeast upon another element of the flour. And if we admit that yeast is generated during the panary fermentation, then the conclusion would be inevitable, that another element of the flour beside the sugar or gum has been affected; for Liebig has well illustrated the fact, that when yeast is added to wort, ferment is formed from the gluten contained in it; at the same time the sugar is decomposed into alcohol and carbonic acid. Now, in the panary fermentation, which is precisely similar to the fermentation of wort, we might naturally expect that the gluten of the flour would be attracted to reproduce yeast."

1890. Dr Thomson has given the following recipe for making good unfermented bread :—

"Take of—

Flour, . . .	4 lbs.
Supercarbonate of soda of the shops, . . .	5¼ drachms.
Muriatic acid, . . .	6¼ ...
Salt, . . .	5 ...
Water, . . .	35 oz.

The soda is first mixed with the flour very intimately. The salt is dissolved in the water, and added to the acid, the whole being then rapidly mixed as in common baking. The bread may either be baked in tins, or be formed like cottage loaves, and should be kept from one to two hours in the oven. Should the bread prove yellow, it is a proof that the soda has been in excess, and indicates the propriety of adding a small additional portion of acid, the acid varying somewhat in strength." *

1891. Professor Johnston mentions a curious fact as regards the action of yeast. "One of the most satisfactory experiments in proof of the organised or vegetable character of yeast has lately been made by Ludersdorf. He rubbed yeast carefully in a mortar till, when seen under the microscope, all the globules had disappeared, and then mixed it with a solution of sugar. It caused no trace of fermentation, while an equal weight of unrubbed yeast in another similar solution of sugar occasioned a copious evolution of gas. The fermentation brought on by yeast is not, therefore, a purely chemical process, it is the result of the organisation of the particles of yeast. A similar experiment had shewn De Saussure that the leaves of plants cease to decompose carbonic acid when their organisation is destroyed; and Freny has made the same observation in regard to the skins of fruits. While the result is purely chemical, therefore, the im-

* Thomson's *Researches on the Food of Animals*, p. 180-5.

mediate cause in all these cases is the surface of the organised body."*

1892. It is rather remarkable that Raspail, who used the microscope to so great advantage to chemical investigation and elucidation, had no idea of the organic structure of yeast. He observes "I regard *ferment* as a mixture of gluten still unchanged, and of the residue resulting from the change produced on it by the process of fermentation. Do the gluten and the sugar act on each other in this case, either chemically or physically, by a kind of double decomposition, or do they act in a manner resembling the galvanic influence of contact? This is a point which science has not yet (in the year 1834, when the translation of this work was published) been able to determine."†

1893. It is assumed by some people, that a mixture of potatoes amongst wheaten flour renders bread lighter and more wholesome. That it will make bread whiter, I have no doubt; but I have as little doubt that it will render it more insipid, and it is demonstrable that it makes it dearer than wheaten flour. Thus, take a bushel of "seconds" flour, weighing 56 lbs. at 5s. 6d. A batch of bread, to consist of 21 lbs., will absorb as much water, and require as much yeast and salt, as will yield 7 loaves, of 4 lbs. each, for 2s. 4d., or 4d. per loaf. "If, instead of 7 lbs. of the flour, the same weight of raw potatoes be substituted, with the hope of saving by the comparatively low price of the latter article, the quantity of bread that will be yielded will be *but a trifle more than would have been produced from* 14 lbs. *of flour only*, without the addition of the 7 lbs. of potatoes; for the starch of this root is the only nutritive part, and we have proved that but one-seventh or one-eighth of it is contained in every pound, the remainder being water and innutritive matter. Only 20 lbs. of bread, therefore, instead of 28 lbs., will be obtained; and this, though white, will be comparatively flavourless, and liable to become dry and sour in a few days; whereas, without the latter addition, bread made in private families will keep *well* for 3 weeks, though, after a fortnight, it begins to deteriorate, especially in the autumn." The calculation of comparative *cost* is thus shown:—

Flour, 14 lbs., say at 1¼d. per lb.,	=	1s. 5½d.
Potatoes, 7 lbs., say at 5s. per sack,	=	0 2
Yeast and fuel, ...	=	0 4½
		2s. 0d.

The yield, 20 lbs., or 5 loaves of 4 lbs. each, will be nearly 5d. each, which is dearer than the wheaten loaves at 4d. each, and the bread besides of inferior quality.

1894. "There are persons who assert—for we have heard them—that there is no economy in baking at home. An accurate and constant attention to the matter, with a close calculation of every week's results for several years—a calculation induced by the sheer love of investigation and experiment—enable us to assure our readers, that a gain is invariably made of from 1½d. to 2d. on the 4 lb. loaf. If *all* be intrusted to servants, we do not pretend to deny that the waste may neutralise the *profit*; but, with care and investigation, we pledge our veracity that the saving will prove to be considerable."‡ These are the observations of a lady well known to me.

1895. The microscope has ascertained the *structure of wheaten flour*. "The largest grains of the fecula of wheat," says Raspail, "do not generally exceed ·002 of an inch in size. They are spherical, and along with them we see empty and torn membranes, resulting from the bruising of the grains by the mill. They are much smaller, rounder, and better preserved, when they are extracted from the grain while it is greenish, and not ripened on the stalk. . . Panification," he observes, "is a process whose object is to burst all the grains of fecula, which are in the farina, associated with a very fermentable substance called gluten. The finest and best baked bread is what is made of farina abounding in an elastic gluten; for this gluten, rising in large blisters by the dilatation of the gases imprisoned within it, allows each feculent grain to participate in the communication of the heat, and to burst, as it would by boiling. Hence, after panification, if the paste has been well kneaded, we do not find a single grain of fecula entire. The bread will be duller and less properly baked, if it contains less of this gluten. This is the reason why, other circumstances being alike, the bread of rye and barley is less nourishing than that of wheat. Wheaten bread will likewise be heavier and less perfect, according as the flour has been more or less mixed with other grain or with fecula. It has been observed," he continues, "that the more of foreign fecula we mix with flour, the less increase of weight does the bread acquire. Thus, 6 lbs. of flour produce 8 lbs. of bread; but 3 lbs. of fecula of the potato, with 3 lbs. of flour, produce only 6 lbs. of bread. The reason of this is the following:—The grains of fecula do not imbibe the water, but only are moistened by it; in other words, it only adheres to them. The gluten, on the other hand, imbibes it as a sponge would do, and the more it is kneaded the more it imbibes, and the water thus imbibed adds to the weight of the bread. There are two reasons, then, against this sort of mixture; and this adulteration, though it be not a crime, is still a fraud, because the immediate result of it is to diminish at once the weight and the nutritive quality of the bread." Thus the minutest scientific research corroborates facts evolved by practice.

1896. *Wheat contains more gluten* than any of the other grains, and it is this substance which confers the relative value on wheat as an article of food. It is most developed when used in the form of bread. "If we prepare two masses of

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 411, note.
† Raspail's *Organic Chemistry*, p. 334. ‡ *Quarterly Journal of Agriculture*, vol. ix. p. 584-9.

gluten by kneading, says Raspail, "we shall not be able to make them unite by simple contact; but if we tear open the side of each, and bring the edges together, the smallest effort will be sufficient to unite the two masses into one. The object of kneading, then, is to press the two edges of the glutinous parcels against each other. Hence the quantity of gluten will vary according to the mode of kneading employed. Thus Beccaria, who contented himself with placing the farina in a sieve, and keeping it under a stream of water, but without stirring it, obtained less gluten than Kesselmeyer, who in the first place made a paste of the farina, and then kneaded it continually under a stream of water, till the water ceased to pass off milky. In the former process, the weight of the water falling on the farina brought a few parcels together, but kept asunder or disunited the greater number, which consequently passed through the sieve. In the second process, on the contrary, the hand in kneading compressed, turned in every direction, and brought together by every point of contact, the scattered parcels, and scarcely allowed the water to carry off any thing but the round and smooth grains of fecula. I have ever found that, in this process, we obtain more or less gluten, according as the paste is pressed in different ways; for when it is merely compressed perpendicularly, we lose a good deal more of the gluten than when it is rolled upon itself with some force."

1897. In regard to the *nutritive properties of gluten,* there is no doubt they are of a superior order, though not for the reason ascribed by Magendie, who concluded that gluten is nutritious because sugar, which contains no nitrogen, could not support dogs in life beyond a certain time; while Parmentier was led to infer that gluten remains undigested. "But who does not perceive," justly asks Raspail, "that animals, till then accustomed to live on flesh, must suffer on being all at once deprived of this aliment, just as a horse would suffer from being fed on flesh instead of hay; for as digestion is a complex operation, why should we seek to study it by violating its elements! Sugar will not ferment by itself—why, then, expect that it should ferment without albumen in the stomach! If this mode of experimenting entitle us to erase sugar, oil, and gum from the list of nutritive substances, we must also erase pure gluten, and even pure albumen; for if an animal be fed on them alone, it will die just as certainly as if it had been fed exclusively on sugar. This is one of those questions," he concludes, "in which both sides are wrong, and the truth lies in blending the opposite opinions together. Neither gluten nor sugar, taken singly, is nutritive; but they become alimentary when united."*

1898. Notwithstanding the reasonableness of these remarks of Raspail, certain experimenters insist that the nutritive value of bread is in proportion to the quantity of gluten it contains; and in like manner they determine the value of wheat, because certain varieties of foreign wheat are used by our bakers to mix with our own wheat, and, it being found that those varieties of foreign wheat contain more gluten than certain other varieties of British wheat, the conclusion is formed, without the investigation of other circumstances, that a mixture of foreign wheat is at all times necessary to enable our bakers to make the finest quality of nutritious bread. Thus, Sir George Mackenzie, Bart., in a recent pamphlet, that may be regarded as a supplement to another one which appeared from his pen at a former period, on a kindred subject, observes that "Each of these varieties (of wheat) differ from the rest in its habits of growth and in productiveness, and above all in its degree of fitness for the purposes of the baker. Now, it is or ought to be well known that the baker *cannot* use home-grown wheat by itself, on account of its deficiencies in certain qualities. He has therefore to procure, from foreign countries, wheat possessing those qualities in a high degree, to mix with that of home growth, to enable him to produce good bread. Much has been said of rendering Great Britain independent of foreign supply. But it has been a sad mistake to suppose that this can be done by increasing merely the *quantity* of home produce. Let that be done to any amount—still, if nothing else be attended to, quantity will not render us independent. We must have *quality* too. The only means, by the application of which we can hope to become comparatively independent, has been furnished by organic chemistry. I believe I was the first to call attention to this; but I have called hitherto in vain, so difficult is it to expel old notions and prejudices, and to substitute knowledge derived from fact and experience. Admitting the fact that the baker must have foreign wheat, the question arises, what can be done to render it unnecessary for the baker to import it? The answer is, to produce wheat at home of *similar quality*. It is not manures, it is not soil, it is not the most careful draining and cultivation, that will render the wheats now cultivated so much better as to supersede foreign wheat. We may produce finer-looking and more abundant crops, but we cannot change the inherent qualities of any wheat. What, then, is to be done? is the next question. We must first ascertain *what it is* that renders foreign wheat superior to our own, for the purpose of making bread. For the answer we must apply to the *chemist*. He proceeds, first, to determine the proportions of the different component parts of foreign wheat. This done, he subjects the varieties of wheat grown at home to the same processes, and finds that the proportions of certain ingredients of foreign grain are greater in reference to others than in the home-grown wheat. This discovery having been made, and as we know that foreign wheat has been grown in this country, and *failed* to give satisfaction, we must not sit still, under the impression that our *climate* will not admit of wheat being grown equal in quality to foreign. It may be—perhaps is—quite true, that most of

* Raspail's *Organic Chemistry*, p. 114, 130, 182, and 396.

the varieties of wheat cultivated abroad will not succeed with us. But to conclude, in the present state of our knowledge, that we cannot produce any wheat equally good as foreign grain, is absurd. There are many varieties of wheat, and new ones may be raised; and I maintain that if, possessing a small farm of its own, with a proper establishment, an association proceed to collect varieties of wheat of the best character, to analyse them, and select the best sorts, and to try them on a farm of their own, in reference to soil and climate, some may be found adapted to our climate, and suited in all respects to the farmer and baker—for the farmer also must have wheat possessing certain qualities. In the search, the chemist would have to be constantly applied to, and the closest attention would have to be bestowed by a botanical physiologist on the growth and habits of the varieties under trial. The soil, of course, would have to be examined, the various manures applied, and the results registered. A meteorological register should also be kept, and observations made of the effects of the weather. If among known varieties we cannot find one to answer expectation, then we must resort to hybridisation, which, being judiciously managed, will doubtless yield some new varieties adapted to our views."*

1899. It may be fully admitted, that British bakers mix foreign among our own wheat in making bread; but the practice is confined to the bakers resident in large towns, where foreign wheat can be easily obtained at any time. The bakers in the country towns and villages never use foreign wheat, except, it may be, under the peculiar circumstance of a scarcity of wheat in our own country. The reason why even bakers in large towns use foreign wheat at all is, not that the British wheat is of inferior *quality* to the foreign, but that the foreign wheat, at the commencement of winter, is in a better condition for grinding into flour than the British. The foreign wheat used by our bakers is almost wholly brought from the ports of the Baltic, and the practice of the farmers and dealers in grain, in that part of the Continent, is to prepare their wheat for shipment by kiln-drying. If it were not kiln-dried, it would most likely heat, and be thereby injured on board ship. The kilns used there for drying grain are quite of a different construction from ours. They consist of a double cone of iron, the inner one being of cast iron, in which the fire is lighted—the outer one consisting of sheet iron. The wheat is passed in a thin stream upon the cast-iron heated cone, between the double cones, and the steam derived from the water evaporated from the grain, issues at the top between the cones. It is known to all farmers and millers, that British wheat is too damp or raw to be ground into flour during the winter. The month of March must first pass away ere the wheat of this country is dry enough to be ground by itself into flour. It could be kiln-dried, no doubt; and though our kilns are not suited for drying it properly—either smoking or roasting it too much—kilns like those of the Continent could easily be constructed here for the purpose. But there exists a strong dislike on the part of both our bakers and millers to use kiln-dried wheat by itself. The bakers aver that the flour retains a flavour of the kiln, which even the process of fermentation in baking does not altogether dissipate; and the millers truly assert that kiln-dried wheat is too free for their millstones, the grain splintering to pieces before the bran is shelled off. The foreigners kiln-dry their wheat, because the process renders it safe for exportation by sea; and as they use no wheat flour for bread, they are not interested in preserving the natural taste of the flour, or the best state of the grain for grinding. While, therefore, the British wheat cannot be ground into flour by itself in winter, and the foreign wheat cannot bear the action of the stones by itself, the baker and miller have no alternative but to mix the raw British wheat in winter with the dry kiln-dried foreign wheat; and the mixing secures the double advantage of drying the raw wheat by means of the kiln-dried, while the kiln-dried is softened by being in contact for a time with the raw. The proportion in which the two states of wheat are mixed varies from one-third to one-sixth of the foreign kiln-dried, according to the state of rawness of the British wheat. The expediency of using foreign wheat at all by the baker arises, if not solely, in a great part to meet the exigencies of the miller, the dressing of whose millstones is unsuited equally to grinding wheat in a raw or brittle state.

1900. As to the superiority of foreign wheat in making the best bread, it is, in my opinion, of doubtful pretension. I have given Sir Humphry Davy's (1875) statement of the wheat of warm countries abounding more in gluten—and the fact is not surprising, when we know the dry state in which foreign wheat is always sent to this country. Professor Johnston states that English wheat loses from 15 to 17 per cent of weight by being dried; while foreign wheat, from Seminoff, for example, loses only 13 per cent.† But be the proportion of gluten in foreign wheat what it may, it is not on account of the greater proportion of it that the baker mixes foreign wheat with the British, but simply to remove the rawness of the home wheat by a process which will render it eminently fit to be ground into flour, without the slightest risk of injuring its sweetness for bread. The bakers in the country reserve some old British wheat to mix with the raw of the new crop, and they make as good bread therewith as the bakers do who use foreign wheat; and home wheat, after it has been fairly dried in the stack or granary—best in the stack—is ground by itself into flour, and makes as good bread as foreign, and is then in a better state for grinding by itself than the kiln-dried foreign wheat is by itself.

1901. What, therefore, has been said regarding the higher nutritive powers of foreign wheat

* Mackenzie's *Short Plea*, p. 5-7.

† Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 867, note.

over British I consider to have arisen from the criterion attempted to be established by Liebig, and some other chemists, of what constitutes the true principle of nutrition in bread. That criterion would maintain that the greater abundance of gluten in a wheat is a sure test of its nutritive superiority. That some error lurks in such a rule the following fact indicates. I requested Professor Johnston to analyse for me two specimens of wheat, as respects their comparatively nutritive powers, one grown in 1845, the other in 1846. They were both of the same variety of wheat, grown in similar circumstances, as to soil and management, on the same farm in Lincolnshire, and the analyses stood thus:—

COMPOSITION OF LINCOLNSHIRE WHEAT.

	Grown in 1845.	Grown in 1846.
Water per cent, ...	12·77	13·16
Protein compounds, or muscle-forming matter in the whole grain, ...	15·31	14·14
Protein compounds in the whole grain freed from hygrometric water, ...	17·60	16·26
Protein compounds in sifted flour of grain freed from water, .	15·09	15·77

A note accompanying the analyses says, that "the numbers 15·09 and 15·77 ought not, properly, to be compared with each other, but with those immediately above them. The grain in each case was merely pounded in a mortar, and, though they were sifted through the same sieve, the one may have been more pounded than the other, and therefore when sifted may have given a finer flour, containing more of the bran, in which the excess of the protein compound resides." Chemically speaking, the amount of the protein compound is the test of the relative nutritive powers of these two samples of wheat, and of course the wheat grown in 1845 was more nutritive, and ought of course to have been of more value, than that grown in 1846. Now, 1845 was an unfavourable season for the growth of good wheat; the crop was generally inferior throughout the kingdom: the above sample of that year was lean, hungry, and not unlike the winnowings of good wheat, and would have made heavy clammy bread; and a corn-merchant valued it at 10s. less per quarter than the wheat of 1846, which was beautifully fine. Are we to conclude, then, that the wheat which makes heavy clammy bread is more nourishing than that which makes light, spongy bread?—that the corn-merchant and baker do not know the wheat that will make the best bread?—and that no dependence can be placed on the external characters of grain, as regards their nourishing properties? Certainly not.

1902. Wheat is used in *starch*-making. "In starching linen," says Raspail, "the fecula of the potato, of the horse-chestnut, &c., may be used, as well as that of wheat; and it may be used either hot or cold, in the state of starch or of powder. The effect will be the same, provided the irons used be sufficiently heated. It is sufficient to mix the fecula with a little water, to dip the linen in it, clapping it with the hand, and to apply the hot iron while the linen is still moist. The grains of fecula will burst from the action of the heat, the membranes will dilate as they combine with a portion of the water that is present, the soluble mass will be freely dissolved in the rest of it, and the linen will be starched and dried by one process." Fecula is used in making size for paper as well as glue; and "it is known that weavers are obliged, in order to preserve the humidity of the *batter* used in dressing the threads, to work habitually in low, damp, and consequently unwholesome places. Dubuc, an apothecary at Rouen, proposed to add to the dressing a deliquescent chloride, which, by attracting the moisture of the air, might prevent the drying of the batter, and thus admit of the workman carrying on his labour in drier and more-healthy places. Vergnaud recommends the use of the fecula of the horse-chestnut, which contains a proportion of potash sufficient to prevent the batter from drying." * "The wheat of the south of Europe, in consequence of the larger quantity of gluten it contains, is peculiarly fitted for making *macaroni* and other preparations of flour, in which a glutinous quality is considered as an excellence." † The macaroni is formed into different sized tubes, by the dough being pressed from a machine in broad fillets, the edges of which are brought into contact and adhere while the dough is yet moist. Macaroni makes the finest flavoured dish with *Parmesan* cheese.

1903. A crop of wheat, yielding 30 bushels per acre, weighing 1800 lbs., affords of nutritive matter 270 lbs. of husk or woody fibre; 990 lbs. of starch, sugar, &c.; 180 to 340 lbs. of gluten, &c.; 36 to 72 lbs. of oil or fat; and 36 lbs. of saline matter. ‡

1904. "It is a very remarkable circumstance," as observed by Dr Lindley, "that the native country of wheat, oats, barley, and rye should be entirely unknown; for although oats and barley were found by Colonel Chesney, apparently wild, on the banks of the Euphrates, it is doubtful whether they were not the remains of cultivation. This has led to an opinion, on the part of some persons, that all our cereal plants are artificial productions, obtained accidentally, but retaining their habits, which have become fixed in the course of ages. This curious subject has been discussed in the *Gardener's Chronicle* for 1844, p. 565, 779, &c., whither the reader is referred for farther information." §

1905. "Under the name of wheat are comprised an immense number of varieties, produced during a cultivation of many centuries. Two principal varieties are usually recognised, viz. *Triticum æstivum* and *Triticum hibernum*—sum-

* Raspail's *Organic Chemistry*, p. 135.
† Davy's *Agricultural Chemistry*, p. 136, edition of 1839.
‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 928.
§ Lindley's *Vegetable Kingdom*, p. 112.

mer and winter wheat—the limits of which, both polar and equatorial, must differ somewhat; but this difference is not ascertained, because travellers, and even botanists, seldom allude to the distinction. Wheat is cultivated in Scotland to the vicinity of Inverness, (lat 58°;) in Norway to Drontheim, (lat. 64°;) in Sweden to the parallel of lat. 62°; in western Russia to the environs of St Petersburg, (lat. 60° 15′;) while in central Russia, the polar limits of cultivation appear to coincide with the parallel of 59° or 60°. Wheat is here almost an exclusive cultivation, especially in a zone which is limited between the latitudes of Tchernigov, lat. 51° and Ecaterinoslav, lat. 48°. In America the polar limits of wheat are not known, on account of the absence of cultivation in the northern regions. The physical conditions of these limits are, in the different countries where cultivation has been carried to the utmost extent, as follows:—

		Mean temperature, Fahr.		
	Lat.	Year.	Winter.	Summer.
Scotland, (Ross-shire,)	58°	46°	35°	57°
Norway, (Drontheim,)	64	40	25	59
Sweden, ...	62	40	25	59
Russia, (St Petersburg,)	60 15′	38	16	61

This table shows how little influence winter cold has in arresting the progress of agriculture towards the north; and this is confirmed in the interior of Russia, where Moscow is much within the limits of wheat, although its mean winter temperature is (according to Schouw) 53° 2′. The spring-sown wheat escapes the cold of winter, and wheat sown in autumn is protected during winter by a thick covering of snow. The farther in advance to the north, the more deep and enduring is the covering. The temperature of air, during the severe season, can therefore have no direct action on plants which are annual, or at least herbaceous, and buried under the snow. The isothermal curve of 57° 2′, which appears to be the minimum temperature requisite for the cultivation of wheat, passes in North America through the uninhabited regions of Canada. At Cumberland House, which is situated in the middle of the continent of North America, in lat. 54° N., long. 102° 20′ W., the officers of the Hudson's Bay Company have established a prosperous agriculture. Captain Franklin found fields of barley, wheat, and even maize, (Indian corn,) growing here, notwithstanding the extraordinary severity of the winter. The polar limits of the cultivation of wheat is the more important, since, during a part of their course, they coincide with the northern limits of those fruit trees which yield cider; and in some parts also with the limits of the oak. Agriculture and forests, therefore, both undergo a sudden and remarkable change of appearance on approaching the isothere of 57° 2′. In middle and western Europe, wheat, (*Triticum vulgare*) is cultivated chiefly in the zone between lat. 36° and 50°; farther north, rye (*Secale cereale*) is generally preferred. To the south of this zone, new combinations of heat, with humidity, and the addition of many other cultures, sensibly diminish the importance of this precious cereal. The isochemial curve of 68° or 69°, which appears to be the extreme limit of the possible cultivation of wheat towards the equator, oscillates between lat. 20° and 25°. The cultivation of wheat is very productive in Chili and in the united state of Rio de la Plata. On the plateau of southern Peru, Meyer saw most luxurious crops of wheat at a height of 8500 feet, and at the foot of the volcano of Arequipo, at a height of 10,600 feet. Near the lake of Tibicaca, (12,795 feet high,) where a constant spring heat prevails, wheat and rye do not ripen, because the necessary summer heat is wanting; but Meyer saw oats ripen in the vicinity of the lake."*

1906. *Barley.*—Its botanical position is the 3d class *Triandria*, 2d order *Digynia*, genus *Hordeum*, of the Linnæan system; and in the natural order of *Gramineæ* by Jussieu. Dr Lindley places barley, in his natural system, in class iv. *Endogens;* alliance 7, *Glumales*; order 29, *Graminaceæ*, and genus 11, *Hordei*, the same position as wheat. Professor Low divides the cultivated barleys into two distinctions, namely, the 2-rowed and the 6-rowed, and these comprehend the ordinary, the naked, and the sprat or battledoor forms.† Mr Lawson describes 20 varieties of barley;‡ while the Museum of the Highland and Agricultural Society contains specimens of 30 varieties.§ The natural classification of barley by the ear is obviously of three kinds—4-rowed, 6-rowed, and 2-rowed. Fig. 180

Fig. 180.

4-ROWED BERE OR BIGG. 6-ROWED BARLEY. 2-ROWED.

* Johnston's *Physical Atlas—Phytology*, Map No. 2.
† Low's *Elements of Practical Agriculture*, p. 244.
‡ Lawson's *Agriculturist's Manual*, p. 33. § *Catalogue of the Museum*, p. 60.

represents the 3 forms, where *a* is the 4-rowed, or bere or bigg; *c* is the 6-rowed; and *b* the 2-rowed; all which figures represent the ear in half its natural size. Of these the bere or bigg was cultivated until a recent period, when the 2-rowed has almost entirely supplanted it, and is now the most commonly cultivated variety, the 6-rowed being rather an object of curiosity than culture.

1907. In classifying barley by the *grain*, there are just two kinds, *bere* or *bigg*, and *barley*, and, though both are awned, they are sufficiently marked to constitute distinct varieties. In the bere, fig. 181, the median line of the bosom is so traced as to give the grain a twisted form, by which one of its sides is larger than the other, and the lengthened point is from where the awn has been broken off. The figures represent the grain of the natural size.

Fig. 181.

SCOTCH BERE OR BIGG.

1908. In the barley, fig. 182, the median line passes straight, and divides the grain into two equal sides, and whose shortness and plumpness give it a character of superiority. The cluster of grain is of the natural size.

Fig. 182.

ENGLISH BARLEY.

1909. The bigg was long chiefly cultivated in Scotland, and a 2-rowed variety, under the name of common or Scotch barley, has long been in cultivation; but several of the English varieties are now naturalised, and in their new sphere show a brighter and fairer colour, plumper and shorter grain, quicker in the property of malting, though less hardy and prolific, than the common barley.

1910. The crenulated or shrivelled skin across both sides of the median line in the English barley is a good criterion of malting; and as most of the barley raised in this country is converted into beer or spirits, both of which require malt to produce them of the finest quality, it is not surprising that those varieties of barley which yield the greatest return of malt should always realise the highest prices.

1911. A good crop of barley yields a return of from 48 to 60 bushels the imperial acre. Good barley weighs from 55 lbs. to 59 lbs. per bushel. A crop of 60 bushels per acre will yield of straw, in the vicinity of a town, 176 stones of 14 lbs. to the stone, or $1\frac{1}{10}$ ton, and the weight of the grain of that crop, at 56 lbs. per bushel, will be $1\frac{1}{2}$ ton. It takes of bigg 111 grains to weigh 1 drachm; of 6-rowed barley, 93; and of Chevalier barley, 75 grains. Of the three kinds, the Chevalier is much the heaviest; and taking the number of grains in a drachm at 75, and the weight per bushel 57 lbs. the number of grains of Chevalier barley in a bushel will be 547,200.

1912. By far the largest proportion of the best barley grown in this country is converted into *malt* for making malt liquor and spirits, and barley is also used for distillation in the raw state. In 1831 and 1841 the following quantities of malt paid duty at 2s. 7d. per bushel, viz:—

	England and Wales.	Scotland.	Ireland.	Total.
	Bushels.	Bushels.	Bushels.	Bushels.
1831	32,963,470	4,186,955	2,101,844	39,252,269
Duty	£4,131,879	£524,810	£263,459	£4,920,148
1841	30,956,348	4,058,246	1,149,691	36,164,285
Duty	£3,879,791	£508,690	£144,110	£4,532,591

1913. The use of malt in this country has fallen off materially during the last hundred years, when compared with the number of the people; but it would not be correct to attribute the circumstance wholly to the effect of taxation, although there can be no doubt that the consumption has been materially checked by the duty imposed. The introduction of tea and coffee into extensive use throughout the kingdom must necessarily have interfered with the consumption of beer; and the same effect must have followed the increased use of spirits, only a small proportion of which is distilled from malted grain.

1914. An increase of consumption in the last 15 years was occasioned by the repeal of the duty on beer, which, while it existed, was in fact an additional duty on malt, but nevertheless the consumption has fallen off in proportion to the increase of population, as thus:—

	Bushels used.	Population.	Consumption of bushels per head.
In 1831,	39,252,269	24,029,702	1·63
1841,	36,164,285	26,711,694	1·35

1915. "The importation of malt from foreign countries is strictly prohibited; and as from some cause or other, not very well understood, barley brought from beyond seas cannot be profitably malted here, our landowners," observes Mr Porter, "enjoy the practical monopoly of the home market. The foreign-grown barley that is sometimes imported is used for grinding, and other purposes for which inferior qualities are adapted, and thereby admits of a more extensive use of the superior home-grown barley in the form of malt. When the corn trade was free, and the duty on malt was more reasonable than it has been of late years, the barley districts of England afforded an abundant supply of a quality adapted to the use of the maltster."*

1916. Pot and pearl barley are made from barley for culinary purposes; and both meal and

* Porter's *Progress of the Nation*, p. 563-5.

flour are manufactured from barley for the purpose of making unleavened bread, which is eaten by the labouring class in some parts of the country, and barley bannocks are esteemed a luxury by people in towns. Porridge of barley-meal, with rich milk, is accounted a pleasant and light supper, and less heating than that of oatmeal. Of the states of barley the soft is best adapted for making into malt and meal, and the flinty into pot barley.

1917. It was supposed that the reason for the flinty barley making the best pot barley was, that it contains the most gluten or nitrogen; but Professor Johnston showed by analysis that it contained less gluten than the soft barley, in the proportion of 8·03 to 10·93.

1918. Though the composition of barley is of similar materials to that of wheat, the whole grains of two varieties grown at Hohenheim contained—

	Water.	GLUTEN, &c. Ordinary state.	GLUTEN, &c. Dry state.
Jerusalem barley, . .	16.79	12.26	14.74
Common winter barley,	13 80	15.35	17.81

yet barley thus contains little gluten compared to wheat. If barley-meal be made into a dough, and washed with water upon a sieve, nearly the whole passes through, the husk almost alone remaining.

1919. The composition of barley-meal is—

Water, ...	14
Gluten, albumen, &c. .	14
Starch, ...	68
Fatty matter, . .	2
Saline matter, or ash, .	2
	100

I have already given the composition of barley ash in (1288.)*

1920. The grains of the fecula of the barley are very fine, not exceeding .00098 of an inch in size. Barley flour only contains 3 per cent of gluten, and is therefore much less nutritive than wheaten flour. The *hordein*, ascribed by Proust to act so important a part in the germination of barley, is asserted by Raspail to be nothing more, under the microscope, than bran. "That this is the case," he says, "is proved by dissection; for if we make a transverse slice of each of the grains of wheat and barley, we shall perceive that the pericarp of the wheat peels off entire like a circular band, while that of the barley can only be detached in very small fragments. Now, what takes place, under the edge of the scalpel," he alleges, "will also happen under the pressure of the millstones; consequently, the bran will be much more minutely divided in the farina of barley than in that of wheat. In boulting flour, therefore, it will remain in the sieve; while, in the other, its almost microscopic fragments will pass through with the fecula and gluten, and will be almost inseparable, by mechanical means, from the farina." Hence, if pearl barley "be ground, we obtain from it a farina as white as that of wheat, and containing only a very minute portion of hordein, equivalent to the amount of those fragments of the pericarp which had been protected by their situation in the posterior groove of the grain."†

1921. "The meal so highly commended by the Greeks was prepared from barley. . . . It was not until after the Romans had learnt to cultivate wheat, and to make bread, that they gave barley to the cattle. They made barley-meal into balls, which they put down the throats of their horses and asses, after the manner of fattening fowls, which was said to make them strong and lusty. Barley continued to be the food of the poor, who were not able to procure better provision; and in the Roman camp, as Vegetius has informed us, soldiers who had been guilty of any offence were fed with barley instead of bread corn."‡

1922. *Malting.*—This process produces a considerable change in the constitution of the grain. The barley is steeped in cold water for at least 40 hours, according to law. Here it imbibes moisture, increases in bulk, and emits a quantity of carbonic acid gas, not exceeding 2 per cent. The moisture imbibed is 0.47, that is to say, every 100 lbs. of barley, when taken out of the steep, weighs 147 lbs. The increase of bulk is one-fifth, that is, 100 bushels of grain measures out 120 bushels. The steep water dissolves from $\frac{1}{50}$ to $\frac{1}{100}$ of the husk of the barley, and hence barley becomes paler by steeping. The steeped barley is then put on a floor in a heap 16 inches deep, to remain so for 26 hours. It is then turned with wooden shovels, and diminished in depth to a few inches by repeated turnings. In 96 hours the grain becomes 10° hotter than the air, and then *sweats*, when it is frequently turned, the temperature being preserved in the grain from 55° to 62°. The roots now begin to appear, the stem called *acrospire*, springs from the same end, and advances within the husk to the other end of the grain; but the process of malting is stopped by kiln-drying before the germ has made much progress. The kiln, at first 90°, is raised gradually to 140°. The malt is then cleaned, and the rootlets removed, as they are considered injurious, and are called *comins*. Malt is from 2 to 3 per cent greater in bulk than the barley, and it loses one fifth or 20 per cent in weight, of which 12 per cent is lost by drying; so the real loss is only 8 per cent, accounted for by the steep water carrying away $1\frac{1}{2}$ per cent, dissipated on the floor 3 per cent, roots cleaned away 3 per cent, and waste $\frac{1}{2}$ per cent. The roots take away the

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 881-3.
† Raspail's *Organic Chemistry*, p. 120-206.
‡ Phillips' *History of Cultivated Vegetables*, vol. i. p. 50.

glutinous portion of the grain, and the starch is converted into a sort of sugar.

1923. *Beer.*—Beer is a beverage of great antiquity. "The earliest writer who mentions *beer*," commences Dr Thomson, in his account of the process of malting, of which the foregoing paragraph is the substance, "is Herodotus, who was born in the first year of the 74th Olympiad, or 444 years before the commencement of the Christian era. He informs us that beer was the common drink of the Egyptians, and that it was manufactured from barley, because vines did not grow in their country. In the time of Tacitus, whose treatise on the *Manners of the Germans* was written about the end of the first century of the Christian era, beer was the common drink of the Germans. Pliny mentions beer as employed in Spain, under the names of *cœlia* and *ceria*, and in Gaul under the name of *cervisia*. Almost every species of corn has been used in the manufacture of beer. In Europe it is usually made from *barley*, in India from *rice*, in the interior of Africa, according to Park, from the seeds of the *Holcus spicatus*. But whatever grain is employed, the process is nearly the same, and it is usual in the first place to convert it into malt."*

1924. "Barley is cultivated farther north than any of the other grains: fields of it are seen in the northern extremity, in the Orkney Islands, and in Shetland (lat. 61° N.,) and even at the Faröe Islands (lat. 61° to 62° 15′ N.) Iceland (lat. 63° 30′ to 66° N.) does not produce it, although an industrious population have made every exertion to acquire some species of cerealia. In western Lapland, the limit of barley is under lat. 70° near Cape North, the northern extremity of Europe. In Russia, on the shores of the White Sea, it is between the parallels of 67° and 68° on the western side, and about 66° on the eastern side, beyond Archangel. In central Siberia, between lat. 58° and 59°. Such is the sinuous curve which limits the cultivation of barley, and consequently that of all the cereals. A little farther north, all employment of vegetables ceases, at least as an important object of nourishment—the people live on the product of their cattle, as in the high Alps, or by hunting and fishing, according to locality. But beyond the limits of barley there occurs a narrow and indeterminate zone, in which certain early potatoes are cultivated, and where the snow does not cover the ground for a sufficient length of time to prevent the raising of some lichens, some fruits, barks, or wild roots, fit for the nourishment of man. As the introduction of the potato is, in comparison to barley, recent in these regions, it almost every where forms the limit between the agricultural and the pastoral or nomad life. From the importance of the cultivation of barley in the north, it is evident that wherever the human species has attained the first stage of civilisation, the attempt will have been made to advance it as far as possible towards the pole. If, then, it is limited by a sinuous curve, as already explained, it is because circumstances of a purely physical nature oppose to it an insurmountable barrier. A mean temperature of 46° 4′ during summer seems to be, for our continent, the only indispensable condition for the cultivation of barley; in the islands of the Atlantic Ocean, a summer temperature of three or four degrees higher appears to be necessary for its success. Iceland, indeed, where this grain cannot be cultivated, presents in its southern districts at Reikavik, a mean temperature of 37°.4′ for the year—24° for the winter, and 49°.4′ for the summer. It appears that here considerable rains are the means of preventing the cultivation of cerealia. Thus the limit of barley in the countries where its cultivation is of the most importance, varies between 46°.4′ and 49° of mean temperature, during summer. In the continental regions 46°.4′ is sufficient; but in the islands the excessive humidity requires to be compensated by a little heat in summer. Barley is cultivated as an alimentary plant as far as the northern limit of rye and oats. Farther north it loses its importance, and is very little cultivated. Between the tropics this cereal does not succeed in the plains, because it suffers from heat more than any of the other cultivated grains."†

1925. *Oats.*—Oats are cultivated on a large extent of ground in Scotland—one-fifth of the arable ground; and it is believed that no country produces of them greater crops of finer quality. The plant belongs to the natural order of *Gramineæ*, of the Jussieun system, and it occupies the class *Triandria*, order *Digynia*, genus *Avena*, of the Linnæan system. In Lindley's natural system it occupies class iv. *Endogens*, alliance 7, *Glumales*, order 29, *Graminaceæ*, and genus 9, *Aveneæ*. Its ordinary botanical name is *Avena sativa*, or cultivated oat. The term oat is of obscure origin. Paxton conjectures it to have been derived from the Celtic *etan*, to eat.‡ There are a great number of varieties of this grain cultivated in this country. Mr Lawson describes 38; § and 54 are deposited in the Highland and Agricultural Society's Museum.‖

1926. The natural classification of the oat by the grain consists only of two forms—one plump and short and beardless, as in fig. 183, which represents grains of the potato-oat, in different positions, beardless, plump, smooth-skinned, and shining, having the base, from which the rootlets emerge, well marked, and the end from which the germ rises short, and bluntly pointed.

Fig. 183.

THE POTATO OAT.

* Thomson's *Organic Chemistry—Vegetables*, p. 1011-12.
† Johnston's *Physical Atlas*—Phytology, Map No. 2.
‡ Paxton's *Botanical Dictionary*, art. *Avena*. § Lawson's *Agriculturist's Manual*, p. 44.
‖ *Catalogue of the Museum*, p. 59.

1927. The other form of grain, fig. 184, is long and thin, and has a tendency to produce long awns, or a beard. The specimens are of the white Siberian early oat, which does not grow on an ear having the panicles on one side of the rachis, as is the case with the Tartarian oat, fig. 186, but on a regularly balanced ear, like fig. 185. It is cultivated in the poorer soils and higher districts, resists the force of the wind, and yields a grain well adapted for the support of farm-horses. The straw is fine and pliable, and makes an excellent dry fodder for cattle and horses, the saccharine matter in the joints being very sensible to the taste. It comes early to maturity, and hence its name.

Fig. 184.

THE WHITE SIBERIAN EARLY OAT.

1928. The natural classification of the oat by the *ear* is obvious. One kind, fig. 185, has its branches spreading equally on all sides, shortening gradually towards the top of the spike in a conical form, and the panicles are beardless. This is the potato oat. While the ear is yet recent, the branches are erect, but as the seeds advance towards maturity, and become full and heavy, they assume a dependent form. By this position, the air and light have free access to the ripening grain, while the rain washes off the eggs or larvæ of insects that would otherwise prey upon the young seed. This variety is extensively cutivated in Scotland on account of the fine and nourishing quality of its meal, which is largely consumed by its people. It is cultivated in the richer soils of the low country. The plant is tender, and the grain is apt to be shaken out by the wind. The straw is long and strong, inclining too much to reediness to make good fodder. It is late in coming to maturity. Its peculiar name of the potato oat is said by one writer to have been derived from the circumstance of the first plants having been discovered growing accidentally on a heap of manure, in company with several potato plants, the growth of which was equally accidental,* while another writer says plants of it were first found in 1789 in Cumberland, growing in a field of potatoes. The ear in the figure was taken from the stack.

Fig. 185.

THE POTATO OAT.

1929. The other kind of the ear of the oat has its panicles shorter, nearly of equal length, all on the same side of the rachis, and bearded. Fig. 186, a head of Tartarian oat, taken from the stack, represents this kind of ear. The seeds of this variety of form also assume the dependent form, and from this circumstance, as well as that of possessing a beard, it is of such a hardy nature as to thrive in soils and climates where the other grains cannot be raised. Of this variety of form the Tartarian oat is most extensively cultivated, the wild oat being regarded as a troublesome weed amongst the cultivated grain. This variety derives its name, most probably, from having been brought originally from Tartary. It is much cultivated in England, and not at all in Scotland. It is a coarse grain, more fit for horse-feed than to make into meal. The grain is dark-coloured, awny ; the straw coarse, harsh, brittle, and rather short.

Fig. 186.

THE TARTARIAN OAT.

1930. The *crop* of oats varies from 36 to 72 bushels per imperial acre, according to the kind, and the circumstances of soil and situation. Oats vary in weight from 36 lbs. to 48 lbs. per bushel. Whiteness, of a silvery hue, and plumpness, are the criteria of a good sample. The potato oat, 47 lbs. per bushel, gave 134 grains to 1 drachm ; the Siberian early oat, weighing 46 lbs. per bushel, gave 109 grains ; and the white Tartarian oat, weighing 42 lbs., gave 136 grains ; so that these kinds respectively will afford 806,144, 641,792, and 731,136 grains of oats per bushel.

* Rhind's *History of the Vegetable Kingdom*, p. 218.

A crop of potato oats, yielding 60 bushels to the acre, at 47 lbs. per bushel, will weigh of grain 1 ton 5 cwts. 20 lbs., and will yield of straw 1 ton 5 cwts. 16 lbs., in the neighbourhood of a large town; or, in other words, will yield 8 kemples of 40 windlings each, and each windling 9 lbs. in weight. But I have been made acquainted with a crop of Hopetoun oats near Edinburgh, of no more than 60 bushels to the imperial acre, yielding 2 tons 18 cwts. 16 lbs. of straw. The common oats yield more straw, in proportion to the grain, than the potato variety. In particular spots, such as on the banks of the river Islay, near Coupar-Angus, 114 bushels per imperial acre, of potato oats, have been frequently reaped.

1931. The portion of the oat crop consumed by man is manufactured into *meal*. It is never called flour, as the millstones are not set so close in grinding it as when wheat is ground, nor are the stones for grinding oats made of the same material, but most frequently only of sandstone—the old red sandstone or greywacke. Oats, unlike wheat, are always kiln-dried before being ground; and they undergo this process for the purpose of causing the thick husk, in which the substance of the grain is enveloped, to be the more easily ground off, which it is by the stones being set wide asunder; and the husk is blown away, on being winnowed by the fanner, and the grain retained, which is then called *groats*. The groats are ground by the stones closer set, and yield the meal. The meal is then passed through sieves, to separate the thin husk from the meal. The meal is made in two states: one *fine*, which is the state best adapted for making into bread, in the form called oat-cake or bannocks; and the other is coarser or *rounder* ground, and is in the best state for making the common food of the country people—porridge, *Scotticè*, parritch. A difference of custom prevails in respect to the use of these two different states of oatmeal, in different parts of the country, the fine meal being best liked for all purposes in the northern, and the round or coarse meal in the southern counties; but as oat-cake is chiefly eaten in the north, the meal is there made to suit the purpose of bread rather than of porridge; whereas, in the south, bread is made from another grain, and oatmeal is there used only as porridge. There is no doubt that the round meal makes the best porridge, when properly made—that is, seasoned with salt, and boiled as long as to allow the particles to swell and burst, when the porridge becomes a pultaceous mass. So made, with rich milk or cream, few more wholesome dishes can be partaken by any man, or upon which a harder day's work can be wrought. Children of all ranks in Scotland are brought up on this diet, verifying the poet's assertion,

> "The halesome parritch, chief o' Scotia's food."
>
> BURNS.

Forfarshire has long been famed for the quality of its brose and oat-cake, while the porridge of the Borders has as long been equally famous. It is so every where, the sharp soil producing the finest cake-meal, and clay land the best meal for boiling. Of meal from the varieties of the oat cultivated, that of the common Angus oat is the most thrifty for a poor man, though its yield in meal is less in proportion to the bulk of corn.

1932. In regard to the *yield of meal* from any given quantity of oats, when they give half their weight of meal, they are said to give *even meal*. Supposing a boll of oats of 6 bushels to weigh 16 stones, it should give 8 stones or 16 pecks of meal, and, of course, 8 stones of refuse to yield even meal. But the finer class of oats will give more meal in proportion to weight than this—some nearly 9 stones, and others as much as 12 stones. The market value of oats is therefore estimated by the meal they are supposed to yield, and, in discovering this property in the sample, millers become very expert. When oats yield less than even meal they are considered to give ill, or are unprofitable to make into meal, and are disposed of for horses, or kept at home for that purpose.

1933. "The farina of the oat seems, to the unassisted eye, cottony, or, as it were, felted, from the presence of an innumerable quantity of hairs with which the seeds are covered. The grains of the fecula have a size of about ·00276 by ·0018 of an inch. They appear in general yellowish, and strongly shaded. Some of these have the appearance, but not the form, of the fecula of the potato."*

1934. The chemical analysis of the oat has been carefully investigated, within these few years, by Mr Norton, of Newhaven, in the United States of America, whilst an assistant in the laboratory of the Chemistry Association of Scotland in Edinburgh; and some of the results thus obtained I have already given, such as the composition of the grain of the oat in (1292,) the per-centage of ash in it in (462,) and the composition of the ash in (1294.)†

1935. "We find no mention made of oats in Scripture," says Phillips, "which expressly states that Solomon's horses and dromedaries were fed with barley;" but "the use of oats as a provender for horses appears to have been known in Rome as early as the Christian era, as we find that that capricious and profligate tyrant, Caligula, fed *Incitatus*, his favourite horse, with *gilt oats* out of a golden cup." Oats are mixed with barley in the distillation of spirits from raw grain; and "the Muscovites make an ale or drink of oats, which is of so hot a nature, and so strong, that it intoxicates sooner than the richest wine."‡

1936. "The oat *(avena sativa)* is cultivated extensively in Scotland, to the extreme north point, in lat. 58° 40′. In Norway its culture

* Raspail's *Organic Chemistry*, p. 113.

† This highly interesting Memoir by Mr Norton may be perused in the *Transactions of the Highland and Agricultural Society* for July 1846, p. 321-56.

‡ Phillips' *History of Cultivated Vegetables*, vol. ii. p. 9.

extends to lat. 56° ; in Sweden to lat. 63° 30′. In Russia, its polar limits appear to correspond with those of rye. Whilst, in general, oats is cultivated for the feeding of horses, in Scotland and in Lancashire, it forms a considerable portion of the usual food of the people. This is also the case in some countries of Germany, especially in the south of Westphalia, where the inhabitants of the "Sauerlands" live on oaten bread. South of the parallel of Paris oats is little cultivated; in Spain and Portugal it is scarcely known; yet it is cultivated with considerable advantage in Bengal, to the parallel of lat. 25° N."*

1937. Oatmeal has long been the ordinary food of the Scottish ploughman, and in several districts of that country he lives upon it three times a-day, consuming a stone every week ; and a stouter and more healthy man cannot be seen. It was considered a rather anomalous circumstance to find men thriving as well on oatmeal as on wheat bread and butcher meat ; but the anomaly has been cleared up by the investigations of chemistry. In the analysis of the oat in (1292,) it may be seen that the grain contains fully 7 per cent of oil or fat, and 17 per cent of avenine—a protein compound, as the gluten of wheat is—making together 24 per cent of really nutritive matter, capable of supporting the loss incurred by labour of the fibrous portion of the body. All vegetables contain fat, and the largest proportion of vegetable fats contain the elaic and margaric acids, mixed with a small proportion of the stearic. The elaic is always in a fluid state, and the margaric and stearic in a solid; and of the latter two, the margaric is much less, and the stearic acid very much greater in animal fat than in those of plants, (1600.) It is by the dissipation of this oil or fat by heat, in baking, that the agreeable odour of the oat-cake is at once recognised on approaching the humble cottage of the labouring man.

1938. Dr Robert D. Thomson recommends that, "when it is proposed to make a loaf of oatmeal and flour, the common oatmeal should be sifted so as to obtain the finest portion of the meal, or it may be ground to the proper consistence. This should be mixed with an equal weight of best flour—Canadian, for example—and fermented. I have not succeeded in making a good loaf with a smaller amount of flour than a half, although I have tried it in various proportions. If we were to attempt to raise oatmeal without an admixture with flour, in consequence of the absence of gluten, that principle which retains the carbonic acid of fermentation, we should obtain only a sad, heavy, doughy piece of moist flour. This form of bread, it appears to me, and to many who have examined it, would be a great improvement on the hard, dry oat-cakes, so much used in the more unfrequented parts of our country, where the inhabitants have scarcely as yet commenced to share in what are in other localities considered to be necessaries of life."†

1939. When Dr Thomson avers, "If we were to attempt to raise oatmeal without an admixture with flour, in consequence of the absence of gluten, that principle which retains the carbonic acid of fermentation, we should obtain only a sad, heavy, doughy piece of moist flour," he must never have seen or tasted the fine barm-raised oatmeal loaves, used with beer, at the harvest-dinners in Forfarshire, and which are relished by the work-people there much better than the best wheaten bread. Such an oat-loaf, with fresh butter and new honey, forms a most delightful relish at the farmer's harvest breakfast or tea table.

Fig. 187.

EAR OF RYE.

1940. *Rye.*—Botanically, this plant occupies the class *Triandria*, order *Digynia*, genus *Secale*, of the Linnæan system ; the order *Gramineæ* of Jussieu; and class iv. *Endogens*, alliance 7, *Glumales*, order 29, *Graminaceæ*, genus 11 *Secale*, of the natural system of Lindley. It is the *Secale cereale* of the botanists, so called, it is said, from *á secando*, to cut, as opposed to leguminous plants, whose fruits used to be gathered by the hand. A figure of the spike of rye is shown in fig. 187, and is not unlike the spike of a hungry bearded wheat. There is only one known species of this plant, which is said to be a native of Candia, and was known in Egypt 3300 years ago; but there are several varieties which are raised as food, 4 of which are described by Mr Lawson,‡ and 7 to be seen in the Museum of the Highland and Agricultural Society.§

1941. The grains of rye are long and narrow, not unlike shelled oats or groats, but more flinty in appearance. They are shown in various positions in fig. 188, and are of the natural size.

Fig. 188.

GRAINS OF RYE.

1942. The rye is not much cultivated in this country, particularly in Scotland, where only a patch here and there is to be seen. It is, however, extensively cultivated on the Continent, especially in sandy countries, where it forms the principal article of food of the labouring classes.

1943. The produce of rye may be about 24 bushels per acre, and the weight of the grain is stated at from 52 lbs. to 57 lbs. per bushel ; the number of grains in 1 drachm being 165, at 55 lbs., the bushel should contain 1,161,600 grains.

1944. The grain of rye, according to Bous-

* Johnston's *Physical Atlas*,—Phytology, Map No. 2.
† Thomson's *Researches on the Food of Animals*, p. 176.
‡ Lawson's *Agriculturist's Manual*, p. 31. § *Catalogue of the Museum*, p. 62.

singault, yields 24 per cent of bran and 76 of flour. The composition of the grain is :—

Gluten, albumen, &c.,	10·5
Starch,	64·0
Fatty matter,	3·5
Sugar,	3·0
Gum,	11·0
Epidermis and salts,	6·0
Loss,	2·0
	100·0

"The gluten of rye," says Dr Thomson, "differs in several particulars from that of wheat. It is less tenacious and more soluble. When it was allowed to ferment, Einhoff perceived a strong smell of nitric acid, which is peculiar to this species of gluten. The starch of rye bears a striking resemblance to that of wheat. Like this last, it does not form a colourless solution with boiling water, and always precipitates at last, when the solution is left a sufficient time to rest."*

1945. The grains of the fecula of rye meal are peculiarly shaped. "The largest grains of this fecula," says Raspail, "are about ·002 of an inch in size ; but what distinguishes them from all the other varieties is, that they are flattened, and with sharp edges like discs, and for the most part marked on one of their sides with a black cross, or three black rays united at the centre of the grain."†

1946. In a crop of 25 bushels to the acre, weighing 1300 lbs., the nutritive matter derived from rye consists of 130 lbs. to 260 lbs. of husk or woody fibre ; 780 lbs. of starch, sugar &c. ; 130 lbs. to 230 lbs. of gluten, &c. ; 40 lbs. to 50 lbs. of oil or fat ; and 26 lbs. of saline matter.

1947. The grain of rye leaves 2·425 per cent. of ash, which is thus composed :—

	Will & Fresenius. GIESSEN.	Bichon. CLEVES.	MEAN.
Potash,	32·76	11·43	22·08
Soda,	4·45	18·89	11·67
Lime,	2·92	7·05	4·93
Magnesia,	10·13	10·57	10·35
Oxide of iron,	0·82	1·90	1·36
Phosphoric acid,	47·29	51·81	49·55
Sulphuric acid,	1·46	0·51	0·98
Silica,	0 17	0·69	0·43
	100 00	102·85	101·35 ‡

1948. "Rye *(Secale cereale)* is cultivated in Scandinavia, on the western side to the parallel of lat. 67° N., and on the eastern side to lat. 65° or 66° N. In Russia, the polar limit of rye is indicated by the parallel of the city of Jarensk, in the government of Wologda, lat. 62° 30′. . . . It is as common in Russia, Germany, and some parts of France, as it is rare in the British islands. Rye-bread still forms the principal sustenance of at least one-third of the population of Europe ; it is the characteristic grain of middle and northern Europe ; in the southern countries it is seldom cultivated."§

1949. Rye-bread is heavy, dark-coloured, and sweet ; but, when allowed to ferment, becomes sour. In Russia, 100 lbs. of rye flour, containing 16 per cent of water, yield from 150 lbs. to 160 lbs. of bread. There, horses get it on a journey, in lieu of corn.

1950. *Beans.*—Beans belong to a very different tribe of plants to what we have been considering. They belong to the natural order *Leguminosæ* of Jussieu, because they bear their fruit in legumes or pods ; and in the Linnæan system they occupy the class and order *Diadelphia decandria.* In Lindley's natural system they occupy the sub-class iii. *Perigynous Exogens*, alliance 42, *Rosales*, order 209, *Fabiaceæ*, and tribe 5, *Phaseoleæ.* Their ordinary generic term is *Faba vulgaris ;* formerly they were classed amongst the vetches, and called *Vicia Faba.* The common bean is divided into two classes, according to the mode of culture to which it is subjected, that is, the field or the garden. Those cultivated in the field are called *Faba vulgaris arvensis*, or, as Loudon calls them, *Faba vulgaris equina*, because they are cultivated chiefly for the use of horses, and are usually termed horse-beans. With the garden bean we have nothing to do, though some farmers attempt to raise a few varieties of them in the field, but I believe without success. All beans have butterfly or papilionaceous flowers. Mr Lawson has described 8 varieties of the field bean ; and 10 varieties are placed in the Highland and Agricultural Society's Museum.‖ The variety in common field-culture is thus well described by Mr Lawson : "In length the seed is from a half to five-eighths of an inch, by three-eighths in breadth, generally slightly or rather irregularly compressed and wrinkled on the sides, and frequently a little hollowed or flattened at the end ; of a whitish or light brown colour, occasionally interspersed with darker blotches, particularly towards the extremities ; colour of the eye black : straw from 3 to 5 feet in length. There is perhaps," continues Mr Lawson, "no other grain over the shape and colour of which the climate, soil, and culture, exert so much influence as in the bean. Thus, in a dry warm summer and harvest, the sample is always more plump and white in colour than in a wet and cold season ; and these more so in a strong rich soil than in a light, and more so in a drilled crop than in one sown broadcast."¶ Fig. 189 represents the horse-bean of its natural size.

Fig. 189.

THE HORSE-BEAN.

* Thomson's *Organic Chemistry,—Vegetables*, p. 878. † Raspail's *Organic Chemistry*, p. 116.
‡ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 372, 889, 928.
§ Johnston's *Physical Atlas,*—Phytology, Map No. 2.
‖ *Catalogue of the Museum*, p. 68. ¶ Lawson's *Agriculturist's Manual*, p. 62.

1951. "The leguminous order," observes Dr Lindley, beautifully, "is not only among the most extensive that are known, but also are of the most important to man, whether we consider the beauty of the numerous species, which are among the gayest-coloured and most graceful plants of any region, or their applicability to a thousand useful purposes. The cercis, which renders the gardens of Turkey resplendent with its myriads of purple flowers; the acacia, not less valued for its airy foliage and elegant blossoms than for its hard and durable wood; the brazilletto, logwood, and rosewoods of commerce; the laburnum; the classical cytisus; the furze and the broom, both the pride of the otherwise dreary heaths of Europe; the bean, the pea, the vetch, the clover, the trefoil, the lucerne, all staple articles of culture by the farmer, are so many leguminous species. The gums, Arabic and Senegal, kino, senna, tragacanth, and various other drugs, not to mention indigo, the most useful of all dyes, are products of other species; and these may be taken as a general indication of the purposes to which leguminous plants may be applied. There is this, however, to be borne in mind, in regarding the qualities of the order in a general point of view—viz., that, upon the whole, it must be considered poisonous, and that those species which are used for food by man and animals are exceptions to the general rule; the deleterious juices of the order not being in such instances sufficiently concentrated to prove injurious, and being in fact replaced, to a considerable extent, by either sugar or starch." *

1952. The produce of the bean crop varies from 20 to 40 bushels per imperial acre, the prolificacy of the crop palpably depending on the nature of the season. The average weight may be stated at 66 lbs. per bushel. It only requires 5 beans to weigh 1 drachm, so that a bushel only contains 42,240 grains of beans. I have not cultivated the bean so much as to enable me to ascertain the weight of a good crop of straw or haulm, in comparison with that of the grain, for it is seldom that the same season gives the largest return of both; but I have seen it stated, that "it has been known to yield 2 tons per acre." † A crop of 40 bushels, at 66 lbs. per bushel, gives 1 ton 3 cwts. 64 lbs. per acre.

1953. Beans are given to the horse, whole, boiled, raw, or bruised. They are given to cattle in the state of meal—that is, the husk and grain ground, not very finely, overhead. Beans, however, can be ground into fine flour; and in this state is used to adulterate the flour of wheat. Its presence is easily detected by the peculiar smell arising from the flour when warm water is added to it. Beans impart essential service to horses having fatiguing work. "If beans do not afford more nutriment," observes Stewart, "weight for weight, than oats, they at least produce more lasting vigour. To use a common expression, they *keep the stomach longer*. The horse can travel farther; he is not so soon exhausted. . . . . In the coaching stables, beans are almost indispensable to horses that have to run long stages. They afford a stronger and more permanent stimulus than oats alone, however good. Washy horses—those of slender carcass—cannot perform severe work without a liberal allowance of beans; and old horses need them more than the young. The quantity varies from 3 to 6 lbs. per day; but in some of the coaching stables the horses get more, 1 lb. of oats being deducted for every 1 lb. of beans. Cart-horses are often fed on beans, to the exclusion of all other corn, but they are always given with dry bran—which is necessary to keep the bowels open, and to insure mastication—and for old horses they should be always broken." "There are several varieties of the bean in use as horse-corn; but I do not know that one is better than another. The small plump bean is preferred to the large shrivelled kind. Whichever be used, the bean should be old, sweet, and sound; not mouldy, nor eaten by insects. New beans are indigestible and flatulent; they produce colic, and founder very readily. They should be at least a year old."‡ All kinds are constipating.

1954 According to Einhoff, the field bean is composed of

Water, . . .	15·6
Husk, . . .	10·0
Legumen, albumen, &c., .	11·7
Starch, . . .	50·1
Sugar, . . . }	8·2
Gum, &c., . . . }	
Oil and fat, . . .	?
Salts and loss, . .	4·4
	100·0

"Vaquelin could detect no sugar in it. He and Cornea de Serra found, in the *skins* of the bean, *tannin* striking a blue with the persalts of iron, *animo-vegetable matter* mixed with tannin, insoluble in water, but soluble in potash. The *cotyledons* contained a sweet-tasted substance, starch, legumen, albumen, an uncombined acid, with carbonate of potash, phosphates of lime, magnesia, and iron. The *germen* of the bean contained white tallow, legumen, albumen, phosphate of lime, and iron."§ The legumen of the bean is analogous in substance to the gluten of the wheat.

1955. The composition of the ash of the bean I have already given in (1300,) and the nutritious matter in an acre of beans in (1298.)

1956. The grains of the fecula of the bean "are egg or kidney shaped, often presenting an interior grain, as if enclosed in the principal one. Some of them are broken down and empty. They attain the size of ·002 of an inch."‖

1957. The ancients entertained some curious notions in regard to the bean. The Egyptian priests held it a crime to look at beans, judging

* Lindley's *Vegetable Kingdom*, p. 546-7. † *British Husbandry*, vol ii., p. 215.
‡ Stewart's *Stable Economy*, p. 205-6. § Thomson's *Organic Chemistry,—Vegetables*, p. 887
‖ Raspail's *Organic Chemistry*, p. 116.

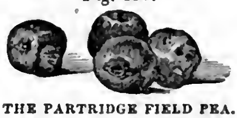
the very sight unclean. But the bean was not every where thus contemned, for Columella notices them in his time as food for peasants, and for them only—

"And herbs they mix with beans for vulgar fare."

"The Roman husbandmen had a religious ceremony respecting beans somewhat remarkable: When they sowed corn of any kind, they took care to bring some beans from the field for good luck's sake, superstitiously thinking that by such means their corn would return home again to them. The Romans carried their superstition still farther, for they thought that beans, mixed with goods offered for sale at the ports, would infallibly bring good luck to the seller." They used beans, however, more rationally, when they were employed "in gathering the votes of the people, and for electing the magistrates. A *white* bean signified absolution, and a *black* one condemnation. From this practice, we imagine, was derived the plan of *black-balling* obnoxious persons."* It would appear, from what Mr Dickson states, that the *faba* of the Romans—a name, by the way, said to be derived from *Haba*, a town of Etruria, where the bean was cultivated—is the same as the small bean of our fields.†

1958. *Pease.*—The pea occupies a similar position, in both the natural and artificial systems of botany, as the bean. The plant is cultivated both in the field and in the garden, and in the latter place to great extent and variety. The *natural* distinction betwixt the field and garden pea is founded in the flower, the field-pea always having a red-coloured, and the garden almost always a white one; at least the exceptions to this mark of distinction are few. The botanical name of the pea is *Pisum sativum*, the cultivated pea; and those varieties cultivated in the field are called in addition *arvense*, and those in the garden *hortense*. The name is said to have been given to it by the Greeks, from a town called Pisa, in Elis, in the neighbourhood of which this pulse was cultivated to great extent: Mr Paxton derives the name from the Celtic word *pis*, the pea, whence the Latin *pisum*.‡ Mr Lawson has described 9 varieties of the field pea; and the Highland and Agricultural Society's Museum contains 14 varieties.§ Of these a late and an early variety are cultivated: the late kind, called the *common gray field-pea*, or *cold-seed*, is suited for strong land in low situations; and the early, the *partridge*, *gray maple*, or *Marlborough pea*, adapted to light soils and late situations, is superseding the old gray Hastings, or *hot-seed* pea. The gray pea is described as having "its pod semi-cylindrical, long, and well filled, often containing from 6 to 8 peas. The ripened straw indicates 3 varieties—one spotted with a bluish green ground, one light blue, and one bluish green without spots." The partridge pea has its "pods broad, and occasionally in pairs, containing from 5 to 7 peas, of a medium size, roundish, and yellowish-brown speckled, with light-coloured eyes. The ripe straw is thick and soft-like, leaves large and broad, and average height 4 feet."|| Fig. 190 shows a group of the partridge field pea of the natural size.

Fig. 190.



THE PARTRIDGE FIELD PEA.

1959. The produce of the pea-crop is either in abundance or a complete failure. In warm weather, with occasional showers, the crop may amount to 48 bushels, and, in cold and wet, it may not reach 12 bushels the acre. The grain weighs 64 lbs. the bushel, and affords 13 grains to 1 drachm; consequently a bushel contains 106,496 peas.

1960. The composition of the pea, according to Braconnet, is this:—

Water,	12·5
Husk,	8·3
Legumen, albumen, &c.,	26·4
Starch,	43·6
Sugar,	2·0
Gum, &c.,	4·0
Oil and fat,	1·2
Salts and loss,	2·0
	100·0 ¶

1961. I have given the composition of the ash of the pea in (1300,) and the nutritive matter in an acre of pease in (1296.)

1962. "The grains of the fecula of the pea are nearly of the same size as those of the bean, and of the form of those of the potato. When fresh, they are as strongly shaded at the edges as those of the bulbs of the *Alstrœmeria pelegrina*. Their surface is unequal. The largest of them is about ·002 of an inch."**

1963. The pea was formerly much cultivated in this country in the field, and even used as food, both in broth and in bread, *pease bannocks* having been a favourite food of the labouring class; but, since the extended culture of the potato, its general use has greatly diminished. It is now chiefly given to horses, and also split for domestic purposes, such as making pea-soup,—a favourite dish with families in winter. Its flour is used to adulterate that of the wheat, and is easily detected by the peculiar smell which it gives out with hot water. Pease-meal in brose is administered in some cases of dyspepsia. Pea-pudding is eaten as an excellent accompaniment to pickled pork. Pea and barley bread is eaten on the Borders by the peasantry. It

* Phillips' *History of Cultivated Vegetables*, vol. i. p. 67-8.
† Dickson's *Husbandry of the Ancients*, vol. ii. p. 182-4.
‡ Paxton's *Botanical Dictionary*, art. *Pisum*. § *Catalogue of the Museum*, p. 68.
|| Lawson's *Agriculturist's Manual*, p. 70.
¶ Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 895.
** Raspail's *Organic Chemistry*, p. 116.

was customary in the country to burn peas in the sheaf, and mix them with butter for supper, under the name of *carlins*. In some towns where ancient customs still linger, roasted peas are sold in winter in the hucksters' stalls. Pigeons are excessively fond of the pea, and I have heard it alleged that they can devour their own weight of them every day.

1964. *Wheat straw.*—Wheat straw is generally long. I have seen it upwards of 6 feet in length in the Carse of Gowrie, and it is always strong, whatever may be its length. Of the two sorts of wheat, white and red, the straw of white wheat is softer, more easily broken by the thrashing-mill and decomposed in the dunghill. Red wheat straw is tough. It is used for stuffing horse-collars. The strength and length of wheat-straw render it useful in thatching, whether houses or stacks. It is yet much employed in England for thatching houses, and perhaps the most beautifully-thatched roofs are in the county of Devon. Since the general use of slates in Scotland, the thatching of houses there with straw has almost fallen into desuetude. Wheat straw makes the best thatching for corn-stacks, its length and straightness insuring safety, neatness, and despatch in the process, in the busy period of securing the fruits of the earth. It forms an admirable bottoming to the littering of every court and hammel of the steading. As litter, wheat straw possesses superior qualities. It is not so suited for fodder, its hardness and length being unfavourable to mastication ; yet I have seen farm-horses very fond of it. Horses in general are fond of a hard bite, and, were wheat straw cut for them by the chaff-cutter, I have no doubt they would prefer it to every other kind of straw. It is imagined that, were wheat straw cut in short lengths, say of 4 inches, it would make not only a more economical litter for stables and courts than long straw, but that the manure derived from it would be more equally decomposed in the soil. Of late years upholsterers have introduced wheat straw as stuffing in mattresses for beds, under the name of *paillasse*, but such a mattress is a miserable substitute for crisp, curled, elastic horse hair.

1965. The *chaff* of wheat does not seem to be relished by any stock, and is therefore strewn on the dunghill, or upon the lairs of the cattle within the sheds. When it ferments, it causes a great heat, and on this account I suppose it would make a valuable ingredient in maintaining a heat around the frames of forcing-pits. The odour arising from wheat straw and chaff fresh thrashed is glutinous.

1966. No analysis has yet been made of wheat-straw and chaff, but the ash of wheat straw has been found to contain the following ingredients :

	Berthier.	Boussingault.	Fromberg.	Mean of the two last.
Potash, }	10·86	9·56	15·52	12·44
Soda, }	...	0·31	...	0·16
Lime,	5·36	8·83	4·58	6·70
Magnesia,	...	5·19	2·45	3·82
Oxide of iron,	2·32	1·04	1·56	1·30
Phosphoric acid,	1·12	3·22	2·92	3·07
Sulphuric acid,	0·44	1·04	10·59	5·82
Chlorine,	2·82	0·62	1·56	1·09
Silica,	77·08	70·19	60·58	65·38
	100·00	100·00	99·76	99·78
Per centage of ash,	4·40	7·00		

1967. The nutritive matter derived from an acre of wheat straw, weighing 3000 lbs., consists of 1500 lbs. of husk or woody fibre ; 900 lbs. of starch, sugar, &c. ; 40 lbs. of gluten, &c. ; 60 lbs. to 100 lbs. of oil or fat ; and 150 lbs. of saline matter.

1968. *Barley straw* is always soft, and has a somewhat clammy feel, and its odour, with its chaff, when new thrashed, is heavy and malt-like. It is relished by no sort of stock as fodder ; on the contrary, it is said to be deleterious to horses, on whom its use is alleged to engender grease in the heels. Barley straw is thus only used as litter, and in this respect it is much inferior to wheat straw, either for cleanliness, durability, or comfort. It does not make a good thatch for stacks, being too soft and difficult to assort in lengths, apt to let through the rain, and rot.

1969. Barley chaff is much relished by cattle of all ages, and, rough as the awns are, they never injure their mouths in mastication. It soon heats in the chaff-house, and, if not removed in the course of two or three days—dependent on the state of the air—decomposition will rapidly ensue. Both barley straw and chaff seem to contain some active principle of fermentation.

1970. The ash of barley straw contains these ingredients:—

	Boussingault.	Sprengel.	Mean.
Potash,	9·20	3·43	6·31
Soda,	0·30	0·92	0·61
Lime,	8·50	10·57	9·53
Magnesia,	5·00	1·45	3·22
Oxide of iron, and a little oxide of manganese,	1·00	0·65	0·83
Alumina,	...	2·78	1·39
Phosphoric acid,	3·10	3·06	3·08
Sulphuric acid,	1·00	2·25	1·63
Chlorine,	0·60	1·33	0·97
Silica,	67·60	73·56	70·58
	96·30	100·00	98·15
Per centage of ash,	7·00	5·24	6·12

1971. The nutritive matter derived from an acre of barley straw weighing 2100 lbs., consists of 1050 lbs. of husk or woody fibre; 630 lbs. of starch, sugar, &c.; 28 lbs. of gluten, &c.; oil or fat ?; and 105 lbs. of saline matter.

1972. *Oat straw.*—This straw is most commonly used as fodder, being considered too valuable to be applied in litter. It makes a sweet soft fodder, and, when new thrashed, its odour is refreshing. It is very clean, raising little or no dust. Sheep are very fond of oat straw, and will prefer it to bad hay; and, even on the threatening of a coming storm, when on turnips, I have seen them prefer it to good hay. Of the different sorts of oat straw, that of the common oats is preferred, being softer, sweeter, and more like hay than that of the potato-oat. When oats are cut a little green, the straw is much improved as fodder, and it has been recommended to be cut green and won, and used like hay, under the name of *oat-hay.** In Holland, oat-straw is built in the hay-stack, and both are cut together and used as fodder by horses and cows.

1973. Oat chaff is not much relished by cattle. It is very clean, and on this account, as well as its elasticity, is very commonly used in the country to fill the tickings of beds, for which purpose the chaff is riddled through an oat-riddle, and the grosser refuse left in the riddle thrown aside.

1974. The composition of the ash of oat straw is as follows:—

	Levi. KURHESS.	Boussingault. ALSACE.	Mean.
Potash,	12·18	26·09	19.14
Soda,	14·69	4·69	9·69
Lime,	7·29	8·84	8·07
Magnesia,	4·58	2·98	3·78
Oxide of iron,	1·41	2·24	1·83
Phosphoric acid,	1·94	3·19	2·56
Sulphuric acid,	2·15	4·37	3·26
Chlorine,	1·50	5·00	3·25
Silica,	54·25	42·60	48·42
	99·99	100·00	100·00
Per centage of ash,		5·10	

1975. The nutritive matter afforded by an acre of oat straw weighing 2700 lbs., is, of husk or woody fibre, 1210 lbs.; of starch, sugar, &c., 950 lbs.; of gluten, &c., 36 lbs.; of oil or fat ?; and of saline matter 175 lbs.

1976. *Rye Straw.*—This straw is always small, hard, and wiry, quite unfit for fodder, and perhaps would make but uncomfortable litter in a stable, though it would no doubt be useful in a court, for laying a durable bottoming for the dunghill; but as it forms most beautiful thatch for houses, of course it would do for stacks, if it were not too expensive an article for the purpose. It is much sought for by saddlers for stuffing collars of posting and coach-horses, and, in want of it, wheat straw is substituted. It is also in great request by brick-makers, who, as stated by a writer, gave as much as £5 per load for it in the neighbourhood of London, in the winter of 1834-5, but for what particular reason is not mentioned.† Its ordinary price is £2 per load. Rye straw is sometimes three or four times as heavy as the grain, which is a remarkable feature in this straw.

1977. The plaiting of rye straw for hats was practised as long ago as the ancient Britons. I have seen very good hats and bonnets for daily use made by field-workers from the upper joint of wheat straw. Bee-hives and *ruskies*—that is, baskets for supplying the sowers with seed—are beautifully and lightly made of rye straw; but where that commodity is scarce, which is usually the case in Scotland, wheat straw is substituted.

1978. The ash of rye straw contains these ingredients:—

	Will and Fresenius.
Potash,	17·36
Soda,	0·31
Lime,	9·06
Magnesia,	2·41
Oxide of iron,	1·36
Phosphoric acid,	3·82
Sulphuric acid,	0·83
Chlorine,	0·46
Silica,	64·50
	100·11
Per centage of ash, about	4·00

1979. The nutritive matter supplied by an acre of rye straw, weighing 4000 lbs., is, of husk or woody fibre, 1800 lbs.; starch, sugar, &c., 1500 lbs.; gluten, &c., 64 lbs.; oil or fat ?; and of saline matter, 160 lbs.

1980. *Pea and Bean Straw, or Haulm.*—It is difficult in some seasons to preserve the straw of the pulse crops, but, when properly preserved, no kind of straw is so great a favourite as fodder with every kind of stock. An ox will eat pease straw as greedily as he will hay; and a horse will chump bean straw with more gusto than ill-made rye-grass hay. Sheep enjoy pease straw much. The product of the pulse crops is considered much too valuable to be given as litter. Since bean chaff is so much relished by cattle, there is little doubt that bean and pea haulm, cut into chaff, would not only be relished, but be economically administered; and were this practice attended to in spring, the hay usually given to horses at that season might be dispensed with on farms which grow beans and pease. It is said that, when work-horses are long kept on bean straw, their wind becomes affected. This may be the effect of new or ill-win bean straw, but I cannot suppose that, when well win, it can have any such effect.

1981. Young cattle are very fond of bean chaff, and, with turnips, thrive well upon it. Cows also relish it much.

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 148.
† *British Husbandry*, vol. ii. p. 170, note.

1982. According to Sprengel, the ash of the straw of the bean and pea contains the following ingredients:—

	Field-bean.	Field-pea.
Potash,	53·08	4·73
Soda,	1·60	...
Lime,	19·99	54·91
Magnesia,	6·69	6·88
Alumina,	0·32	1·21
Oxide of iron,	0·22	0·40
Oxide of manganese,	0·16	0·15
Phosphoric acid,	7·24	4·83
Sulphuric acid,	1·09	6·77
Chlorine,	2·56	0·09
Silica,	7·05	20·03
	100·00	100·00

Per-centage of ash, from 4½ to 6.

1983. The nutritive matter derived from an acre of pease straw, weighing 2700 lbs., consists, of husk or woody fibre, 675 lbs.; starch, sugar, &c., 1200 lbs.; gluten, &c., 350 lbs.; oil or fat, 40 lbs.; and saline matter, 135 lbs.*

1984. 100 lbs. of the *ash* of each of these sorts of straw, gave the following quantities of each of its constituents:—

Constituents.	Wheat Straw.	Farley Straw.	Oat Straw.	Rye Straw.	Bean Straw.	Pease Straw.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Potash,	0½	3½	15	1	53½	4¾
Soda,	0¾	1	a trace	0½	1½	—
Lime,	7	10½	2¾	6	20	54¾
Magnesia,	1	1½	0½	0½	6½	6¾
Alumina,	2¾	3	a trace	} 1	0¼	1¼
Oxide of iron,						0½
Oxide of manganese,	} —	0½	a trace	—	} 0¼	0¼
Sulphuric acid,	1	2	1½	6	1	6¾
Phosphoric acid,	5	3	0¼	2	7¼	4¾
Chlorine,	1	1½	a trace	0¾	2¾	0¼
Silica,	81	73½	80	82¼	7	20
	100	100	100	100	100	100

On comparing these numbers, we cannot fail to remark how large a proportion of potash bean-straw contains; how small a trace of soda exists in all the straws; how large a proportion of lime is in pease straw, compared with bean straw, and with the grain of the pea itself; how large a proportion of silica is in pease straw compared with bean straw; but, on the other hand, how large a proportion of phosphoric acid is in bean straw compared to pease straw.

1985. Of all the different kinds of straw, it appears that wheat, oats, pease, and bean straw are used for fodder, and barley straw is only fit for litter; and where a sufficiency of oat and bean straw exists, wheat straw might be dispensed with for fodder. This being the relative positions of the different kinds of straw, their supply should be so arranged as to prevent the waste of fodder-straw in litter; and this may easily be accomplished by having oat straw in the straw-barn with barley or wheat straw. The procedure should be in this wise: In the early part of winter, the grain chiefly in demand is barley. Barley straw should therefore be supplied, stack after stack, until all the stock, with the exception of the seed-corn, is disposed of. During winter, the corn for the horses should be thrashed, and laid up in granary, and, as common oats are usually given to horses, the straw of them would form the best sort of fodder to be supplied simultaneously with the litter-straw of barley. After the barley is disposed of, towards spring, the demand for wheat commences, and then the wheat straw should come in lieu of barley straw for litter. Farther on in spring, the bean straw comes in lieu of oat straw for fodder. In this way, provision is made both in fodder and litter until the grass is ready for stock.

1986. The colour of the fodder affects that of the dung of the various animals; thus, pease and bean straw and chaff make the dung quite black, wheat straw gives a bleached appearance to the dung of horses, and oat straw a yellow hue.

1987. I don't know that the specific gravity of straw has ever been ascertained by experiment; but I should say, judging by hand, that barley straw is the lightest, and wheat straw the heaviest, not speaking of the weight of rye straw, of which I have no experience. This is the order of the quantity of silica which each kind of straw contains, as seen in (1984,) but this circumstance cannot determine the point, as pease straw contains nearly three times as much silica as bean straw, and yet bean straw is certainly heavier than pea straw.

1988. Such are the kinds, uses, and constitution of the straw usually raised on farms; and the proper management of them, so as to confer the greatest comfort to stock, and procure the largest amount of manure to the farm, is a matter deserving of much consideration. I fear there is too much truth in the observation of Sir John Sinclair, when he says that "the subject of straw is of greater importance than is commonly imagined; and the nature of that article, taken in the aggregate, entitles it to more attention than has hitherto been bestowed upon it. Farmers are apt to consider it as of little or no worth, because it is not usually saleable, and is rarely estimated separately from the yearly produce of the soil. But, though seldom saleable, except in the vicinity of towns, it has an intrinsic value as a fund for manure, and a means of feeding stock." †

1989. The proper management of straw to which I refer is, that the respective kinds shall always be appropriated to their best uses—that is, the straw best adapted for litter shall not be given as fodder, for if it be, the animals will be rendered discontented. If barley-straw, for instance, is put before cattle that have been accustomed to oat-straw, they will not only not eat the

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, pp. 365-79 and 928.

† Sinclair's *Code of Agriculture*, p. 361.

usual quantity of fodder, but will eat the diminished quantity with disrelish. On the other hand, if fodder-straw is strewn about for litter, it is not used to the best advantage, being partly wasted. Again, if more straw is thrashed at a time than can be consumed in a few days in fodder, what of it remains to the last becomes dry and brittle, and unfit for the use of stock; and even litter-straw, if kept for a long time before it is used, becomes much lighter, and loses a portion of its value. So far, therefore, as the straw is concerned, it is bad practice to stack up thrashed straw for a long time, as some farmers seem fond of doing, for certainly some of its properties as fodder or litter are wasted. The plan is, to thrash the straw when and as often as it is required, both for fodder and litter, and it will be always in the freshest state for use in both ways. But to follow out this plan successfully, requires the previous consideration, whether there is a sufficient number of stacks in the stack-yard for the purposes of fodder and litter throughout the season; and if so, those should be selected best suited for each purpose, during the winter, when good straw is most appreciated. The remainder can be used for the inferior purposes of bottoming the courts and stacks of the ensuing crop and season. Should the whole quantity of straw, however, be inadequate to the demands upon it, it should be thrashed only as required, and dealt out with an economical hand, so that no part of the season shall be inadequately supplied. Do these considerations usually engage the attention of farmers? I fear not, and certainly not so much as they deserve. I am aware it may be replied, that it is of greater interest to the farmer to meet the market of grain, than lose the advantage by not thrashing out the straw. Such a necessity may occasionally happen, but, in following it, it behoves him to consider, on the other hand, the probable injury arising to his stock and manure from inattention to the state of the straw? I suspect the subject has received but little consideration in this view of the matter.

1990. At one time it was a prevalent notion that straw could not be converted into good manure unless it were consumed by the cattle and horses; and the celebrated Bakewell carried this idea to such a height, that if he had not stock sufficient of his own to consume all his straw, he took in those of others for the purpose. But he lived to see his error. Opinion changed to the opposite extreme, so much so, that many farmers persuaded themselves that straw *consumed* by stock was wasted, and should only be used for litter. This latter opinion is nearer the truth than the former, but goes beyond the truth; for although it is correct to say that stock ought to *depend* on green crops to fatten them, it is also true that these are much assisted in their assimilation into the animal system by the fodder. The stomach requires to be distended by food, and nothing does so as easily as sweet, dry fodder, and it is an agreeable change to the ox after a hearty meal of turnips. Fattening stock really consume very little fodder; and, when placed before them at pleasure, they pick out a few choice straws sufficient for their purpose. The animals are thus afforded as much liberty of choice in their food as their confined situation will admit. Above all, when prepared food is becoming more and more common on farms, it cannot be prepared in the best manner without chopped straw.

1991. The *value* of straw may be estimated from the quantity usually yielded by the acre, and the price which it realises. Arthur Young estimated the straw yielded by the different crops—but rejecting the weaker soils—at 1 ton 7 cwt., or 3024 lb. per English acre. Mr Middleton estimated the different crops in these proportions :—

	Cwt.		lbs.	
Wheat straw, . .	31	or	3472	per acre.
Barley, „ . .	20		2440	„
Oats, „ . .	25		2800	„
Beans, „ . .	25		2800	„
Pease, „ . .	25		2800	„
Average rather more than	25	or	2862	„

or 1 ton 5 cwt. 62 lbs. per English acre.

1992. Mr Brown, Markle, East Lothian, computed the produce of straw as follows in stones of 22 lbs. per Scotch acre, which I contrast with the imperial :—

	Stones.		lbs.		cwt.	lbs.	
Wheat-straw,	160	or	3520	or	31	48	per Scotch acre.
Barley, „ .	100		2200		19	72	„
Oats, „ .	130		2860		25	60	„
Beans & pease,	130		2860		25	60	„
Average, .	130	or	2860	or	25	60	per „ .

or 1 ton 5 cwt. 60 lbs. per Scotch acre, and 1 ton 0 cwt. 76 lbs. per imperial acre.*

1993. In the immediate vicinity of Edinburgh, the produce, both in Scotch and imperial measures, per acre, is this :—

						Stones.		lbs.		ton.	cwt.	lbs.
Wheat-straw,	9	kemples of	16 st. of	22 lbs.	=	144	or	3168	or	1	8	32
Barley, „	7	„	„	„	=	112		2464		1	2	0
Oat, „	8	„	„	„	=	128		2816		1	5	16
Average,	8	„	„	„	=	128	or	2816	or	1	5	16

or 1 ton 5 cwt. 16 lbs. per Scotch, or 1 ton 0 cwt. 13 lbs. per imperial acre. On comparing this result—from the vicinity of a large town, where a large supply of manure can always be obtained—with Mr Brown's general estimate for the whole country, and finding the quantity less, we must conclude that Mr Brown's estimate is above the mark as an average for the country;

* Sinclair's *Code of Agriculture*, p. 362-3.

and unless the produce of straw be very much greater in England than in Scotland, we must also conclude that the estimates of both Arthur Young and Mr Middleton are above the general average; 1 ton the imperial acre of straw is too high an average for Scotland.

1994. In regard to the market value of straw, it being usually prohibited to be sold except in the vicinity of towns where manure can be received in return, it is only from the price received for it in towns that we can form an estimate of its value. In Edinburgh, the usual price of wheat straw is 12s. per kemple of 16 stones of 22 lbs., or 9d. per stone; and of oat straw, 10s. the kemple, or 7½d. per stone. These quantities are thus contrasted in Scotch and imperial measures:—

Wheat-straw, 144 st. of 22 lbs. at 9d. per st. = £5, 6s. 4d. per Scotch acre, of 10 bolls of 4 bushels, = 10s. 7d. per boll.
Oat, „ 128 „ „ 7½d. „ = £4, 0s. 0d. „ „ 10 bolls of 6 bushels, = 8s. per boll.

Equivalent to

Wheat-straw, 181 st. of 14 lbs. at 5¾d. per st.= £4, 6s. 9d. per imp. acre of 32 bushels, = 2s. 8d. per bushel.
Oat, „ 161 „ „ 4¾d. „ = £3, 4s. 0d. „ „ „ 48 bushels, = 1s. 4d. per bushel.

1995. In those parts of the country where straw, with its corn, is allowed to be sold on foot—that is, as it grows in the field, but prohibited from being sold by itself—the price for wheat straw is 6s. per boll of 4 bushels, and oat straw 5s. per boll of 6 bushels. The quantity of straw per boll and per bushel will stand thus:—

Wheat straw,	14 st.	8 lbs. of 22 lbs. per boll of	4 bushels	= 3 st.	11 lbs. per bushel.
Oat, „	12 „	17 „ „ „	6 „	= 2 „	3 „ „
Equivalent to					
Wheat, „	18 „	1 „ 14 „ „	4 „	= 4 „	7 „ „
Oat, „	16 „	1 „ „ „	6 „	= 2 „	9 „ „

1996. The Romans used straw as litter, as well as fodder, for cattle and sheep They considered millet-straw as the best for cattle, then barley-straw, then wheat-straw. This arrangement is rather against our ideas of the comparative qualities of barley and wheat-straw; but the hot climate of Italy may have rendered the quality of barley straw better, by making it drier and more crisp, and the wheat-straw too hard and dry. The haulm of pulse was considered best for sheep. They sometimes bruised straw on stones before using it as litter, which is analogous to having it cut with the chaff-cutter.

1997. Where straw is scarce, they recommend the gathering of fern, leaves, &c., which is a practice that may be beneficially followed in this country, where opportunity occurs.

1998. Varro says, "it is the opinion of some that straw is called *stramentum*, because it is strewed before the cattle."*

ON THE FORMING OF DUNGHILLS IN WINTER.

1999. Towards the close of winter, the dung will have accumulated so high in the large courts I and K, Plate II, as to become nearly level with the feeding-troughs, thereby making them inconveniently low for the cattle. Before such an inconvenience occurs, the dung should be removed, and formed into dunghills, in the fields intended to be manured in the ensuing season; and the most convenient and proper time to do this is when the frost, snow, or rain, prevents the ploughing of the land. The court K, besides its own litter and the refuse from the corn-barn C, contains the litter of the work-horse stable O, and of all the pig-sties; and the court I only contains its own manure. The dung from the cows' courts *l* and *o'* should also be taken away, to save annoyance to the cows heavy in calf wading in deep litter; but the well-trodden litter in the hammels M and N, seldom becomes inconveniently high.

2000. I am thus particular in detailing the contents of each court, because, being different in their constituent parts, they should be appropriated to the crop most in want of the particular manure. For example, the court K contains a large proportion of stable litter, and not a little from that of the pig-sties; so its contents are somewhat of a different nature from those of the court I, and of the hammels M, which contain nothing but the litter of cattle. If it is desired to raise the crop which thrives best with a large proportion of horse-dung, the court K would supply it; while the court I and the cows' courts *l* and *o'* supply only cow-dung for the crop most suitable for it. Or should the crop

* Dickson's *Husbandry of the Ancients*, vol. ii. p. 407.

require a manure of medium proportion, then the contents of all the courts should be mixed together. The appropriation of dung to the particular crop best suited for it is not so much attended to by farmers as it deserves; and it is not urged by me as a theoretical suggestion, but as practically being the best mode of applying the manure of the farm to raise crops to the best advantage. To make myself more intelligible, I shall suppose that carrots are to be raised on a field of light land; then the land should be dunged in the autumn with a manure such as the contents of the court K, because it contains a large proportion of horse-litter. When potatoes are desired to be raised on heavy soil, which is not their natural one, horse-litter also should be used. Turnips grow best with cow-dung, and therefore the contents of the courts I and *l*, and of the hammels M, would be best for them. Should carrots not be raised, and the soil be naturally favourable to the potato, and therefore horse-dung not be specially wanted, all the different sorts of dung should be mixed together, to form dunghills possessing general properties.

2001. There is another matter which deserves consideration before the courts are begun to be cleared of their contents, which is the position the dunghills should occupy in the field; and this point is determined partly by the form which the surface of the field presents, and partly from the point of access to the field. In considering this point, which is of more importance than it may seem to possess, it should be held as a general rule, that the dunghill should be placed in the field where the horses will have the advantage of going down-hill with the loads from it, when the manure is applied to the land. *Wherever practicable, this rule should never be violated, as facilities afforded to labour in the busy season are of great importance.* If a field has a uniformly sloping surface, the dunghill should be placed at the highest side; but the access to the field may only be at the lowest side, and it may be impracticable to reach the highest side by any road. In such an untoward case, the loads should be taken to the highest side, up a ridge of the field; and frosty weather be chosen to form the dunghill in it, as the cart-wheels and horses' feet will then have firm ground to move on. But if it is impracticable to lead dung there, on account of the continued soft state of the land, or of the steepness of the ascent, the only alternative is to form the dunghill at the side nearest the access. When the field has a round-backed form, the dunghill should be placed on the top of the height, to allow the load to go downhill on both sides of the dunghill; and, to form a proper site for a dunghill in such a case, a headridge should have been formed for it along the crest of the height, at the time the stubble was ploughed. In a level field, it is immaterial which side the dunghill occupies.

2002. The precise spot which a dunghill should occupy in a field is thus not a matter of indifference. I have seen a dunghill placed in the very centre of a field which it was intended wholly to manure. From this point, it is obvious, the carts must either go across every ridge between the one which is being manured and the dunghill, or go direct to a headridge, and thence along it to the ridge to be manured. This latter alternative must be adopted if the dung is to be deposited in drills; and if not, the drills prepared for the dung will be much cut up by the passage of the carts across them—a practice which should never be allowed when neat work is desired. The dunghill should be placed on a head-ridge or a side-ridge of the field; and of these two places I prefer the side-ridge, because the abutting length of every dunghill prevents the ends of all the ridges opposite them being ploughed or drilled to their proper length. The dunghill on a side-ridge curtails only a portion of the single ridge which it occupies. When a field requires two dunghills, the one first to be used should be placed *along a ridge* at such a distance *beyond* the space of ground the manure it contains will just cover, measured from the side of the field from which the manuring is to commence, as that the ridge occupied by the dunghill may be ploughed to its end before it is manured; and the dunghill to be used second should be placed along the farthest side-ridge; but this second-used dunghill should be first formed, being farthest off. Should the weather be fresh and the ground soft, a dunghill should be made on the side-ridge nearest the gateway, and, should no frost occur, this one should be made large enough to manure the whole field. A large dunghill in one place will doubtless take more time to manure the field at the busy season, than two dunghills at different places; but, in soft weather and soil, it is better to incur future inconvenience in good weather, than make the horses drag half-loads axle-deep along a soft headridge. When proper sites can be chosen for dunghills in fields, the loads, in the busy season, will not only have a passage downhill, but the dung will be situate at the shortest distance from the place it is wanted, and the ploughed or drilled land uninjured by cart-wheels and horses' feet.

2003. The fields in which dunghills should be formed, are those to be fallowed in the ensuing season; that is, to grow the green crops, such as potatoes and turnips, and for the bare or summer fallow—if there be any—which depends on the state of the soil, whether it be foul or dirty, or whether or not the land can grow green crops. The potato coming first in order, the land for them should first have its manure carried out and formed into a dunghill. The turnips come next, and, lastly, the bare fallow. All the dunghills should of course be respectively made of such a size as to manure the extent of land to be occupied by each crop. The manure for bare fallow, not being required till much later in the season, may be left untouched in the courts, or made in purpose in summer.

2004. I have already said (in 1086, 1087, and 1088) that the courts ought to be completely littered before being occupied by the cattle: but as no one would believe the care that is requisite in laying down straw in a court, except those who have witnessed the inconvenience and loss of time incurred in removing dung from it, this seems a befitting time to show how the inconvenience does really arise. The courts are usually cleared during frost, when time is erroneously regarded of little value, because the plough is rendered useless; but, notwithstanding this common opinion, a loss of a small portion of time, even at this season, may have a material effect upon several future operations. For example: the hard state of the ground may favour the carriage of manure to a distant field, to gain which, most of the time is spent upon the road. Suppose frost continued as long as to allow time to carry as much manure as would serve the whole field, provided ordinary diligence were used on the road, and no interruption occurred in the courts. Suppose further, on manuring the field in summer, there was found to be less manure in the dunghills, by a small quantity, than was wanted, and that half-a-day, or, at most, a whole day's driving from the steading would have supplied the requisite quantity, it is clear that the one day's driving could have been accomplished in frost at much less trouble than at the season when the manure is wanted. But this sacrifice of time *must* be made at the instant, or the field will be deprived of its due proportion of manure. This is no hypothetical case; it has occurred in every farmer's experience. Now, what is the primary cause of this dilemma? Either too much time had been spent upon the road in driving the manure, or interruption experienced in the courts. To which of these two causes ought the waste of time to be properly attributed? With regard to driving, farm-horses get into so regular a pace upon the farm road at all times, that little loss or gain of time can be calculated on their speed; and besides, when a head of carts is employed at any work, each cart must maintain its position in the order, otherwise it will either be overtaken by the one behind, or be left too far behind by the one before. The probability therefore is, that the loss of time is incurred in the courts, and the reason is this:—The usual mode of taking away the wet litter from the work-horse stable is to roll as much of it together with a graip as one man can lift, and throw it into a barrow, in which it is wheeled into the court, and emptied on any spot to get quit of it in the shortest time, and left in heaps to be trampled down by the cattle. Backloads of thatchings of stacks, not always dry, are carried into the courts, put down any where, and partially spread. Long straw ropes, which bound down the thatching of the stacks, are pulled along the court. In doing all this—and it is not all done at one time—no idea ever enters the head to *facilitate the lifting of the straw* afterwards; and when it is lifted before it becomes short by fermentation, considerable difficulty is experienced in the removal of it. A lump of long, damp straw is seized in one part by a graip, and the other part, being coiled in the heap it was first laid down, cannot be separated without much exertion on the part of the ploughman, pulling it this way and that; and in a court occupied by young cattle, it is too soft to be cut with the dung-knife. Another graip encounters a long straw-rope, which, after much tugging, is broken or pulled out, and thrown upon the cart with its ends dangling down. In short, not a single graipful is easily raised, and the work is not expedited when a heap of chaff evades the grasp of the graip. Add to this the few hands generally sent to assist the ploughman to fill the carts, and the consequent time spent by the team in the court, and some idea may be formed of the causes which wastes much time in this necessary work. It is not that the men are actually idle, for in these circumstances they may be worked very hard, and yet show but a small result for their exertion; but it is easy to conceive that, in this way, much time may be uselessly thrown away, which might have been saved by previous proper arrangement, and as much time lost in clearing all the courts as would have given all the carts a half or whole day's driving, which is just what was required to remove the dilemma experienced in manuring the field. The only effectual method of preventing the recurrence of so great delay in carrying out manure, is to put down the litter so as it may be easily lifted; and to afford as much assistance in the court as to detain the horses only a short time, and keep them constantly on the road: and a constant walk for a short winter day will not fatigue them.

2005. *The litter should be laid down at first, and continued to be so, in this manner.* On fixing on the gate of the court through which the loaded carts should pass to the nearest road to the fields requiring the manure in the ensuing season, and, after covering the ground of the court evenly with straw, as mentioned in (1087,) the litter should be laid above it in small quantities at a time, beginning at the end of the court farthest from that gate. The litter should be spread with the slope of its lower part towards the gate, and carried gradually forward every day until it reaches the gate; and every kind of litter, whether from the work-horse stable, the stack-yard, or straw-barn, should be intermixed and treated in the same manner. The straw-ropes, as I mentioned before, (1722,) should be cut into small pieces, and spread about, and the chaff not fit for fodder sprinkled about, and not laid down in heaps. Thus layer above layer is scattered, until they make a mass of manure of sufficient height to be carried out and formed into dunghills in the fields. Were all the straw for litter cut short with a chaff-cutter, as has been proposed, no precaution would be necessary to spread it about, and the dung would be more easily removed with the graip than the present plan.

2006. When the time has arrived for *emptying the courts*, the process is *begun at the gate* through which the loaded carts are to pass, and the dung first lifted there will come up in sloping layers, having an inclination from the ground to the top of the dung-heap, not in entire layers of the whole depth of the dung heap, but in successive small detached layers, one beside the other, and succeeding one after the other, from the gate to the farther end of the court. The empty carts enter the court by another gate, if there be one, and, without turning, take up their position where the loaded cart was before, and has just passed through the gate appointed for it. When there is only one gate to a court, and the court not very large, and the lot of beasts obliged to be kept in it, for want of room to put them elsewhere, it is better for the empty cart to wait on the outside until the loaded one has gone away. When the court is large, with only one gate, the empty cart should go in, and turn round to be ready to succeed the one being filled. On dropping work at mid-day, it will save time, at starting again after dinner, to fill the first cart returning empty from the field, that has not time to reach it again loaded, and return before dinner-time; and allow it to stand loaded, without the horses, until the time for yoking, when the horses are put to it, and it then forms the first load ready to start for the field immediately at the hour of yoking.

2007. On clearing a court, or any part of it, it should be *cleared to the ground;* because the manure made from a dung-heap that has been simultaneously formed, will be more uniform in its texture than that made from a heap composed entirely of new dry straw on the top, or of old and wet straw at the bottom. Besides, it is much better, for the future comfort of the cattle, that the court receive a fresh dry littering from the bottom, than that the wet bottoming should remain.

2008. Cattle sometimes are injured by a cart or horse when the court is emptying; and, to avoid the risk, they should be confined in the shed as long as the people are at work in the court.

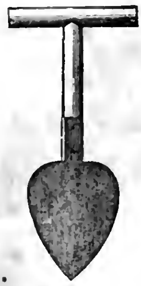
2009. *To form a dunghill in the field requires some art.* A dunghill having a breadth of 15 feet, and of four or five times that length, and of proportionate height, will contain as much manure as should be taken from one spot in manuring a field quickly. Suppose that 15 feet is fixed upon for the width, the first carts should lay their loads down at the nearest end of the future dunghill, in a row across the whole width, and these loads should not be spread very thin. Thus, load after load is laid down in succession upon the ground, maintaining the fixed breadth, and passing over the loads previously laid down. On frosted ground the bottoming is easily formed. After the *bottom* of the dunghill has thus been formed of the desired breadth and length, the further end is made up, by layer after layer, into a gradual slope upwards from the nearest to the farthest extremity. This is done with a view to effecting two purposes; one to afford an easy incline for the loaded carts to ascend, the other to give ease of draught for the horses to move along the dunghill to all parts, to compress it firmly with the carts. Every cart-load laid down above the bottom layer is spread around, in order to mix the different kinds of dung together, and to give a uniform texture to the whole heap of manure. To effect this purpose the better, a field-worker should be employed to spread the loads on the dunghill as they are laid down; the ploughmen being apt to spread it as little as possible. When the centre has reached the height which will enable the dunghill to contain the desired quantity of manure, that height is brought forward towards the nearer end; though the centre will first attain the greatest elevation, as a slope at both *ends* is required—one to allow the carts to take up the requisite quantity of dung from one end, and another to allow them to come easily off at the other end. It is essential to have the whole dunghill equally compressed, with a view to making the manure of similar texture throughout. After the carting is over, the scattered portions of dung around, and the thin extreme ends of the dunghill should be thrown upon the top, and trampled down, and the entire top brought to a level. Such a finishing to a dunghill is very generally neglected.

2010. The *object aimed at by the compression* of the dunghill by the loaded carts, is to *prevent immediate fermentation.* So long as the temperature continues at its average degree in winter of 45°, there is little chance of much activity in the interior of a dunghill; but towards spring, when the temperature increases, it will show symptoms of action; but even then a temperature of 65° is required to begin the second stage of fermentation. The first fermentation only evaporates the water, and the destruction of fibre only commences with the second stage of fermentation.

2011. Covering the dunghill in the field with a thick layer of earth, with a view to exclude the air and check fermentation, is unnecessary in the coldest months of winter, though of service in spring to a dunghill which is not to be immediately turned. A dunghill, made up in a loose manner at once in graipfuls from each cart-load, gives, in effect, the dung a turning, and, when even covered with earth, soon becomes fermented enough for an early crop, such as beans; but if it is not to be used until an advanced period of the season, when the temperature will have increased considerably, the loose dung will ferment too rapidly. The new-made dunghill thus formed should therefore be covered with earth or not, according to the use to be made of it.

2012. The dung in the hammels, and especially in the hammels M, will be found much more compressed than that in the large courts I and K, in consequence of the heavy cattle moving over it so often within a limited space. It is sometimes so compressed as almost to resist the entrance of the graip. To enable it to be easily lifted, it should be cut in parallel divisions with the *dung spade*, fig. 191. This consists of a heart-shaped blade of steel, thinned to a sharp edge along both faces ; and its cross-head, or helve, is fastened to it with nails into a split socket. The height of the spade is 3 feet, length of the cross-head 18 inches, length of the helve 18 inches, and length of the blade 16 inches, its breadth 10 inches. It is sharpened with a scythe-stone. In using this spade, it is raised with both hands by the cross-head, and its point thrust with force into the dung-heap, making a rut across the dunghill. The blade, it will be observed, is heart-shaped, not squared like a common spade, because, when cutting the dung-heap to a greater depth than the length of the blade, the rounded ears escape catching the dung which square ones would, on the blade being drawn up. A man's strength is required to use this spade effectively, a woman's being too weak. Another instrument for cutting dung is like the common hay-knife, and used in like manner, but is not so efficient as this implement.

Fig. 191.



THE DUNG-SPADE.

2013. It is a practice of some farmers to keep the dung from the cow-byres in a loose state in a dung-court, enclosed with a stout wall 3 or 4 feet in height, into which the dung is wheeled as it comes from the byre, on a plank as a roadway for the barrow to ascend, and it is allowed to accumulate to the height of the walls, or even more. The dung never requires turning, and soon becomes in a state fit for potatoes or turnips. This plan saves the trouble of turning the dung, but the dung must be led direct from the court to the field at a season when labour is precious, and, when the field is distant, the extra time spent in taking out the manure may more than counterbalance the cost of turning. This dung may be reserved for a near field, but the nearest may be found to be at an inconvenient distance in the busy season.

2014. Of late years the carting out of dung, as described above, has been objected to, because, as alleged, the gasses useful to vegetation are thereby dissipated. I do not see the force of this objection in winter, when, certainly, no *decomposing* process can naturally originate or proceed in the dung-heap. Water, it is true, may be evaporated at a very low temperature, even below 50°, but what harm can accrue from this? and if dung must be prepared by fermentation for some crop, of what avail is it to prevent fermentation, if the manure is no more than sufficiently prepared when applied ? Of course, *waste* of the materials of the dung-heap should be provided against. To provide against waste from fermentation, it has been suggested to make the dunghills under cover, instead of in the open air, in order to ward off the rain and keep the heap dry, as the rain may dissolve and carry off the soluble salts of the dung. The shed would certainly keep the dunghill dry, and thereby retard its fermentation, but whether the dung would be as good by the treatment, would depend upon circumstances. If the large courts, as also those of the hammels — which are at present open to the air — were covered, so as to prevent the rain falling on the dung-litter, the state of the dung would be the same as that is at present which is made under the sheds of the courts and hammels, and which is avowedly too dry to make good manure, and could never make good manure at all, unless it were mixed with the wet dung-heap of the open courts. To have the dung-litter moist enough by the urine alone of the animals, less litter must be laid down in the courts so covered, than is at present in the open courts. So little straw would then be required to be used in litter, that the dung-litter would be unable to support the weight of the cattle, and their limbs would penetrate through it—a state to which cattle ought not to be subjected. It thus seems to be desirable, for the sake of both cattle and the manure, to use the straw in litter, so as to make the dung-heap as moist as will make good manure, and as firm as will easily and comfortably support the weight of the cattle. Both these requisites cannot be obtained under a covered shed; and if the present mode is really injurious to the manure, the only alternative is to put the cattle under cover, in byres, and manufacture the manure as desired ; but before such a change can be accomplished, the treatment of young cattle in winter, and the plans of steadings, would require to be entirely altered.

2015. It has been made a subject of complaint against farmers, that uncovered courts receive so much rain so to dissolve and carry off a large proportion of the valuable salts contained in the urine and dung of the cattle. This evil, in my opinion, does not arise so much from the want of a cover over the courts, as the want of water-spouts along the eaves of those parts of the steading which immediately border upon the courts. The courts can receive no more rain than falls on their areas, and this, we have seen, (in 654,) does not exceed, during the winter quarter at least, 1·92 inch in depth—a quantity which could easily be absorbed and retained in the litter, were the rain to fall gradually. The roofs of the buildings send down a large proportion of all the rain received in the courts, and they send it down in quantities at a time—a condition which empowers the rain to carry off forcibly a part of the products of the dung. But this result is clearly not attributable to the want of cover to the courts, but the want of spouts to the houses.

2016. But allowing the courts to be, as they generally are, uncovered, and the buildings unsupplied with rain-water spouts, it is still subject for consideration, whether or not the wet dung-litter of the courts should be put under cover, when formed into dunghills, so as to prevent, at the least, the carrying off the products of the dung by the rain that may fall from the time the dunghill is formed until it is used ; whether, in short, the covering of dunghills is practicable in the fields? The object of the cover seems to be entirely to prevent, or at least to retard, the fermentation of the dung-heap, so as the gases forming the constituents of the dung shall not be generated and dissipated in the air, but retained in the dung-heap, and, after being ploughed into the soil, evolved only when wanted by the plants. Could a plan be devised which would give so complete a command over the fermentation of the dung-heap, it would be worthy of adoption by all farmers; but is such a result certain? Let us cogitate on all the particulars required to be provided for the adoption of such a plan. It is easy to erect a shed in every field, but, to answer its purpose, it would require to be constructed of a peculiar form, and in a particular manner. If it is desirable to retard the fermentation of the dung-heap—and the desire to cover it implies that condition—the heap must be compressed, and there is no means so ready of compressing it, as by the weight of the horses and carts. Now a shed, to afford head-room for the depth of the future dunghill, to take horses and carts under it, should be of considerable height, and would be an expensive structure. Were the dung put under the cover without compression—that is, wheeled in barrows by the cart-loads, as laid down by the carts—the dung would in effect receive a complete turning, and be strongly encouraged to fermentation. To avoid this risk, were the dung retained in the courts until the season arrived when the dung ought to be turned, the dung-litter will have accumulated to an inconvenient height in the courts and hammels. To avoid this inconvenience, and to secure the retardation of the fermentation, were the walls and feeding-troughs of the courts and hammels raised so high as to contain the season's dung, the troughs would be placed inconveniently high for the cattle to reach the turnips in the early part of the feeding season. I think all these conflicting circumstances might be compromised in this way : Let the dung be taken out of the courts when the frosty weather permits it, and compressed, as at present, by the carts on one of the side-ridges of the field, and, as long as the cold weather continues, there is very little chance of destructive fermentation occurring. Let a shed be erected in the fence of the field, parallel with the side-ridge of the field, and the dung-heap should be formed along the side of the shed. Let the shed have permanent walls and a permanent roof, and let the sides be made capable of being closed in: and, as to the dimensions of such a shed, suppose the field to be manured contains 25 acres, and allowing 20 cart-loads to the acre, accommodation would require to be made for 500 cubic yards of dung, which contain 13,500 cubic feet.

2017. Now the form of such a shed requires consideration, if we desire to have the manure in its best condition. Mr Rowlandson, of Bootle Village, near Liverpool, has considered this subject practically, and this is his opinion of it:—"The fermentation of manure heaps," he observes, "depending upon the presence of heat, moisture, and the atmosphere, the skilful farmer will avail himself of the means in his power to promote or retard fermentation, by dispensing with or admitting one or other of these agents, as the case may require. This is done in several ways. . . . The free admission of the atmosphere is one of the principal causes of excess of fermentation; and Boussingault, although he does not state this to be the *cause*, admits that 'it is of much importance that the heap be pretty solid, in order to prevent too great a rise of temperature, and too rapid a fermentation, which is always injurious. At Bechelbronn, our dung-heap is so firmly trodden down in the course of its accumulation, by the feet of the workmen, that a loaded waggon, drawn by four horses, can be taken across it without very great difficulty.' Notwithstanding what has just been stated, many able writers on the matter have asserted that tramping down manure is injurious. It is obvious that each party is right according to circumstances. If a manure-heap is required almost for immediate use, nothing is more certain than that a free admission of the atmosphere is necessary, in order to promote free and rapid fermentation; but this is done at the expense of a considerable escape of its volatile contents. On the other hand, if intended to lie for some months, as is frequently the case, pressure, and consequent absence of a great portion of atmospheric air, is advantageous, fermentation being by this means retarded, and generally proceeds more equally throughout the mass. . . . .
By restricting the admission of air, we have a direct command over the fermentation of the manure-heap; and this can only be accomplished by placing the manure in pits. If they have a rough covering, so much the better. The usual shape of a manure-heap is that of a cube or parallelopepidon, each being a figure of six sides, five of which are exposed to the influence of the atmosphere, the bottom only not being surrounded by it. By the pit we shall completely reverse the order, one side, the top, only being exposed to the atmosphere ; and that is also the side, from the altered circumstances of the heap, into which the air will have the greatest difficulty in penetrating. In fact, from the absence of draught from the sides, fresh volumes of air will only penetrate the top by means of pressure. . . . . . The best formed manure, in the

shortest period, that I ever witnessed, was that from the pit belonging to an extensive cart proprietor. In the stable there were usually about thirty horses; the pit was formed in the yard, and covered over with thick planks, part of which was covered over with earth, and paved, only a few boards remaining loose for the convenience of removing the manure, with a trap-door for the purpose of putting the manure into the pit. The yard was roofed in, so that no extraneous moisture could be admitted — so circumstanced that, in summer, the whole of the mass, except the accumulation of the last few days, was converted into a well-fermented workable state in the course of ten days or a fortnight: in winter it took about three weeks to accomplish the same. It might be supposed that serious annoyance would be felt at the escape of ammonia, and that a most extraordinary heat would be generated; but such was not the case. I have been present when such a pit was being emptied, but the heat was not nearly so intense as that frequently observed in ordinary farm-yard heaps; and, unlike the latter, it was not entirely confined to the centre, whilst the sides were comparatively cool, but pervaded the whole mass in an equal degree. No perceptible smell of ammonia was perceived, but a very copious amount of aqueous vapour was evolved in the course of its removal—so much so, that you could not, at times, see the workmen in the pit when removing the manure. . . . . Another advantage to be derived by using pits is, that, in winter, the caloric arising from the fermentation of the heap could not be dissipated so speedily as it is under the present system, when surrounded by a cold, perhaps a frosty atmosphere. It is so well known that manure-heaps formed in winter do not ferment equally, or scarcely at all, that it has given rise to the axiom, that one load of manure formed in summer is worth two formed in winter." * The last observation is a strong argument against turning dung-heaps in winter, and, of course, in favour of keeping them in a compressed state until a short time before the fermented manure is wanted to be applied to the soil.

2018. From what has been stated, and from the circumstances of the case, the construction of a shed for containing the manure-heap, when preparing in the field for laying on the land, should be to have a stone-and-lime wall to support a permanent roof; and, to put the eaves of the roof beyond the reach of the cattle, when grazing in the field in summer, the wall should be 6 feet above the ground. The width of the shed should not be more than what a man can reach across with the graip, when emptying the dung out of it into the carts; and this space may be taken at 10 feet, which width would admit of a cheap roof, in as far as the timber is concerned. To form the shed into a pit, and give scope to fermentation when it is wanted, the dung-heap should be fermented at about 9 feet in thickness, which would cause the pit to be 3 feet below the level of the ground. To enable the floor to keep out water, the shed should be thoroughly drained all round, and the floor should be well puddled to retain the dung water. To contain 13,500 cubic feet of dung in a shed 10 feet wide and 9 feet deep, would require it to be 150 feet in length; but as it would be more convenient to have two sheds, to contain half the quantity at the opposite sides of the field, than the whole quantity in one place, a shed on each side, of 75 feet in length, with the other dimensions given above, would contain all the dung. And, when these sheds were made in the line of the fence, they would be useful to the fields on both sides of them; and, when erected in the angle where 4 fields meet, one shed would serve the purpose of all the fields; and at that point they would be most conveniently placed for using the head-ridges by the carts. A part of the wall in the centre of each side of the shed should be made only 3 feet high and 6 feet wide, to allow the carts to back to and get loaded when the dung was removing to the field. A similar form of shed *h′* may be seen alongside the figure of the liquid-manure tank *k′*, Plate 11.

2019. What I have suggested in regard to the general treatment of the dung-heap seems, therefore, a feasible one—namely, to cart out the dung in winter, and to compress it in a heap by the side of the shed with the carts and horses; and, as the season advances, and the heat may promote fermentation naturally, to wheel the dunghill into the shed to ferment, and where it may be expected to be ready for use in the course of a month or six weeks, according to the temperature of the weather and the material it is composed of, being aware that horse-dung ferments more quickly and actively than cow-dung. The cover of the shed will protect the fermenting mass from rain, and, when the space which allowed the dung to be put into the shed is boarded up, very little free air will find admission into the inside of the shed. Out of such a shed will, of course, cause more trouble to cart away the dung than from the open field; but if the dung is preserved in a better condition in it, the advantage will more than counterbalance the additional expense of taking it out, which is only manual labour.

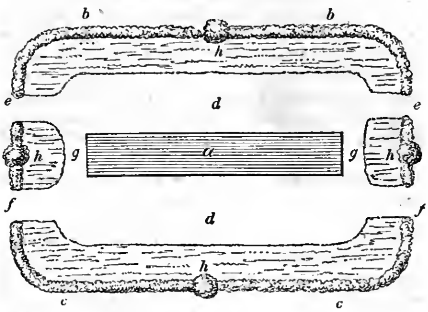
2020. But it may be remarked, that when the dunghill is left in the air, when first formed from the courts, the rain or snow will find their way through it, and injure the quality of its contents by washing away the soluble portions of the dung. No doubt this may take place to a certain degree; but, as long as there is no active fermentation in a dunghill, and it has been well compressed, and covered on the top with earth, or any other material that would ward off rain, the oozing from it will be very small, and, at all events, the loss will not be great. "The amount of my observation," remarks Mr Rowlandson, in the paper quoted above, "that in heaps, as usually formed, with free access to the atmosphere, a larger amount of humic acid, soluble in alkalies, is formed than when the

* *Journal of Agriculture* for October 1845, p. 75-8.

manure is placed in pits, and access of the atmosphere is limited. In the latter case, some humic acid is formed; in both cases, the humic acid is in the same state as that which is found in barren mosses, as I have determined by repeated experiments. The humic acid has a strong affinity to combine with the alkalies, potash, soda, and ammonia, in manure-heaps, and this forms the brown-coloured solution which is observed running from them after rain. It is perfectly obvious, therefore, that every drop of the brown-coloured liquid which oozes from the manure-heap contains, in combination, one or other of the above named alkalies, two of which, potash and ammonia, are of so much importance as fertilisers. The mode I have suggested of placing the manure in pits may be said to remedy this evil, as, at all events, it will prevent the liquid from running away. It is of no importance, however, preserving the liquid of manure-heaps in the state described, as I have repeatedly found that no beneficial effects are derived from the use of it." It will be observed that these remarks apply to the dung-heap in a state of fermentation, but, when not fermenting, the dung-heap, in winter, parts with very little liquid; and, by the time it would part with more, it will have been placed in the shed. All oozing would, of course, be prevented, were the dung placed in the shed at once; but it would be too soon fermented, if not tramped down, and it could not be so by men, as Boussingault practises; as such a mode would be too expensive in this country, and not so effectual as with horse and cart; and, what is still more objectionable, the dung so compressed in such a pit could not be turned for fermentation but with inordinate trouble. The first breadth to be turned would have to be thrown and wheeled out, and again wheeled in to fill up the last breadth; and, in the mean time, every breadth would be turned with much inconvenience and loss of time. I am certain the value of all the oozings lost would never compensate for this additional trouble, and the bad work in the turning; and the oozings, after all, are not entirely lost, as the midden-stance requires no more manure.

2021. As the subject of dung-pits in fields is new in the husbandry of this country, I shall give a figure of one which I think might answer the purpose in any part of the fence of a single field, or in the point of section of two fences in the corners where four fields meet. Fig. 192 is such a place, where *a* is the shed, 80 feet long and 12½ feet broad, over walls, standing either E. and W., or N. and S., whichever is most convenient for the dung to be brought from the steading to the corners of the four fields, of which *b b c c* are each a fence; *d d* are the midden-stances, 18 feet wide each, upon which the dung is first formed, when taken out of the courts early in winter, but, if towards the end of winter, it should be put into the shed at once; the one stance being for the use of the fields *b b*, and the other for that of the fields *c c*. As most of the dung experiences much warmth from a high temperature of the atmosphere, before it is ploughed into the ground, a screen of larch plantation, 12 feet in width, as *h h h h*, may be of use in some seasons, and it may also be of service in

Fig. 192.



A DUNG-PIT FOR FOUR FIELDS.

protecting the outside of the midden from heavy rains from any quarter in winter; *e e* are the slip-gates, 10 feet wide, for taking the dung in and out to the fields *b b*, and *f f* those for the fields *c c*. Of course, the midden-stances *d d* should be firmly causewayed or macadamised. Such an arrangement, shed, stances, and fences, would occupy a space of 134 feet long by 84½ feet broad, or just about a quarter of an acre. The fences of the four fields meet that of the midden-stance at the points *h*; *g g* is a passage for carts at both ends of the shed.

2022. A rather curious and entirely unlooked-for effect took place from the oozings of dunghills in two fields, on the estate of Pumpherston, near Mid-Calder, in the county of Edinburgh, in March 1848. Tile-drains, that had been made in the autumn preceding, were found to be choked in spring, and bursting out water to the day. On opening them, the tiles within a limited space were completely filled with a peculiar substance. The subsoil in one field was gravelly, and the drains three feet deep; that of the other, clay, with drains of twenty inches deep. In both cases the drains leading from a dunghill were only so affected, and the conclusion arrived at was, that the oozings from the dunghills had induced the growth of the substance found in the tiles. The substance was of a dirty gray colour, slimy, tenacious, some pieces of it resembling fragments of skin, but appearing to consist, when pulled asunder, of minute fibres, too fine to be easily observed by the unassisted eye. It had an extremely offensive, putrid, animal odour, having a distinct resemblance to that of cow-dung. It was impregnated with a good deal of earthy matter which long washing with water could not entirely separate. It was pronounced by Dr Greville, the famed cryptogamist, to be a plant—the *Conferva bombycina*—the filaments of which are exceedingly fine, and act as a cobweb in catching and retaining minute insects, larvæ, and floating atoms of inorganic matter in water. These plants grow rapidly, and as rapidly pass into putrescence; and accordingly in this case they had disappeared entirely from the drains in the course of a fortnight after, when I went to witness the singular phenomenon.*

2023. No dunghill, therefore, should be formed above tile-drains, for although in this case the alarming state of the drains was but of short duration, more permanent injury may be experienced by other causes. Any how it is safer to avoid such inconveniences, both by placing the dunghills beyond the reach of drains, and also by making the sites of dunghills impervious to liquids. A side-ridge of a field is the safest place, and, when the dung is put into a pit, it is quite out of the way of doing harm.

2024. The dung from a cow-byre placed in a covered pit, direct from the byre, will, I have no doubt, remain a long time, after the arrival of warm temperature, unsusceptible of fermentation; and it is most probably from this property that it has received the character of being a *cold* manure; whereas horse-dung easily ferments, and goes rapidly through all the stages of fermentation to that of the destructive, which is technically called *fire-fanging*, and on this account it has received the character of being a *hot* manure. Both mixed together form a valuable manure, especially when the cow-dung bears the largest proportion.

2025. The hot nature of horse-dung, and its rapidity of fermentation, are supposed partly to arise from its containing more nitrogenous matter than cow-dung; but, according to the analyses afforded by Boussingault, it would seem, at first sight at least, that such an opinion is not well-founded. The analyses are :—

	Fresh dung.		Dry dung.	
	Cow.	Horse.	Cow.	Horse.
Water, .	90·60	75·31	——	——
Nitrogen, .	0·22	0·54	2·3	2·2
Saline matter,	1·13	4·02	12·0	16·3

"From these analyses," remarks Professor Johnston, "it appears that, though recent cow-dung contains more water than horse-dung, yet the dry matter of the former is richer in nitrogen than that of the latter. Were this generally the case, it ought, one would suppose, after becoming a little drier, to ferment, or be as warm as horse-dung. However this may be, the two circumstances—that the nitrogen of the food is discharged chiefly in the urine, and that the cow voids a much larger quantity of urine than the horse—incline me to believe that cow-dung must *generally* contain less nitrogen than that of the horse, and that this is really the cause of its greater coldness. The correctness of this opinion can only be tested by a series of careful analyses. At the same time it is proper to add, that the peculiar state of combination in which the nitrogen exists in two bodies, supposing the proportion in both to be the same, may modify very much the rapidity of the decomposition they respectively undergo in the same circumstances."

2026 "Though fermenting with such apparent slowness, fresh cow-dung undergoes in forty days a loss of one-fifth of its solid matter, (Gazzeri.) Though this result was observed in Italy, yet there is sufficient loss in our climate also to make it worth the while of an economical farmer to get his cow-dung early in heaps, and to shelter it as much as possible from the sun and air."

2027. "Even when fed on the same food, the dung of the horse should be richer than that of the cow, because of the large quantity of urine the latter animal is in the habit of voiding. In the short period of twenty-four hours, horse-dung heats, and begins to suffer by fermentation. If left in a heap for two or three weeks, scarcely seven-tenths of its original weight will remain. Hence the propriety of early removing it from the stable, and of mixing it as soon as possible with some other material by which the volatile substances given off (much ammonia) may be absorbed and arrested." Here is a strong motive for cleaning out the work-horse stable every day, and of spreading the litter from it over the face of the cattle-court, so as it may be intimately mixed with their litter and dung, and also of tramping a dunghill firmly (2005.)

2028. "Pigs' dung is still colder and less fermentable than that of the cow. . . . A specimen examined by Boussingault was found to contain per cent.

	Recent.	Dry.
Water, . .	81·00	——
Nitrogen, . .	0·63	3·37

being richer in nitrogen even than horse-dung." My experience determines pigs' dung to be hot, and excellent; and this was also the opinion of the ancients, as the Quintilli remarked, that "the dung of hogs being of superior goodness, is improper for corn-fields, on account of its abundant heat, for it instantly burns corn grounds."†

2029. "Sheep's dung is a rich dry manure, which ferments more readily than that of the cow, but less so than that of the horse. Boussingault found a specimen to consist of—

	Recent.	Dry.	
Water, .	63·0	—	per cent.
Nitrogen, .	1·11	1·99	

The food of the sheep is more finely masticated than that of the cow, and its dung contains a little less water, and is richer in nitrogen; hence, probably, its more rapid fermentation."‡

2030. An ingenious suggestion has been made by Mr Kirk, Preston Mains, East Lothian, to *check the spread of the seeds of weeds amongst manure.* His suggestion is founded on the general law of the growth of plants, that certain classes of soils produce certain classes of plants. This law I have endeavoured to illustrate very fully from (382 to 435.) The suggestion is, to put the manure of the straw obtained from one kind of soil on to another. Thus, the straw

* *Transactions of the Highland and Agricultural Society* for July 1848, p. 278-9.
† Owen's *Geoponika*, vol. i. p 68.
‡ Johnston's *Lectures on Agricultural Chemistry*, 2d ed. p. 821-2.

obtained from clay soil, that is wheat land, when made into manure, should be applied to light soil—that is, turnip soil; and as, according to this law, natural plants, called by farmers weeds, which thrive upon the clay soil, would not thrive upon the light, it appears to be within the power of the farmer to prevent, or at least to check, the propagation of weeds by seed. Putting this suggestion into practice would be attended with some difficulty; for although Mr Kirk seems to think it is easy "to make all the straw grown on one kind of soil into manure by itself," and which, he conceives, "might be accomplished with very little additional trouble to the farmer, where several hammels are employed in the feeding of cattle,"* yet in large courts it would be almost impracticable to prevent the mixture of straw of a stack from clay land with that from light land; and it would be as difficult to devise a plan by which the straw off clay land should be used in the small courts of the hammels, while that from a light soil was in use for litter in the large courts. Besides all this, the best fodder being obtained from light land, the cattle, while using it, could not be littered with straw from clay land, without running the risk of destroying the object in view. The suggestion, however, being founded on correct theory, might be subjected to *experiment*, which alone can devise a plan for carrying it out into practice. But would it not be better to have the land so clean, as that no seeds of weeds shall be carried from it with the straw of the crops?

2031. Mr John Hannam, in his interesting little memoir on the economy of waste manures, says—"Should the farmer *be compelled* to form a manure-heap in the field, I would advise him by no means to carry it to the field fresh, and to let it decompose there, as is generally the case, before he uses it;" implying that, whenever dung-litter is carried to the field, it must necessarily decompose there. This is by no means a necessary consequence, as it is nearly impossible for fresh dung-litter to ferment anywhere in winter, when tramped hard with carts and horses. Were it shaken up loose and moistened, in order to encourage fermentation with the first increase of atmospheric temperature, a slight decomposition might soon be induced, which would afterwards become active; but such a result would not occur if the dung were compressed into a firm state by adequate means.

2032. He further advises, "before he takes it from the couch, he should have it nearly as rotten as he wishes it to be. He should wet it well with the drainings, and, when he carries it to the field, cover it up with road scrapings, earth, &c. At the bottom of the heap, too, there should be a good bed of earthy matter laid. In this way the manure will come out for use almost as fresh as when put in, the atmosphere having had no access, and the earth at the bottom and on the top absorbing the liquid and gaseous matters that would otherwise have escaped." Without dwelling upon the inconsistency involved in the instruction, that "before he takes it from the couch, he should have it nearly as *rotten* as he wishes it to be," with the assertion that "when he carries it to the field, covers it up with road-scrapings, earth, &c., the manure will come out for *use* almost as *fresh* as when put in, the atmosphere having had no access, &c.," only conceive the labour implied in all this treatment of the manure, and consider how the horses and men are to accomplish it in the course of a season. There is first the taking the dung from the courts, the byres, and the hammels, to the shed at the liquid-manure tank, there to be well watered with the drainings, and fermented so as to be as rotten as is desirable; then the carting to the field in which it is to be used, and there made into a heap, not upon the ground as it is, but upon a previously constructed "good bed of earthy matter," which of course must have been brought into the field; for if made of its own soil, no advantage would accrue to the field; and lastly, the dung has to be laid on the field. On the supposition that all the dung of a farm is to be treated in this manner before it is considered ready for use, the extent of shed-room at the liquid-manure tank must be very great, and the supply of liquid manure to "well water" such a mass of dung very large; but when the men and horses are to find time to cart out thrice all the dung thus treated before it is laid upon the land, is more than I can conjecture.

2033. Mr Hannam thus expresses his strictures on the treatment the farm-yard manure usually receives from the hands of farmers:—"Again, is it an uncommon case for us to see hundreds of tons of rich farm manure, and vegetable matter, undergoing rapid decomposition in the fields, and so exposed to the alternations of weather—to the storms of winter, and the sun and showers of spring—that the principal portion of the liquid and gaseous fertilisers it contains must 'run or fly away' before the manure is used?" Surely this is the language of exaggeration, for no "rapid decomposition" can take place in dung among "the storms of winter;" and as few "gaseous fertilisers" can "fly away" in "the sun and showers of spring," the heat of early summer being required to produce either result in a mass constituted as farm-yard manure generally is; and as to "the principal portion of the liquid" "running away" "in the fields," the earth that receives it will surely derive as much benefit from it, as the "bed of earthy matter" below the heap, and the "road-scrapings" above it, both recommended to be formed to receive this very liquid.

2034. Strictures apply with more truth, and will come more forcibly home, and likely be more attended to, when thus expressed,—"How seldom are the stores of vegetable, animal, and other matters useful to vegetation, which observation may discover and industry collect on many farms, made use of." †

2035. It is easy to refer to the practice of other countries, and exhibit it as a pattern to our

* *Quarterly Journal of Agriculture*, vol. viii. p. 485.
† Hannam *On the Economy of Waste Manures*, p. 59-62.

farmers; but before the advice will be taken, or the admonition listened to, it will be necessary for him who admonishes to show that dissimilar motives induce the adoption of the same practice in different countries,—a proposition which will be found difficult to solve ; and yet the proposal to adopt certain foreign practices in our country would be as difficult to practise if proposed in plain terms ; for the *motive* of the Fleming, the German, and the Swiss farmer, in applying liquid manure to their crops in summer, is to counteract the injurious effects of the ordinary heat and drought which are experienced by them in that season; and, in order to possess liquid manure for that purpose, all the live-stock in Germany and Flanders, and part of those in Switzerland, are kept constantly in the house; and further, to provide abundance of food for the stock, when so confined, much industry is exerted to raise forage in those countries in summer. The same summer heat and drought stint the growth of the straw of their cereal crops.

2036. Now, no such *motive* exists in this country, and therefore it is, and for no other reason—for depend upon it, where an intelligent people perceive an advantage, they will, ere long, use the means of obtaining it—the Continental practice does not prevail here. In ordinary years, we do not need to counteract the baleful effects of drought in summer, that season being no more than hot enough, and therefore our green crops, and the straw of our cereal ones, grow luxuriantly; and as the same cause encourages the growth of perennial grasses, our cattle, instead of being confined in the house all summer, are put out to pasture on them, very much to the saving of labour; and this difference in the climates is sufficient to explain our apparent want of industry, when compared with the constant toil imposed by their climate upon the agricultural population of Germany, Belgium, and Switzerland, who are observed by travellers working in the fields from early dawn to sunset; and whose patient industry, thus displayed, is very naturally the theme of much of the laudation which has been bestowed upon them by observers, who look no farther than on the surface of things.

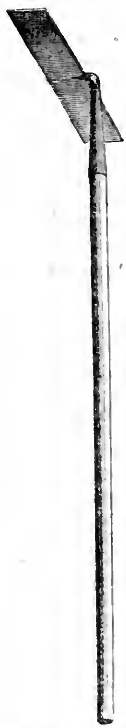
ON THE FORMING OF COMPOSTS IN WINTER.

2037. Although winter is not the season to expect a quick fermentation to arise among the materials composing a compost dunghill, or *midden*, as it is technically termed in Scotland—being the corresponding phrase to the English *mixen*—it is a favourable time for collecting those materials together in convenient places, and mixing them in their proper relative proportions.

2038. There are many materials which may be collected at the very commencement of winter—such as the quicken or couch grass collected in the fields, while preparing them for the green crops of last year; the dried potato haulms collected on raising the potato ; the scourings of ditches, and the weeds destroyed during summer; the dried leaves that may have fallen in the end of autumn; any moss or turf that may be available on the farm; and any vegetable matter whatsoever.

2039. Immediately after a rainy day, when the land is in such a state of wetness as to prevent work being done upon it, and the horses have nothing particular to do, two or three of the men should each take a *mud hoe* or *harle*, such as fig. 193, and rake the loose straws and liquid mud on all the roads around the steading to the lowest side of the roads, and as much as possible out of the way of carts and people passing along; while the rest should take graips and shovels, and form the raked matter into heaps, to be led away, when it will bear lifting, to the compost-heap. The best state for the roads near the steading in winter, is to have a *hard* and *smooth* surface, and this they will have, with an inclination that causes the water to run easily into a ditch hard by. A scraping now and then with the mud hoe will make such a road dry and comfortable, even in winter.

Fig. 193.



THE MUD HOE OR HARLE.

2040. Where there is plenty of straw, as on clay farms, some farmers put it upon the roads around the steading, to trample it down and wet it with rain, and then lead it to the dunghill in the field. The object aimed at of wetting the straw is attained, but such a littering makes the roads very damp and plashy.

2041. The carriage of *mould*, as the

principal ingredient of a compost, is laborious work. With such, a compost is best made on the spot where the soil is found; but when the foundation of a new building or wall affords mould which must be removed at any rate, it should be used in compost, and will repay the trouble of removal. Other materials than mould may, and indeed must, be carried, to form bases when composts are formed; such as sawdust, spent tanners' bark, rape-cake, and refuse of manufactures of sundry kinds. Lime must also be brought to mix with some of them, and without it few composts will be made useful. The refuse productions of the farm must also be carried to the same convenient places.

2042. On laying down the haulms of potatoes or twitch for compost, it is usual to throw down the loads in the corner of the field or elsewhere, without the least regard to order; and the excuse is, that when the potato crop is taking up, every hand is too busily employed to attend to such unimportant things. The potato crop and the weeds ought to be gathered in a proper manner; but that is no reason why the refuse created by them should be mismanaged, and cause future labour and expense. Instead of throwing down the potato stems and twitch any how, a field-labourer should be stationed at the compost-stance, wherever it is, and throw them with a graip into a heap of regular form, when the materials will not only occupy the least space of ground, but be in the best state to receive any additions of liquid or solid matter, and then the most perishable portions of the materials might be covered with the more durable, and placed in the best state to preserve their properties. The neglect I complain of—of apparently unimportant materials—arises from this cause. There is a strong tendency in farmers and stewards, when conducting any labour in the fields, to do what they consider the least important part of the work in haste,—unthinkingly forgetting that correction of hasty work often creates more trouble than the portion of the work for which it was neglected is probably worth. Many instances might be given of *two-handed work* occasioned by such haste. For example, were a field-worker or two placed where the haulms of the potatoes are carried to form a future compost-heap, they would form the heap according to instructions previously received, as the cart-loads are laid down; and as soon as the carriage of the refuse was finished, so would also be the formation of the nucleus of the future compost-heap. But when the haulms are laid down at random by ploughmen anxious to get quit of their loads, considerably more labour will be required to make them into the same form of heap, and the work in the end will not be so well done. Thus, one woman with a light graip will form a heap of as much loose material laid before her in a small quantity at one time, as 3 or 4 women could do the same work, with the same quantity of matter scattered confusedly about. The additional trouble and expense in putting together materials thrown down and scattered, is no saving in the end.

2043. The subject of composts, when followed out in all its bearings, is an extensive one,—for there is not a single article of refuse on a farm but what may form an ingredient of a compost, and be converted into a manure fit for one or more of the cultivated crops. At the same time, great labour attends the formation of composts of every kind, as the materials cannot be collected together without horse-labour; and in summer the labours of the field are most important, when those materials are most abundant; and to employ then the time required to collect them, would be to sacrifice part of the time that should be occupied in indispensable field-labour. The most economical mode of forming composts is to collect the materials at times when leisure occurs, and put them together in compost-heaps, as they are brought in quantities to the compost-stance. This advice will not suit the temper of those who, wishing to obtain their object at once, would make the forming of composts a principal business; but every piece of work should have its legitimate period for its execution. I speak in this matter from experience, and, having been impressed with the utility of composts, and possessing abundance of materials at my command for making what I conceived should be good manure, I persuaded myself that composts might be made to any extent on a farm. Having access to rough bog-turf and peat, dry leaves, black mould, quicken, potato haulms, shell marl, fine clay, and lime-shells, I was favourably situated for making composts. But little did I anticipate the labour I had undertaken. Two years convinced me that it was no child's play to collect together these materials into one or two places, and cart them out again to the fields destined to receive them in the amended form. The labour is not to be overtaken with the ordinary strength of a farm, and, if done in a systematic manner, must be so with men and horses appointed for the purpose, or it should be done when leisure warrants the undertaking. I put together the materials in the best manner I could devise or hear of, turned them at proper times with the greatest care, and enjoyed the satisfaction of possessing a large quantity of good stuff, —and I invariably found that the oldest made compost looked richest, most uniform in its texture, and most active in its effects, and most like old rotten muck; but, notwithstanding its favourable appearance, unless very large quantities were applied, little benefit was derived from it—so that even from 40 to 50 cart-loads to the imperial acre did not produce so good an effect as 12 cart-loads of good muck. I managed the manual part easily, as labourers undertook it by piece-work; but the horse-labour was overpowering, for every acre thus imposed a cartage of 80 to 100 loads, to manure it even insufficiently. An extra pair of horses and a man could not have overtaken the additional labour, and to incur such an expense for the problematical good to be derived from composts above guano or bone-dust, which are easily carried, is more than the most sanguine farmer is warranted in believing.

2044. I may relate a few of the composts I made with those materials. The first was a compound of peat-turf and lime-shells. The turf was wheeled to the margin of the bog on hard land, and allowed to lie some weeks, to drip the water out of it, and to make it lighter for cartage. The lime was mixed in the proportion of 1 cart of lime to 27 of turf. After the compound was twice turned, the mass became a fine greasy pulp, in the course of a few weeks in spring and the early part of summer, so greasy, that no one could walk on it without slipping. It was applied to good turnip land, to raise turnips, and the rule adopted to determine the quantity requisite for an acre was, in the first place, to fill the drills with it, and the quantity required to do this was from 30 to 40 double cart-loads per acre. The crop of white turnips was only tolerable, and certainly not nearly equal to what was raised in the same field with 12 loads of farm-yard dung, while the field became troublesomely covered with the bog-thistle, as also the common field-thistle, and a few of the burr-thistle, the lime not having been in sufficient quantity to destroy the vitality of the thistle-seed contained in the turf, though the degree of heat created in the mass to reduce it to a pulp was considerable. The proportion of the lime ought to have been about 1 load to 3 of turfy peat.

2045. Another compost was made of peat-turf and farm-yard dung, with a sprinkling of lime, as directed by the late Lord Meadowbank in his celebrated treatise on that subject, and which you may consult.* The effect produced from this was better than the former compost, but still not equal to the usual quantity of dung.

2046. A mixture of lime and black mould, made on head-ridges upon which too much earth had accumulated, was applied before the land was drilled up and dunged for turnips, only to thicken the soil; and the labour was not thrown away. The lime, however, ought to have been in the proportion of 1 of lime to 3 of mould.

2047. I tried a compost of rape-cake and mould, the broken cake being sprinkled on while the earth was turning over, and a very brisk fermentation was produced in the mass. After the heat had nearly subsided, it was applied for turnips, with much success. Unfortunately, no account was taken of the exact number of cart-loads per acre of this or any of the other composts applied, such particulars being then seldom noted by farmers, who chiefly supplied the quantity of manure by judgment. Now, however, a better system prevails, when every particular application is weighed or measured with exactness.

* Meadowbank's *Directions for preparing Manure from Peat*, p. 19, 3d edition in 1842.

2048. Shell-marl and bog-turf, when mixed, produced no heat, and of course were not reduced into a uniform mass, for without the agency of heat it is impossible to make any compost homogeneous.

2049. Bog-turf burnt produced ashes which varied much in their specific gravities; those of white colour being light and ineffective as a manure, whilst the red coloured were heavy, earthy in appearance, and well suited to raise turnips; but I was unable to distinguish beforehand which turf would yield the white and which the red ashes. The trouble attending the casting of bog-turf, wheeling it to the side, exposing it to the air to dry, and afterwards burning it to ashes, or carting it away for compost, was much greater than the quantity of ashes or the quality of the compost obtained would compensate.

2050. Two years' labour with the concoction of these materials were sufficient to give me a distaste for the business, and at length I dropped it, and went to the neighbouring towns to purchase street, stable, or cow-house manure, and bone-dust. These never disappointed me, and the eating off the turnips, which they raised every year, with sheep, soon put the soil into a fertile state.

2051. Notwithstanding this resolution, I made a point every year of making up a large compost-heap of the twitch gathered from the fallow land, while it was preparing for the turnips,—of the potato haulms, as they were harrowed together,—and of the dried leaves, which would otherwise have blown about the lawn and shrubberies, and of any other refuse that could be collected together on the farm. These, with the assistance of a little fresh horse-dung, and of such water as the liquid-manure tank, which was situate in the compost-court, afforded, formed a compost which assisted in extending the boundaries of the turnip crop; and if that portion of the crop was not always the heaviest, the larger proportion of the turnips growing on it, being eaten off by the sheep, enabled it to produce its share of the succeeding corn crop and grass, while the soil was deepened by the mould obtained from the compost.

2052. Animals that fall by disease, when their carcasses are subdivided, and mixed with a large quantity of earth, make a compost far superior to vegetable materials, for raising turnips, especially swedes.

2053. The produce of privies, pigeons' dung, the dung of fowls, form excellent ingredients for dissolving in the liquid manure in the tank, and afterwards mixing with a compost-heap.

2054. Of late years, sawdust, long considered a useless article as a manure, and which may be obtained in quantity where saw-mills are at work, is now made useful on being mixed with farm-yard dung, fermented to a considerable degree of heat, and then subdued with water;* or mixed with one-tenth of its proportion with lime and road scrapings, and kept in compost for 3 years.† Such composts have raised turnips, as evidenced by the experience of Mr William Sim, Drummond, Inverness-shire, and Mr H. H. Drummond of Blair-Drummond, Perthshire.

2055. Spent tanner's-bark, when laid for a time on the road around the steading, and trampled under foot and bruised by cart-wheels, and formed into a compost with dung or lime, and allowed to stand a considerable time, is rendered a good manure for turnips. Sawdust, tanner's-bark, and the refuse of the bark of fir-trees, will not bear the expense of a long carriage; but where a supply of them is at hand, their decomposition, though slow, is worth the trouble, because their effect is durable.

2056. In the vicinity of villages where fish are cured and smoked for market, refuse of fish heads and guts make an excellent compost with earth. Near Eyemouth and Burnmouth, on the Berwickshire coast, 30 barrels of fish refuse, with as much earth from the head-ridges as will completely cover the heap, are sufficient for an imperial acre. The barrel contains 30 gallons, and 4 barrels make a cart-

* *Prize Essays of the Highland and Agricultural Society*, vol. xii. p. 529. † *Ibid.* vol. xiii. p. 274

load, and the barrel sells for 1s. 6d. From 400 to 600 barrels may be obtained for each farm in the neighbourhood, in the course of the season. Since the opening of the North British railway, the curing of the fish is given up, much to the loss of the farmers in that locality; and the fishermen now send, by the railway, the fish in a fresh state to the larger towns at a distance. Thus, railways produce advantage to some, whilst they cause loss to others. In the northern counties of Scotland, fish refuse is obtained in large quantities, during the herring fishing season. On the coast of Cornwall, the pilchard fishing affords a large supply of refuse for composts.

2057. Whale-blubber mixed with earth forms a good compost for turnips. This most caustic substance, in a fresh state, should be mixed with a large proportion of earth, and the compost kept for at least 3 years. I have seen a blubber compost, 2 years old, on top-dressing grass, burn up every plant by the roots.

2058. I have heard of a compost of whin and broom cuttings and earth, 3 loads of earth to 1 of the cuttings, mixed and watered for 2 or 3 days, and remaining untouched for 8 or 10 more, when turned, and again allowed to rest for other 10 days, become a fit compost for wheat or oats. The cost of making this compost was estimated at 2s. per cart-load.

2059. "Whilst fallowing a field," observes Mr Rowlandson, "overrun with weeds, twitch, &c., I had the weeds, after being well harrowed, carted to the yard, and placed between 2 layers of fresh horse-manure. As it was my intention to apply the whole as manure to potatoes, I thought it would be advantageous to throw a little nitrate of soda on the weeds, &c. This was done, and a strong fermentation took place; and the whole of the weeds were converted, in the course of 10 days, into a rich black mass. All the work-people attributed this to the *saltpetre*, as they called it, being used. I am inclined to think that the heat generated by the horse-manure caused the weeds rapidly to decompose; and as matter in a state of decay has the property of absorbing oxygen from all other matters with which they come in contact, it is probable that a portion of the nitric acid of the nitrate of soda was decomposed. A very heavy shower of rain fell between the time of mixing the weeds, &c., and the period of removing them to the fields; and I never remembered such a quantity of deep-coloured fluid to exude from so small a mass of manure, evincing that a great quantity of humic acid had been formed, which was probably combined with the soda of the nitrate and ammonia of the decomposed horse-manure, and, not improbably, with the ammonia formed by the decomposition of the nitric acid." *

2060. The solid refuse of manufactures may all be made available for composts; such as the soiled substances from woollen waste,—shoddy, consisting of the short ends and refuse of wool,—croppings, the ends of wool cut off the surface of cloth and merino fabrics,—sweepings, the short dust separated from the wool,—and singeing-dust, obtained on stuff goods being passed quickly over flames of gas; as also flax-waste, obtained from the manufacture of flax, and soap-boilers' refuse, all which, when combined with earth, moistened with liquids, and fermented, form active composts for green and grain crops.

2061. Of the liquid refuse of manufactures—such as the liquid soap-waste, coal-tar, gas-lime, ammoniacal liquor, sugar-refiners' refuse—a compost might be made with earth, or peat, or turf, or any substance which will absorb them, and may be applied to grass land and growing crops as top-dressings with success, after they have undergone active fermentation.†

ON THE CONSTRUCTION OF LIQUID-MANURE TANKS, AND CARTS.

2062. The site of the liquid manure tank, in reference to the steading, may be seen at *k'*, Plate II. It is placed in an enclosed piece of ground near the steading, and at a lower level, in order to have the drains to it as short as possible, that

* *Journal of Agriculture* for October 1845, p. 78.

‡ Hannam *on the Economy of Waste Manures*, p. 78-96.

so thick a substance as liquid manure might pass easily in them to the tank. The drains are seen to run in straight lines from the tank to each suite of courts, such as directly into each of the large courts I and K, to the courts of the byres Q and Y, and to the ends of the hammels M and N, along the middle of which run the drains in connexion with those from the tank. The drains are built in the form given in fig. 72, and at the hollowest point of each court, great and small, is a grating, like fig. 71, placed over the drain to receive the drainage from the dung-litter, when an excess of moisture occurs beyond what the straw can retain.

2063. Tanks are not required on every kind of farm. On *carse-farms*, where much straw and little green food is used, there can be no liquid manure; and on *pastoral-farms*, the stock confined in winter in the steading are too limited in number to afford much of that material. On *dairy-farms*, on the other hand, where many cows are maintained, and much green food consumed by them in byres, tanks should be constructed for the advantage of the grass land. The practice of the farmers of Flanders might be usefully followed on all small dairy-farms, by constructing a small tank under ground in every byre, the contents of which might be enriched with rape-cake and other valuable ingredients. These enriched contents, employed as a top-dressing on pasture and forage land, would increase their produce, for the support of the cows, very considerably. A tank to a dairy-farm seems, therefore, indispensable, and it should be of large dimensions, to meet any enlargement of the dairy. On *farms of mixed husbandry*, if the steading is furnished with rain-water spouts, and the stock well supplied with litter, I do not see that much liquid manure can be collected. I had a circular tank of 12 feet in diameter and 4 feet deep, connected with well-planned courts by neatly-built drains provided with good gratings, and the courts were defended from being deluged with rain water by capacious rain-water spouts, and care taken that the cattle were always provided with a sufficient quantity of litter—with all which accommodations every well constructed steading should be supplied. The tank was not filled in the course of the season above three times—a quantity not worth while providing a liquid-manure cart to take it to the field; and even this small quantity was solely derivable from heavy rains and melting snows for a few days falling directly into the courts, and causing a surplus of water, which was readily conveyed into the tank by the drains. The ordinary supply of the liquid manure was merely a few drops from the sole of the drain into which all the other drains merged. The sole of this drain was only 4 feet above the bottom of the tank, and, except after rain or snow, the liquid manure never reached that height. Still, wherever cattle are housed and fed in large numbers on turnips, a tank should be constructed with drains, to keep the courts comfortably dry.

2064. There are several circumstances to be taken into consideration, before proceeding to construct a tank for liquid manure. When a tank is made deep, such as a well, the building of the lower part will require to be particularly strong, to resist the hydrostatic pressure of the fluid within it, and, of course, will be so much the more expensive in construction. A tank should therefore be shallow, not deeper than four or five feet below the sole of the drains which bring the liquid manure. It is very desirable to have the tank covered, for the sake of protection against accidents, and against undue action of the atmosphere upon the liquid. The most durable covering is an arch; and, to keep the cost of that within bounds, the tank should be narrow, not exceeding six feet. The desired capacity of a tank will thus be attainable by extending its length. A tank should neither let in nor let out liquid. To prevent its letting in water, a drain should be formed where there is the least appearance of it in oozings or a spring: and to prevent the liquid getting out, a puddling of clay should be used, where the subsoil does not consist of tenacious boulder clay. The clay for puddling should be well pugged, or beaten into the consistency of putty.

2065. You will find the particular instructions for the construction of tanks below, and all I shall say here is, that a fall from 6 inches to a foot is required along the floor, according to its length;

and that a roomy man-hole should be made in the arch of the roof, at each end of the tank, and at the deepest end a third opening for the pump.

2066. The pump used in tanks is generally the common cast-iron one; but I have seen a pump lately, of a construction well adapted for the lifting of liquid manure, which at times contains so much sludgy matter, as to clog the action of the valve and plunger of the common pump. The principle here employed is the converse of the screw-propeller of the steam-boat; and its construction is a series of those propellers fixed at short intervals on a vertical axis, placed in the interior of an upright pipe. The axis or spindle is put into rather rapid revolution, and the water rises without priming or any other precaution. No valves nor nice fitting of any kind are required. This machine is a fine example of ingenious, simple mechanism. It was invented by Mr M'Dowall, engineer, Johnston, Ayrshire.

2067. To know the size of tank required for any particular case, an allowance of 1000 gallons for every cow is a good criterion on a dairy-farm, and that number of gallons occupy 162 cubic feet. When enlarged tanks are desired, it is better, because cheaper, to have parallel rows of narrow tanks contiguous to each other, than to extend the breadth or length, and increase the depth of the dimensions given above (2064.) In a series of parallel tanks, the common walls support the arches on both sides.

2068. A tank of 72 feet in length, 6 feet wide inside, and 6 feet deep below the soles of the drains, contains about 2600 cubic feet, and, with a pump and the carriage of materials, would cost about £24.

2069. Mr James Kininmonth, Inverteil, near Kirkcaldy, in Fifeshire, from whom these particulars have been obtained, says "that, from his experience in the construction of a good tank, he considers that economy, if not directed by judicious views for the attainment of efficacy in the object, will be attended with loss and disappointment; and, from his experience also of the valuable benefits of liquid manure, he would not only strongly recommend the adoption of the tank upon all farms, but that it should occupy a part in the plan of every new steading. Were such a system generally adopted, much of the expense attending the collection of common manure from towns and villages, and of the purchasing the still more expensive foreign and manufactured manures, now so largely applied, might be saved. It may also be important to add, that the first year's collection of the liquid manure he considered to compensate in full for all the expenses incurred in the construction of the tank."*

2070. Mr Milburn, Sowerby, by Thirsk, gives the cost of constructing a liquid-manure tank 13½ feet in length, 6½ feet in width, and 6 feet deep, inside measure, with brick in length, and plastered with Roman cement,—a size suitable to small holdings—in these terms:—

	Ft.	in.			
Length within,	13	6			
Width, .	6	6			
Depth, .	6	0=19½ cubic yards.			
Cutting over all, at 3d per yard,			£0	7	9
Walling, including bricks in length, and mortar around them, at 4s. per yard, . .			6	8	0
Plastering and cement, .			0	16	0
Covering and flags, . .			2	15	0
			£10	6	9†

2071. A simple and convenient mode of collecting the liquid manure of a dairy-farm—of from 130 to 170 acres, with a stock of cows from 14 to 24, with young beasts and horses—has been practised by Mr M'Lean, Braidwood, and Mr Wilson, Eastfield, both near Penicuik, Mid-Lothian. Drains are formed from the byres and stables into one main drain, the mouth of which is elevated as high above the ground below it as to admit a liquid-manure barrel—a common butt, mounted on its cart—to stand under it, and receive the liquid direct into the bung-hole; and as the barrel becomes full, it is carted away, and its contents emptied on the field. The barrel contains 150 gallons, and is usually filled three times a-week. When there is an excess of liquid, in consequence of much rain, it is allowed to run into the dunghills below the drain,

* *Transactions of the Highland and Agricultural Society* for March 1846, p. 292-8.
† *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 280.

and after saturating them, it flows into an open shallow tank, from which it irrigates at pleasure a drained moss laid down to perpetual grass.

2072. The cost of these drains are thus given by Mr Wilson :—

In under-byre, including cover of the main drain,	£2	2	6
In upper-byre,	1	6	0
Stable pavement, grates, and cost of putting them in,	2	0	0
Drains from dwelling-house and scullery, including grates,	0	15	0
Expense of cutting a road, to allow the bung-hole of the barrel to be placed under the main drain,	0	10	6
	£6	14	0

2073. A common butt, of the above capacity of 150 gallons, sunk into the ground, forms a good and convenient tank for the use of a labourer's cottage, and, retaining all the liquid refuse from the house, would afford ready means of manuring a portion of the garden.*

2074. The ground along the side of a long tank is the best site for mixing up composts, with the assistance of the liquid manure. Instead of making the composts in the open and level ground, I would form them under cover in a shed, built parallel with the tank, and the floor of which should be as much sunk in the ground as the soles of the liquid-manure drains, in order to allow a free drainage from the shed into the tank. The walls of the shed should be built of stone and lime, as high as 6 feet above the ground, as long as the length of the tank, and 8 or 9 feet in breadth, to make the roof narrow. The floor should be flagged with pavement, having an inclination towards the tank, and numerous openings should pass through the bottom of the wall from the lowest side of the floor, and through the wall of the tank, to serve as conduits for conveying the drainage from the compost-heaps, when they happen to be overcome with an excess of moisture. The roof should be made of durable materials; the back wall next the tank should have perforations just under the eave of the roof, large enough to allow the end of the spout to penetrate them which conveys the liquid from the pump of the tank to different parts of the compost under the shed; and when the compost will take up no more liquid, the liquid will find its way by the small drains on the floor into the tank. The front wall should have an opening 6 feet wide above the ground, through which to fill the shed with compost materials, and afterwards to fill the carts with compost. Here every sort of experiment may be performed in the formation of composts; and, if desired, the shed might be subdivided into compartments, to allow the experiments to be conducted on a smaller scale, and in different stages of fermentation. The ground plan of this compost-shed may be seen at *h′*, Plate II., alongside the tank *k′*.

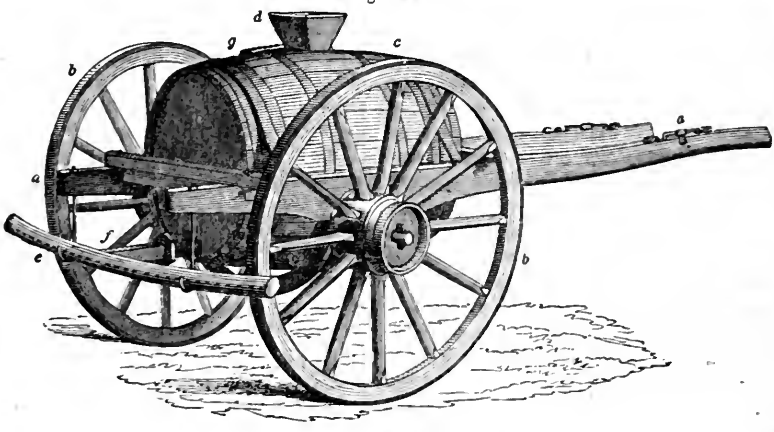
2075. *The Water-Cart.*—The water-cart has been very long in use for the conveyance of water, when the supply of that necessary element for household use has been distant from the steading. It is usually the naked bed-frame of a cart mounted on wheels, and surmounted with a cask of a capacity suited to the demands of the establishment. The cask is furnished with a funnel, inserted in or attached immediately over the bung-hole; and it is likewise furnished with a spigot, or with a stop-cock, inserted into that end of the cask which hangs over the back of the cart. When the water-cart has been drawn to the fountain or the pond, from which water is to be conveyed, it is filled either by means of a common pump, raised so high as to deliver the water which it lifts into the funnel of the cask, or the water is lifted with the hand by means of a *scoop*, having a helve of sufficient length to enable the workman to reach the pond on the one hand, and the funnel on the other. The scoop best adapted to this purpose is a small wooden pitcher, about 8 inches in depth and 10 inches in diameter, the helve passing through its sides in an oblique direction, and a little above its centre of gravity. Liquid manure can be conveyed into a barrel by means of such a scoop as well as water.

2076. *The Liquid-Manure Cart.*—For the more economical distribution of this

* *Transactions of the Highland and Agricultural Society* for July 1848, p. 266.

valuable manure, this machine is now taking its due place amongst the machinery of the farm. As most commonly used, it differs very little from the above, except in its being provided with the distributing apparatus in place of the spigot; but in large establishments the cask is superseded by a covered *rectangular cistern or tank*, which takes the place of a common cart-body. The *watering* of public streets and highways has induced the necessity of the rectangular tank for the distribution of water over the surface of roads, because of the ease with which, by this construction, a greater quantity of water can be put upon one pair of wheels. Here the quantity of water to a given surface is much greater than in the case of a liquid manure, and hence the propriety of a capacious tank for the distribution of *water* on streets, while the same principle (economy in the expense) leads to the propriety of employing a smaller and less expensive vessel for the distribution of liquid manure, which will not in general be superabundant. For a *liquid-manure cart*, a cask of 120 or 140 gallons contents, will be found more economical in first cost than a rectangular tank; and as these machines can be only occasionally in operation, they will, if not very carefully attended to, become leaky while standing unoccupied. In this respect the cask will have a manifest advantage over the tank, for the tightening of a cask is an operation the most simple, by the act of driving up the hoops; while, in the case of the tank becoming leaky, no means of that kind can be resorted to, and the alternative is, either soaking it in water till the wood has imbibed as much of the fluid as will expand its substance and close the leaks, or the vessel must be tightened by some more expensive process. As the more economical of the two, therefore, in point of expense, I have chosen the cask-mounted cart for the illustration. Fig. 194 is a representation in perspective of this cart, of the simplest and most convenient construction.

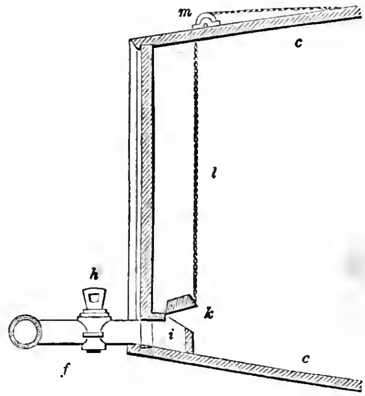
Fig. 194.



THE LIQUID-MANURE CART.

For the more easy means of filling the cask, it is suspended between the shafts of the cart, and this position requires the bending of the axle to nearly a semicircle. The cart is a mere skeleton, consisting of the shafts *a a*, which for this purpose may be made of red pine, their length being about 14 feet. They are connected by a fore and hind bar, placed at such distance as will just admit the length of the cask, while the width between the shafts is suited to the diameter of it. The axle, as already noticed, is bent downward to nearly a semicircle, to receive the cask, and its length will of course be greater than the common cart-axle; even the distance between the caddy-bolts, in a straight line, will be usually greater, but this will depend on the diameter of the cask. A pair of common broad cart-wheels *b b* are fitted to the axle. The cask *c* is suspended on two straps of hoop-iron, the ends of which are bolted to the shafts, and the same bolts pass also through the ends of two lighter straps which pass *over* and secure the cask firmly in its place. The funnel or hopper *d* is usually fixed upon the top of the cask over the bung-hole, or it may be inserted therein by means of an attached pipe. The distributor *e* may be made of sheet-copper, of cast-iron or malleable iron, or even of wood; the copper will be found the most durable, and it should be at least one-twentieth of an inch in thickness. The next best is the patent malleable iron tube: cast-iron, though sometimes used, is not to be recommended, neither is wood desirable, from its liability to choke. The bore of the distributor should be not less than 2 inches, nor is it required to exceed 2½ inches, the length from 7 to 7½ feet, and slightly bent with a uniform curvature, which last property causes it to cover a wider surface of ground than it would do if straight. But, in giving the distributor its curvature, care must be taken to avoid increasing the curvature towards the ends, as is sometimes done, to the prevention of uniform distribution of the manure. The ends of the tube must be closed with movable covers, screwed or otherwise fixed, that they may be removed at pleasure, for the purpose of sponging out the tube when it happens to get clogged up with any solid matter. A line of perforations is made along the hinder side of the tube for the discharge of the fluid; these should be at the distance of one inch apart, and their opening about an eighth of an inch diameter. As the area of these discharging orifices cannot be altered at pleasure, nor their amount of discharge altered for any given time, it becomes necessary, in distributing any given quantity per acre, to regulate that quantity by increasing or diminishing the *rate* of travelling the cart over the ground. The distributor is attached to the cask by means of a stem *f*, of the same materials and bore as the main tube, and it enters the end of the cask close to the lower chime. A stop-cock is frequently put upon the stem *f* to regulate the discharge—and for this purpose it is very beneficial, serving in a great measure to regulate the quantity per acre, but for the entire setting off or on of the supply, the stem *f* opens into a small chamber inside the cask, which chamber is closed by a flap-valve heavily loaded. This valve, when closed, stops the discharge, and, when lifted, the fluid has a free passage to the distributor. The opening of the valve is effected by a small chain attached to the flap, rising to the top of the cask at *g*, where it passes over a small roller, and onward to the fore part of the cart on the nigh side, where it hangs at hand for the carter to set off or on at pleasure. Fig. 195 is a section of part of the cask, and showing the chamber and valve; *f* is again the stem of the distributor, *h* a stop-cock, *i* the chamber, and *k* the valve, which is the common leather flap or clack valve,

Fig. 195.



THE APPARATUS FOR REGULATING THE DISCHARGE OF LIQUID MANURE.

well loaded with lead, *c c* is part of the cask, *l* the chain attached to the valve, and passing over the roller *m*.

2077. When the liquid-manure cart is furnished with a *tank*, the latter can, with equal facility, be placed low for the convenience of filling; thus the axle may be cranked, as in the Liverpool dray-cart, the tank resting on the cranked part of the axle; or the axle may remain straight, and the tank appended below the axle. Such a tank may be conveniently built to contain a ton of the liquid, or about 220 gallons; and the distributing apparatus is the same as for the cask. The distributor, as now made by Mr Crosskill, and which I saw on a cart exhibited by him at the Show of the Highland and Agricultural Society in August 1848, swings upon a stud; and this is a great improvement on the former construction, inasmuch as the distributor always remains in a level position, whatever may be the inclination of the ground upon which the cart has to pass over, and, therefore, always distributes the liquid uniformly; whereas, in a fixed distributor, the liquid is discharged with the greater force, and of course in greater quantity, on the lowest side, for the time being, of the uneven ground. The price of these carts varies considerably, partly from construction, and partly from locality. Mr Crosskill of Beverley quotes £16 as the price of the tank cart, and, with a pump and flexible tube for filling it any where, £5, 8s. more, in all £21, 8s. In Scotland, the average price may be stated at £18, without a pump, and, when mounted with a cask, £15—these prices, of course, including wheels and axle.

2078. I saw a new and rather curious form of liquid-manure cart exhibited by Mr Richard Stratton of Bristol, at the Show of the English Agricultural Society at York in July 1848. The barrel is made of boiler-plate, in the form of an octagon, and its axis acts as the axle of a skeleton cart, between the wheels of which the barrel, containing the liquid manure, revolves on its axis. All the apparatus of valves and distributors are dispensed with, for the liquid is simply distributed by means of a perforated plate, which can be taken out and replaced by another having a different size of perforation. When the barrel is not distributing liquid, the perforated plate is kept uppermost, and has only to be turned undermost to distribute the liquid. It is turned by means of a cord fastened around it. This machine is named the cylinder liquid-manure cart. When made of wood, to contain 100 gallons, its price is £14, 10s., and, when of iron, to contain 150 gallons, £17, 10s., with wrought-iron wheels. This machine appeared to me very simple, and not liable to go out of order.

2079. "The *cistern* for collecting liquid manure in the farm-stead," observes Mr Slight, "though apparently simple in its construction, being merely a covered pond or a well, yet serious errors are frequently committed in its formation. The first and most important consideration for the formation of the cistern, is the effect of hydrostatic pressure; inattention to this has caused the failure of many such cisterns. The liquid we have here to deal with, like all other fluids, acts on the bottom and sides of the vessel or body that contains it, with a pressure directly in proportion to the depth at which the fluid stands, without reference to either length or breadth; that is to say, suppose a cistern whose bottom is 12 inches square, and its depth 10 feet, filled with water, every square inch in the bottom will suffer a pressure equal to the height of a column of water whose base is one inch square and 10 feet, or 120 inches in height. The weight of such a column will be 4½ lbs. nearly, and this would be exerted on every square inch on the bottom, or the whole pressure on the bottom would be 625 lbs., the weight of 10 cubic feet of water. There is a natural law that governs the pressure of fluids, which shows us that they press *equally in all directions*, downward, horizontally, and even upwards, the last arising from the general statical law, that "*action and reaction are equal, and in opposite directions.*" It follows, from these hydrostatical laws, that the lowermost portion of *each side* of our supposed cistern will suffer a pressure from the water equal to that which acts upon the bottom—hence, taking the lowermost inch in the height of the sides of this cistern, it will be pressed with a force of 52½ lbs. or thereby, or 4¼ lbs. on the square inch, and each of the four sides will suffer the same pressure. Suppose, now, that the cistern is elongated in one direction to any number of feet, and again filled to the depth of 10 feet, the pressure on each square foot of the bottom remains the same as before, and so in like manner does it remain the same upon the sides; for the pressure is not altered in any direction, although the proportion of the cistern has been changed. Keeping this in view, it will be seen that length and breadth produce no effect on the pressures that a fluid exerts against the vessel or body that retains it; and that, in calculating the resistance to sustain such pressures, *depth* is the only element requiring to be taken into account. It is also to be kept in view, that pressure on the bottom or sides is directly as the depth; thus, if our supposed cistern were reduced to 5 feet in depth, the pressure on the bottom would only be one-half, or 2¼ lbs. on each square inch.

2080. The conclusion to be drawn from these remarks is, that a cistern, in the form of a pit or well, should be always avoided, unless it can be formed in a natural bed of impervious clay. When such a substratum can be attained, a pit may be adopted, but not otherwise. If such has been found, and the pit dug out, it should be lined with brick, or with stone built in mortar, the bottom being first lined with the same material. When the building approaches to the surface, the wall can be gradually reduced in diameter to a small compass, leaving only an opening of 2 to 3 feet square, which is covered in at small expense; and the saving in this last item is the only apparent advantage that seems to attend the practice of pit cisterns. Deep cisterns are liable to another inconvenience—of their becoming recipients of spring or of drainage water; and it is sometimes more difficult to keep such water *out* than to keep the proper liquid *in*—for if springs and their origin lay at considerable heights, their hydrostatic pressure may be so great as to render the prevention of access to their products a process of great difficulty.

2081. A *cistern* of moderate depth, not exceeding 4 feet below the out-fall of the drains, may be constructed in any situation, whether in gravel or in clay, and its length can be extended so as to afford any required capacity; the breadth being restricted to that for which materials for covering it can be most easily obtained, which may be from 3 to 4 feet, or, if arched, it may be 6 feet. Whatever be the stratum in which such a cistern is to be formed, (unless it be perfectly impervious clay,) it should be puddled to the thickness of at least 1 foot with the best clay that can be procured. For this purpose, the earthy matters are to be dug out to a depth of 1½ foot lower than the intended sole, and to a width of 4 feet more than that proposed for the cistern. Two or three thin layers of the prepared clay are then to be compactly laid over the whole breadth of the excavation, and beaten firmly together at all points, making up the depth to 1 foot, and the surface of it brought to a uniform level. Upon this the side-walls are to be founded, and these may be of brick 9 inches in thickness, or of flat bedded rubble stone 14 inches. The wall should be built in successive courses of about 1 foot in height, the whole being bedded in mortar; and, as each course is completed, the puddle is to be carefully laid and beaten in behind, in layers of 6 inches or thereby, the first layer being properly incorporated with the foundation puddle, and each succeeding layer with the one immediately preceding it. To prevent the side-walls from being pushed inward by the pressure of the puddle or of the bank, tie-walls of brick or of stone should be formed at every 5 feet of the length of the cistern. These may be 9 inches of brick, or 14 inches of stone, and they must have conduits formed at the level of the sole, to allow the liquid to run towards the pump. The sole should be laid all over with brick set on edge, or with strong pavement jointed, the whole having a slight declivity towards one end, where a small well-hole of 9 inches in depth is to be formed to receive the bottom of the pump. The brick or pavement, as the case may be, is to be bedded on the puddle, and grouted flush in the joints with mortar; and when the walls and sole are built up, they should then be pointed in every joint with Roman cement. The covering may be effected with strong pavement, of length sufficient to rest on the side-walls, laid and jointed with mortar; or with rough *found*-stones, where such can be procured; and if neither can conveniently be found, a beam of sound Memel fir may be laid along the middle of the cistern resting on the tie-walls, and, with this bearer, stones of half the length will be sufficient to form a cover. A thin layer of clay may be laid over the stone covers, and upon that a coat of gravel. To prevent accident, it is always desirable to construct the cistern in a situation where it will be as little as possible exposed to the transit of carts; and this may be always obtained at a small additional expense of covered drain to convey the manure from the dunghills to the cistern. The best and most secure plan, no doubt, though the most expensive, is to cover the cistern with an arch of stone or brick.

2082. The *pump* for lifting the liquid from the cistern to the cart may be either of wood or cast-iron, but the latter is preferable. A common sucking-pump of 3½ inches chamber is quite sufficient; the chamber should be bored out, and the pump-boxes, for durability, should be also of metal, with leathern flap-valves. The height of the pump should be such as to deliver the liquid freely into the funnel of the barrel or tank; but if this height is found to raise the pump-lever above the reach of a man's hand, it is only necessary to joint a light connecting-rod to the lever, its lower end being furnished with a cross handle, and by these means the pump-man will be able to work the pump in the same manner as the lower end of the common pit-saw.

2083. *Forcing* and *lifting* pumps have been proposed, and even employed, for the purpose we have here in view, though with questionable propriety; and here it may be proper to explain, that by the term *force-pump*, is to be understood a pump that raises water to any height above the point where the power is applied, by the descent of a solid piston acting in the chamber of the pump, sending the liquid into an ascending pipe, which springs from *below* the piston.

2084. The *lifting* pump differs from this in having a valved piston through which the liquid passes, as in the sucking-pump, on the descent of the piston; and, on its ascent, the valve being now closed, the liquid is *lifted* and forced into the ascending pipe, which, in this case, springs from *above* the piston, the chamber being closed at top with a water-tight stuffing-box. From this brief description, the simplicity, both in construction and in management, of the sucking or common pump, as compared with the other two, will be obvious, the cost being also in favour of the first.

ON LIQUID MANURE.

2085. Farmers have been subjected of late years to much ridicule, and even obloquy, for permitting any leakage to escape from their dung-heaps. This leakage is represented to amount to an enormous quantity, and to be of incalculable value. The quality, I should suppose, would depend on the quantity of rain that may happen to fall after the dung-heaps have been formed in the fields, for all the leakage from a dunghill in a dry season is of very trifling amount; and as to its value—if we may judge from the effect it produces—we should say that no crop received from the area of ground which had been occupied by a midden stance, would amount to double the value of the rest of the field. So that the real loss of the leakage from a dunghill amounts, at most, to the value of a crop derived from an area of ground equal to what the dunghill occupied; and the loss does not even amount to this, since the midden-stance is not manured at all, and the earth is carefully shovelled up from it and carried away to another part of the field; and, after all, no one could point out where the dunghill had stood, after the reaping of the first crop of grain.

2086. I think that much more has been said on this subject than it deserves. Doubtless it is wrong to permit any thing to go to waste, and especially so valuable a material on a farm as manure; but the particular case of the leakage from dunghills in fields has been exaggerated. Much greater waste occurs from the leakage of cattle-courts, and this arises partly from negligence and partly from necessity. It arises from negligence where the liquid manure might be conveyed to a tank; but where this cannot be done, the waste is submitted to from necessity. I have observed instances of both cases. I have seen a leakage from courts, arising not from excess of moisture of what the cattle had eaten and drunk,—for the litter would have easily absorbed all that,—but from the rain deluging the courts at times from the roofs of the surrounding buildings; and this I have witnessed to the degree of being obliged to wade above the shoe-tops in water, where there was no run from the courts—the courts being hollowed in the middle. I have also seen runs from courts, the floors of which were sloped at a high gradient. The tenants were not to blame, because their landlords had placed the steadings upon inclined ground, and had provided no rain-water rones. On the contrary, they deserved commiseration, and should have had tanks built, and rones provided for them. But I have seen, in some cases, steadings standing upon the inclined ground which formed the face of a rock, in which it was scarcely possible to dig a tank. The error was in building steadings in unsuitable situations, and not in the want of tanks.

2087. It may be remarked that these are exceptional cases, but they occur very often, if the circumstances in every case were particularly examined. I have examined many of them, and found the leakage to arise from the unsuitable situations of the steadings, and the want of rain-water rones, rather than from the want of tanks. It is true, tanks might be constructed to counteract these evils; and so they are by enterprising tenants, who take advantage of even accidental runs from steadings, and turn them to good account. I have seen the drainage of hammels, occupied by fattening cattle, directed into a small paddock instead of a tank, and, by the assistance of a small stream, made to irrigate the paddock at proper times in winter. But, to terminate all disputes on this subject, there should be a tank constructed at every steading, whether the convenience of rones be adopted or not, or whether the amount of leakage be great or not. If the tank be found to be useless, no harm will accrue, and when it does collect any liquid, it may be made useful.

2088. If the waste of liquid manure is deserving of public attention, it should be directed to that committed in every town of the kingdom, and especially in every seaport town. The drainage from towns situate in the interior of the country may be, and is in many cases, taken advantage of for irrigation, and for manuring garden ground. The environs of Edinburgh afford striking examples of the beneficial change effected on the soil by means of sewerage water, inasmuch as poor sandy soil, not worth naturally above 20s. per acre, has been converted into rich meadows, yielding at least £20 per acre of yearly rent. But in the seaport towns no use is made of this sewerage water; it is allowed to flow into the river or ocean. Now, when we consider what escapes from every human being every year in dung and urine, and add to these the washings of soap, grease, and other materials incidental to domestic purposes, we may imagine the enormous quantity of the most valuable matter, as manure, which is thus lost every year,—literally wasted. Take one instance,—a striking one,—that of London. It has been ascertained by Boussingault, that man in a healthy state passes 3 lbs. of urine daily; and Liebig states that in the same state he voids $5\frac{1}{2}$ oz. of dung. These two quantities give a total annual quantity of 1220 lbs. of liquid and solid manure, voided by every person on the average. Now, taking 2,000,000 as the population of London, the quantity of those manures voided by the inhabitants of the metropolis, amounts annually to 1,089,285 tons. Chemistry has ascertained that the component parts of the excrements of man are as valuable to vegetation as those of guano; and as the different sorts of guano sell from £6 to £10 per ton, we are warranted in estimating the value of night-soil and urine at £8 per ton, which would give the entire value of this manure, in London alone, every year, at £8,714,280. The statement seems very like an exaggeration, but we can arrive at no other conclusion from the premises, which are doubtless correct. This is not *all* lost every year; but when we consider the many ways in which those materials are wasted by the exercise of personal delicacy alone, we can imagine the larger proportion carried into the Thames by sewerage, in comparison with what is really collected.

2089. Let us now consider the nature and properties of liquid manure. As it exists in the tanks, it consists mostly of water derived from the rain which had fallen in the courts, mixed with a proportion of the urine and dung derived from the various animals which frequent the steading. We should therefore expect to find it a very complicated substance, and on that account well fitted for the use of every species of crop. I am not aware that this particular liquid has been analysed; but M. Sprengel, who has bestowed much attention on all the subjects of manure, in speaking of *ahl*, or the drainings from dung-heaps, observes, "when there is much rain, and the manure-pit becomes flooded (which it never ought to be) with the rain-water from the adjoining roofs, the *ahl* will often scarcely contain 2 per cent of manuring matter, and is then naturally of but little use." This is just the opinion I would express, on seeing the drainings from courts through which rain-water is allowed to discharge itself.

2090. "The drainage of dung-heaps," says Professor Johnston—"the usual liquid manure of our farm-yards—differs in composition according to circumstances. When the *urine* of cattle is *mixed* with *it* in *considerable quantity*, it is found to contain a portion of the constituents, not only of the solid and liquid excretions of the stock, but also of the straw and other vegetable matter which has fermented along with it. It varies in strength, however, very much with the quantity of rain or other water with which it is mixed, or which falls upon the dung-heaps from which it flows." The composition of two specimens of such liquid is as follows:—

	Drainings of Cow dung washed by rain.	Drainings of Farm-yard manure watered with cows' urine.
An imperial gallon contained,	Grains.	Grains.
Ammonia,	9·60	21·30
Solid organic matter,	200·80	77·60
Solid inorganic matter or ash,	268·80	518·40
	479·20	617·30
Inorganic matter in a gallon consisted of:—		
Alkaline salts,	207·80	420·40
Phosphate of lime and magnesia, coloured with a little phosphate of iron,	25·10	44·50
Carbonate of lime,	18·20	31·10
Carbonate of magnesia and loss,	4·30	3·40
Silica and a little albumen,	13·40	19·00
	268·80	518·40

This is the conclusion Professor Johnston derives from these facts, "that the liquid which flows from a dung-heap *watered with urine* is greatly richer in ammonia and in saline matter than that which flows from the solid excrements newly washed by the rain; that the liquid in both cases contains a considerable proportion of phosphate of lime. This does not exist in cows' urine alone. In both cases it has been washed out of the solid dung; and that both contain also an appreciable quantity of silica not existing in urine. This is derived from the straw of the fermenting farm-yard dung, or from the grass which has passed through the digestive organs of the cow; that as fermenting manure can yield in a soluble state every mineral ingredient which a plant requires, the liquid that runs from the farm-yard ought to be no less carefully preserved than the pure urine of our cattle."*

2091. In every case of farming, but the dairy, affording but a very limited supply of liquid manure, even of this diluted kind, our attention is not so excited, in consideration of this ordinary case, as in that of the dairy farm, where the genuine urine of the cow flows but little diluted with extraneous water, and to which, of

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 812-13.

course, it is requisite to afford a tank. It is this view of the case which gives us a closer insight into Flemish farming than any other; not that the Flemings pursue the dairy system of farming in preference, generally, to any other, but as it is their practice to confine their entire number of cattle and horses constantly, summer and winter, in the steading, the providing of tanks is with them a necessary arrangement for keeping their stock in an ordinary state of cleanliness. So the construction of tanks is with them as much a matter of necessity, as it is with those farmers of this country to lose a proportion of their manure, by washings of rain, in steadings built upon inclined faces of rock, and unprovided with rain-water rones. So much is it a matter of business with the Flemish farmer to collect the urine passed by his stock, that they have either vaulted cellars under the byres and stables, or in other convenient places of the steading; and they have, besides, such vaults placed by the roadside, that the excrementary materials they collect from the towns and villages may be emptied into them. And so much do the inhabitants of the towns in Belgium make it a business to collect the liquid and solid manures of their own houses, that it is in evidence before a committee of the House of Commons, that a housemaid may be hired for a year at Bruges for £3 of money wages, with the privilege of disposing of the manure. The value of the manure derived from a house is estimated at £1, 17s. per load per annum. Dr Radcliff tells us that the Belgian load is 15 cwt.; and as each person contributes 1220 lbs. to the manure-heap, the value of the contribution of each person is at most £1, 7s. a-year.

2092. The tanks in Flanders are constructed to any given capacity. They are generally 40 feet long, 14 wide, and 7 or 8 feet deep; some so depressed in the ground, as to allow the plough to pass over them. They cost in building, including materials, 10d. per every tonneau of 38 gallons they contain. A stock of 8 horses and 36 head of cattle, housed summer and winter, will supply 3,000 tonneaux of urine alone—114,000 gallons—great care being taken to secure it from the admission of rain or any other water. This quantity, along with dung and other materials, is fit to manure 21 acres of land, at the rate of 2480 gallons per acre.

2093. In Switzerland, the south of Germany, and in Holland, the urine is mixed with the solid excrements and water, which are allowed to putrefy before applying the compound liquid to the land; and to this manure they give the name of *gülle*. In Flanders, the dung of the cattle and horses is mixed with the urine in the tank, together with the night-soil collected from the towns; and from 2000 to 4000 rape cakes, of 2 lbs. each, are dissolved in every 1000 tonneaux, or 38,000 gallons, of the urine.*

2094. The solid and fluid excrements of animals form a very complicated mixture, as may be seen from the following enumeration by Sprengel; but this renders them the more valuable a manure for vegetables. They contain these substances:—

1. Vegetable or woody fibre.
2. Wax and resin.
3. Chlorophyle, or the green substance of leaves, partly decomposed.
4. Deposited humus.
5. A fatty and oily substance.
6. Mucus.
7. A peculiar brown colouring matter, in the solid excrement of oxen.
8. Vegetable albumen, (hardened.)
9. Animal gelatine.
10. Animal fibre.
11. Salivary matter.
12. Ozmazome.
13. Hippuric acid.
14. Uric acid.
15. Lactic acid.
16. Benzoic acid.
17. Urea.

(12–17: Originating in the urinary passages.)

18. Bilious matter.
19. Bilious resin.
20. Picromel.
21. Oxides of iron and manganese, derived from vegetables.
22. Earths, silica, lime, alumina, magnesia.
23. Salts, consisting of mineral acids and bases, derived from plants and water.
24. Common salt.
25. Carburetted hydrogen.
26. Phosphoretted hydrogen.
27. Sulphuretted hydrogen.
28. Ammonia.
29. Hydrogen.

(25–29: Products of the fermentation and putrefaction of the food in the bodies of animals.)

Numerous as these substances are, it is

* Radcliff's *Agriculture of Flanders*, p. 50.

M. Sprengel's opinion that many more might be discovered by carefully conducted chemical analyses.

2095. The value of these animal excrements as manure depends very much upon the age of the animals, their kind, their mode of employment, the kind and quantity of food they eat, and the nature of the water they drink. Thus:—Age has effect; for the excrements of a full-grown animal are much better than those of young animals. The state of the animal has an effect; the manure from oxen being much better than that from cows, a great proportion of the substance of whose food goes to the production of milk; and in like manner the manure of the wether is better than that of the ewe. The state of the food has an effect; for sheep chewing their food more minutely than cattle, their manure is richer than that of cattle; and the manure derived from cattle fed on the food in the natural state, is better than that derived from food which has been boiled or scalded; but the manure from scalded food is more active than the other, because it is more prepared. The kind of food has an effect; for poor and scanty food cannot supply so rich manure as nourishing and abundant food. The way in which the animals are treated has an effect; for working cattle afford better manure than fattening oxen, because the latter abstract from the food, to support their increasing flesh and fat, the same materials as go to produce milk in cows. The water drunk has an effect; for an ox that drinks 80 lbs. of water a-day will pass more urine than a cow which drinks the same quantity, because a large proportion of the water she drinks goes to the formation of milk. Boussingault found that a cow which drank 132 lbs. of water a-day passed 18 lbs. of urine, and gave 19 lbs. of milk; an ox that drank the same quantity gave 40 lbs. of urine. A horse that drinks 35 lbs. a-day passes only 3 lbs. of urine—no more than a man. This latter fact seems remarkable; but when we consider the much greater extent of surface over the body of a horse compared to that of a man, the insensible perspiration of the horse must carry off a large proportion of the liquid food; whereas a man drinks daily only one-tenth more than the urine he passes.

2096. A comparison of the composition of cows' urine fresh, and after it has been kept a month, will show the change that takes place in it by exposure to the air:—

		Cows' urine. Fresh.	Cows' urine. A month old.	
Water in 100,000 parts by weight,		92,624	95,442	
Urea, along with some resinous colouring matter,		4,000	1,000	
Albumen,		10	...	
Mucus,		190	40	
Benzoic acid (hippuric acid,)	combined with potash, soda, and ammonia, forming salts,	90	250	
Lactic acid,		516	500	
Carbonic acid,		256	165	
Acetic acid,		...	1	
Ammonia,		205	487	occurring partly in an uncombined state.
Potash,		664	664	
Soda,		554	554	
Sulphuric acid,	combined with soda, lime, and magnesia, forming salts,	405	338	
Phosphoric acid,		70	26	
Chlorine,		272	272	
Lime,		65	2	
Magnesia,		36	22	
Alumina,		2	0	
Oxide of iron,		4	1	
Oxide of manganese,		1	...	
Silica,		36	5	
Sulphuretted hydrogen,		...	1	
Sediment, consisting of phosphate, and carbonate of lime, and magnesia, alumina, silica, and oxide of iron, and of manganese,		...	180	
		100,000	100,000	

2097. In winter, urine scarcely contains half the quantity of urea stated in the first column, and is then, of course, of less value; and, when it has been putrefying for a month, it contains more than as much again of ammonia as urine in a fresh state. The ammonia is derived from the decomposition of the urea, and the other organic bodies containing nitrogen. The caustic ammonia remains partly dissolved in the water, and is the substance through which urine not properly putrefied is so apt to injure plants. If exposed long to the atmosphere, the caustic ammonia absorbs from it carbonic acid, becomes mild, and the urine may then be employed without danger as a manure for vegetation. But, on urine being thus exposed to the air, part of it escapes in the form of gas, so that it is proper to add to putrefying urine some acid principle to neutralise the ammonia—to *fix* it, as it is usually termed; and this is most simply and perhaps economically done by adding water to it, which, of equal bulk to the urine, enables the diluted mass to retain four times as much ammonia; that is, in every 100,000 lbs. of diluted urine, 1135 lbs. more of ammonia is retained. Another simple substance for fixing the ammonia is black vegetable mould, which supplies humic acid, and every 90 lbs. of it saturates 10 lbs. of ammonia; but as the best earth contains only 45 per cent of humic acid, 200 lbs. of earth will be required to fix every 10 lbs. of ammonia. Chemical ingredients may be employed to fix the ammonia, but they are all costly.

2098. It is rather important to trace the change in liquid manure occasioned by keeping. Fresh urine of cattle has a yellow colour, occasioned by a small quantity of resinous colouring matter; but on standing exposed to the air, the yellow assumes a brown, and at length a black colour, attributable to the formation of humic acid. In winter, urine does not possess a trace of ammonia, whereas it does in summer, thereby indicating the decomposition of urea by heat in the body before the emission of the urine. The above table shows that exposure of urine for a month to the air has the same effect of decomposing the urea as heat has in the body; and four weeks are not sufficient time to decompose all the urea, as still 0·600 remains. When exposed for three months and longer, urine loses its carbonate of ammonia, which is evaporable as well as the crude ammonia itself. In short, a six months' urine contains not a trace of its original urea, mucus, and albumen, and new acid combinations take place, such as the lactate, humate, sulphate, acetate of ammonia. Urine is supposed to be in a ripe state after it has putrefied in summer for five or six weeks, and in winter for eight or nine, though no absolute rule can be laid down for this point, so much depending on the evaporation of the air. The chemical rule for knowing the ripeness of urine is when it contains neither urea nor caustic ammonia, and this can only be ascertained by chemical investigation. After exposure to the air a year and half, urine contains no organic remains, and only salts and mineral bodies dissolved in water.

2099. The specific gravity of the urine of the horse, according to Fourcroy and Vauquelin, varied from 1·03 to 1·05; according to Prout, 1·029; and to Boussingault, 1·064.*

2100. We have seen how complicated a substance the urine of the cow is, and that of man we may expect, from the variety of his food, to be even more so. It is thus composed, according to Berzelius:—

Water,	933·0
Urea,	30·1
Uric acid,	1·0
Free lactic acid, lactate of ammonia, and animal matter not separable,	17·1
Mucus of the bladder,	0·3
Sulphate of potash,	3·7
Sulphate of soda,	3·2
Phosphate of soda,	2·9
Phosphate of ammonia,	1·6
Common salt,	4·5
Sal-ammoniac,	1·5
Phosphates of lime and magnesia, with a trace of silica and fluoride of calcium,	1·1
	1000·0

2101. That of the horse, the sheep, and the pig, is as follows, on an average:—

	Horse.	Sheep.	Pig.
Extractive matter, soluble in water,	20·28	3·40	1·27
Extractive matter, soluble in alcohol,	21·88	33·30	3·93
Salts soluble in water,	21·70	19·57	8·73
Salts insoluble in water,	19·40	0·52	0·84
Urea,	10·40	12·62	2·85
Hippuric acid,	6·91	?	...
Mucus,	0·06	0·25	0·06
Water,	899·37	928·97	982·27
	1000·00	998·63	1000·00

* Thomson's *Animal Chemistry*, p. 493.

In the constituents which supply nitrogen, the urine of the ox is as rich as that of the horse, and much richer than that of the cow, much of the nitrogen of whose food goes to form the curd of the milk.

2102. The saline and mineral ingredients of the urine of the horse, ox, sheep, and pig, consist of the following substances :—

	Horse.	Ox.	Sheep.	Pig.
Carbonate of lime,	21·75	1·07	0·82	...
— magnesia,	11·26	6·93	0·46	...
— potash,	33·12	77·28	...	12·1
— soda,	15·16	...	42·25	...
Chloride of sodium,	6·27	0·30	32 01	53·1
— potassium,	...	...	12·00	little.
Sulphate of soda,	11·03	...	7·72	7·0
— potash,	...	13·30	2·98	...
Phosphate of soda,	...	...	...	19·0
— lime,	...	... }	0·70 (lime and magnesia)	8·8 (lime to oxide of iron and loss)
— magnesia,	...	... }		
Silica,	0·52	0.35	1·06	
Oxide of iron and loss,	0·79	0·77	...	
	100·00	100·00	100·00	100·0

The conclusion Professor Johnston comes to, in reference to the contents of the foregoing table, is, that "the fermenting urine of our domesticated animals cannot afford phosphoric acid, which must be conveyed to the soil by the solid excrements."*

2103. If urine is applied to grass land or to growing crops, while the urea is undecomposed, or the ammonia is in a caustic state, it will destroy vegetation; but it may safely be applied to the ploughed soil at any time, in as far as the soil is concerned, although it is better received by the soil in some states than in others. Winter is considered the best season for applying the liquid manure, not only because it is then most abundant, but the ground, being all ploughed, is then also in the best state for imbibing it: and if applied to the soil just as it has flowed into the tank, much trouble will afterwards be saved in driving out the water, which must be put amongst it to save the ammonia, and which, in fact, is better saved by the humus of the soil. Evaporation, too, in winter is very limited; and any rain that falls will only serve, by dilution, to retain the ammonia, should it attempt to escape. Frozen ground will not take in liquid manure, though it may be safely emptied upon snow. Very dry ground will not take it in easily. If desired to be applied in the fresh state to grass land or growing crops, it should be mixed with its bulk of water.

2104. It is this circumstance which renders the use of liquid manure so troublesome in practice. For instance, on applying $13\frac{1}{2}$ tons to the acre, after the urine has putrefied for five or six weeks, all the manure obtained from that quantity would very little exceed 10 cwt. If the due proportion of water were added to it, the manure would not exceed 16 cwt., and even when applied quite fresh, the quantity would be under one ton.

2105. "Hence," as M. Sprengel properly concludes from such premises, "it will be obvious to every one that the urine tanks are no such excellent arrangements as they are frequently represented to be; and that it is, in many cases, more profitable to pour the urine over the dung in the dung-pit, or to supply as much straw that the whole of the urine may be absorbed, for then the humic acid arising from the solid excrements will be combined with the ammonia formed, at the same time, from the urea, &c. There is this additional advantage, that the urine, as the most efficient portion of animal excrement, being mixed with the dung, may be distributed more equally over the ground, that no manure-barrels, &c., are required, and that there is no necessity to bestow labour on the preparation of the urine; for the urine, if any, which is not taken up by the dung, may always be most profitably employed in the preparation of compost. In some parts of central Germany, they pour the urine, time after time, into conical heaps of common earth, hollowed to a proper depth in the middle; and when these have stood the proper length of time, and been thoroughly worked for use, they are led to the field. This process is very advantageous where good mould, or earth rich in humus, is not to be had; but must be conducted with the requisite caution: we must, for instance, not pour into the heaps so much urine, that the liquid penetrates through them and escapes; for, even when perfectly clear and colourless, it always still contains carbonate of ammonia, and other ammoniacal

* Johnston's *Lectures on Agricultural Chemistry*, 2d edition, p. 811.

salts, in solution, humate of ammonia being the only one of them which colours the urine brown." *

2106. Good as the practice is of saturating good mould with urine, it is not so advantageous as might be supposed. I formed a cess-pool which received the entire drainage from the house, including that from the water-closets and scullery, amongst a quantity of the richest mould I could collect, and on every year putting the compound or compost on the soil, it was not to be compared in its effects to those of common farm-yard dung or bone-dust. It is doubtless to the mixture of the contents of privies, along with the solution of large quantities of rape-cake in the urine, that the liquid manure used in Flanders owes so much of its efficacy. The same composition in this country would be by far too costly an application, though, of course, equally efficacious. In Flanders they call this compound *bonbons*, (sweet-meats,) to show their high estimation of it.

ON SEA-WEED AS MANURE.

2107. Winter is the season which supplies the greatest quantity of sea-weed for manure. After a severe storm, or even a heavy ground-swell of the sea, large quantities of this remarkable substance are cast ashore in the bays and estuaries of the coast ; and so desirable is it as a ready-made manure for the land, that on those farms which border the sea-coast of our island, and in localities accessible to the shore, the farmer defers every other work in which he may be engaged, to secure a manure which cannot be purchased elsewhere. So well aware is he that the next rising tide may sweep away what the former one had deposited, that his chief aim at the time is to draw the weed beyond the reach of the approaching waves, and then at leisure to drive it upon the particular fields which are destined to receive it.

2108. In East Lothian, on whose shores large quantities of sea-ware are thrown every year, it is put on the land to the amount of 32 loads per acre ; and it being preferable to concentrate its beneficial effects on a limited number of acres, than to attenuate its power over a larger space, as much per acre as desired is put on at once, and the extent of ground manured is measured by the quantity supplied by the sea. The quantity thus supplied depends entirely on the nature of the season, as also on the occurrence of storms at the particular period when the plants are most easily dissevered from the rock. It is this uncertainty of the supply which throws a doubt on the statement of Mr Kerr, in his agricultural report of Berwickshire, that the rents of those farms in East Lothian which have access to sea-weed, are enhanced to the extent of 25s. to 30s. per acre ;† and whatever may have been the case in his day, so great an influence on the value of land is not produced now by sea-weed.

2109. Sea-weed is put on in a fresh state upon the stubbled land before it is ploughed, in winter, in preparation to manuring the soil for the ensuing potato or turnip crop. It is also spread upon the lea ground intended to be ploughed for oats. The weed does not soon become desiccated in winter ; and though rain fall, it only dissolves the mucilaginous and saline substances easily separable from it, and carries them into the soil ; and these two classes of ingredients, no doubt, render the weed so good a top-dressing on every state of the soil. It is only on land capable of bearing green crops that sea-weed can with propriety be applied in winter, for heavy land would then be poached by the horses and carts ; and I think it must be this circumstance, more than any other, which gave rise to the opinion that sea-weed does more good to light than to heavy land.

2110. Sea-weed is also used in a fresh state in winter in trenched ground. In some parts of the coast which is composed of sand, and upon which sea-weed is cast, the inhabitants use the weed by placing it in the bottom of every trench two feet deep, nearly filling them with it, and tramping it in, and then throwing the soil upon it, there to remain until spring, when the surface of the ground is prepared for the sowing of carrots.

* *Journal of the Agricultural Society of England*, vol. i. 455-80.
† Kerr's *Agricultural Report of Berwickshire*, p. 377.

2111. Sea-weed is very succulent, feels slimy, and, when exposed to the summer sun, soon dries into one-third of its bulk, and becomes hard and brittle.

2112. It has been recommended to dry sea-weed, to its being easily carried into the interior of the country; but this would be troublesome in winter; and it is unnecessary trouble, inasmuch as there is no more sea-weed cast ashore than what can easily be used upon the farms on the coast.

2113. Sea-weeds constitute a numerous family of plants. Lindley, in his natural system, places them in class i., *Thallogens*, alliance 1, *Algals;* order 3, *Fucaceæ*, sub-orders 2 and 3, *Halysereæ*, *Fuceæ*. In the Jussien system, they are placed under class i., *Acotyledones*, order *Algæ*. Professor Lindley observes of this tribe of plants, "like all this alliance, the sea-wracks have no particular geographical limits, but occur wherever the ocean or rivers spread themselves over the land. They are, however, remarkable for the enormous space which single species of them occasionally occupy; some of them forming subaqueous forests in the ocean, emulating in their gigantic dimensions the boundless element that enfolds them. *Scytosiphon filum*, a species common in the North Sea, is frequently found of the length of 30 or 40 feet; in Scalpa Bay, in Orkney, according to Dr Neill, this species forms meadows, through which a pinnace with difficulty forces its way. *Lessonia fuscusens* is described by Borry de St Vincent as 25 or 30 feet in length, with a trunk often as thick as a man's thigh. But all these, and indeed every other vegetable production, is exceeded in size by the prodigious fronds of *Macrocystis pyrffera*. This appears to be the sea-weed reported by navigators to be from 500 to 1500 feet in length; the leaves are long and narrow, and at the base of each is placed a vescicle filled with air, without which it would be impossible for the plant to support its enormous length in the water, the stem not being thicker than the finger, and the upper branches as slender as common pack-thread. . . . . Some of the species are eatable, owing, doubtless, to the large quantity of gelatinous matter that they secrete. The young stalks of *Laminaria digitata*, and *saccharina*, are eaten under the name of 'tangle.' When stripped of the thin part, the beautiful *Alaria esculenta* forms a part of the simple fare of the poorer classes of Ireland, Scotland, Iceland, Denmark, and the Faroe Islands. In some of the Scottish islands, horses, cattle, and sheep, feed chiefly on *Fucus vesiculosus* during the winter months; and in Gothland it is commonly given to pigs. *Fucus serratus* also, and *Scytosiphon filum* constitute a part of the fodder upon which cattle are supported in Norway."*

2114. Four species are very common on our coast—the *Laminaria saccharina*, consisting of a single linear elliptic leaf, without any mid-rib; the *Laminaria digitata*, or common tangle, a cylindrical stem, sometimes as thick as a walking-stick, and about two feet long: the *Fucus vesiculosus*, consisting of a double stem, with the edges of the leaf entire, and in the disc of which, near the edges, are immersed a number of vescicles or air-bladders—or crackers, as they are vulgarly called, because they emit a loud report on being ruptured by pressure—about the size of a hazel-nut, and the use of which, no doubt, is to float the leaves in the water: and the *Halidrys siliquaria*, consisting of a waved coriaceous stalk about 4 feet long, greatly branched, dark olive when fresh, and quite black when dry; and it is also furnished with air-bladders or vescicles.

2115. The constitution of these plants is very complicated, affording no fewer than 21 ingredients. The first species, *Laminaria saccharina*, afforded the following substances to the analysis of Gaultier de Claubry in 1815:—

A saccharine matter—manna.
Mucilage, in considerable quantity.
Vegetable albumen.
Green colouring matter.
Oxalate of potash.
Malate of potash.
Sulphate of potash.
Sulphate of magnesia.
Muriate of potash.
Muriate of soda.
Muriate of magnesia.
Hyposulphite of soda.
Carbonate of potash.
Carbonate of soda.
Hydriodate of potash.
Silica.
Subphosphate of lime.
Subphosphate of magnesia.
Oxide of iron, probably united with phosphoric acid.
Oxalate of lime.

The composition of the other species, together with the *Fucus serratus*—which is like the *F. vesiculosus*, but without air-bladders—and the *Scytosiphon filum*, or thread tangle, is very similar to the one here given.†

2116. On combustion, in a particular way, sea-weed yields an impure salt named *kelp*. So long as it is used in the arts, kelp is too expensive to use as a manure. It supplied at one time the soda used by the bleachers, but, at the introduction of foreign barilla, its use as such was discontinued, much to the loss of many proprietors and labourers in Scotland; but the barilla itself has been superseded since the very low price at which soda ash, the dry crude carbonate from the decomposition of sea-salt, is now sold. Kelp, however, is now manufactured into iodine.‡

2117. The composition of the ash of sea-weed

* Lindley's *Vegetable Kingdom*, p. 21. † Thomson's *Organic Chemistry—Vegetables*, p. 944-6.
‡ *Transactions of the Highland and Agricultural Society* for March 1847, p. 629; and for October 1847, p. 75.

burned in the open air, of the mean of twelve analyses, is thus given by Professor Johnston :—

	Ash of Sea-weed. Mean.
Potash,	17·50
Soda,	12·70
Chloride of sodium,	16·56
Chloride of potassium,	0·93
Iodide of sodium,	0·95
Lime,	7·39
Phosphate of lime,	7·24
Magnesia,	9·89
Oxide of iron,	0·24
Sulphuric acid,	24·76
Silica,	1·84
	100·00

This mean analysis of a number of sea-weeds agrees pretty nearly with that of kelp.*

2118. The sea-weed used in Scotland in manure is never cut from the rocks, but is thrown ashore by the sea. When used for converting into kelp, it is cut from the rocks; and the older the plant is, it is the better for being made into kelp, as also into manure, no doubt. But, in other parts of the world, sea-weed is regularly cut from the rocks for manure alone, as may be seen from the following description of the *varec* (the Scottish *wrack*) harvest in Jersey. "The vraic harvest is another peculiarity of Jersey," says Mr Burn Murdoch. "The time of the harvest is regulated by the States—that is, they issue permission to begin cutting upon a certain day, and fix a time at which it is to cease. Friday, the 1st March, was this year (1844) the day of its commencement, and early that forenoon I repaired to the point of Le Hocq to witness the operation. The rocks at this point extend a very great way from the shore at low water, and are covered with the sea-weed. Upon this occasion the tide was very far out, and little appearance of bustle was observable from the shore, the dark nature of the rock preventing the people from being seen from such a distance. Of course, they commence when the tide is farthest out, and retreat as it rises. I walked out to the furthest extremity of the dry portion, and there the multitudes of men, women, and children, and horses and carts, which covered the rocks, quite astonished me. The weed is cut from the rock by short hooks, and laid in small heaps, and then loaded upon the carts and driven off till it is carried beyond high-water mark, where it is generally emptied, and left to be carried inland at leisure. It is a very wet job; but still the country-people like it—it brings them together; and many courtships are said to be carried on at vraic harvest. They bake bread of a particular kind for the occasion, and their food is otherwise of a more generous description than what is in general use: it is, in fact, a kind of gathering or meeting of the whole people, and, as such, causes a variety and stir in the ordinary routine of the Jersey life. The sea-weed thus procured is of great value as manure. It is used chiefly for grass and garden crops." †

ON GAULTING OR CLAYING THE SOIL.

2119. In a part of the fen lands of England, it is a customary practice in winter to cover the surface of a certain proportion of every farm, one-eighth part, with the clay obtained from the subsoil. The fen land referred to contains a portion of the counties of Huntingdon, Cambridge, Norfolk, and Suffolk, and extends to sixty miles in length, and thirty miles in breadth. It consists of a flat, interspersed with small elevations and hills, which, to distinguish from the flat, are called *hard lands*. These elevations are principally in permanent pasture, and form an excellent change for cattle from the fen land.

2120. The drainage of the fen is effected by artificial rivers running to seaward from the different districts into which the fen land is divided. The extent of the districts vary from 200 to 4000 acres each, and they are inclosed by dikes communicating with a main drain, which runs to a windmill or steam-engine, by which the water is pumped out of it, and transferred into the river. The entire country, with the exception of about 6000 acres, is under a regular system of drainage and cultivation.

2121. The soil of the fen consists of decayed vegetable matter on a stratum of moor, which again rests in some places on a subsoil of gravel, in others, and much more generally, of clay. The situation of the clay varies in different districts: in some it is ploughed up at the surface, in others it is not reached until digging for twenty feet below the surface. The nearer the clay is the surface, the better is the land cultivated, the clay being dug up, and the surface top-dressed with it; and it is this process of top-dressing which I propose now to describe.

2122. The fen land adjoining the hard lands partaking of the characters of both, is called *skirty land*, and it possesses, generally, great fertility. For a similar extent

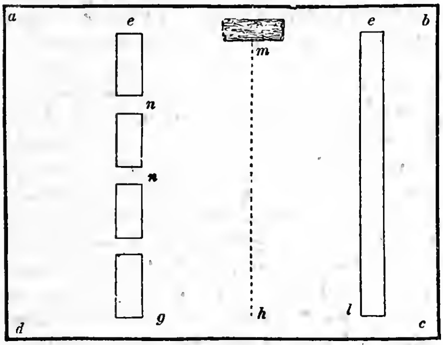
* Johnston's *Lectures on Agricultural Chemistry*, p. 624, 2d edition.
† Burn Murdoch's *Notes on Jersey, &c.*, p. 44-5.

of country, few equal it in productive vegetation, and the greater part being regularly kept in corn crops, it has received the appellation of the "Granary of England."

2123. The fen of Lincolnshire, and that part of Cambridgeshire in the Isle of Ely which is near the sea, being of a silty and salt-marsh character, requires and receives different management.

2124. The process of *gaulting*, or claying the soil, is conducted in this manner:

Fig. 196.



THE CLAYING OF THE SOIL.

—Let *a b c d* be the four sides of the field to be clayed, and let *e e* be the sites of the pits out of which the clay is to be taken. The space between the pits depends on the depth the clay is from the surface: if the clay is deep, the distance between the pits is 12 yards, as between *g* and *l*; if otherwise, it is extended to 20 yards: and varying between these two extremes. When the distance has been determined on, it is marked by a plough making a furrow in each line of pits.

2125. The width of the pits depends also on the depth of the clay; if it is 2 feet deep to the clay, the width is 3 feet 3 inches, but if 6 feet and upwards, the width is made 4 feet.

2126. A pit is dug in the first line *e*, which should be made near the fence *a b*; and at *m*, halfway distant between the first line of pits *e* and the second line *e*, the surface soil taken out of the first pit *e* is laid down. The pits are made 9 feet in length. Should the clay be far down, the sides of the pit *e* should be supported by planks, or frame-work of wood, to prevent the earth falling in, and to protect the lives of the men working in them; for many a life has been sacrificed for the want of this precaution. The clay as it is dug out is taken up with a fork or spade by a girl or boy, and thrown equally over the space indicated between the dotted line *m h* and the fence line *a d*, on both sides of the pit in which the men are working. Two good spits of the spade generally afford the requisite quantity of clay.

2127. After one pit has been sufficiently dug out, another is formed along the line, a space of the ground *n* being left untouched between the pits, of sufficient strength to support the sides from curving in. The upper soil of the second pit is put into the first pit, to fill it up as far as it will go, and the clay is taken out of the second pit and spread upon the surface, exactly in the same manner as described, and so on, from pit to pit, until all the pits in the line are dug. When the first pit in the second line at *l* is begun, its surface soil is wheeled to fill up the last pit dug at *g*; and when all the pits have been dug out in the line *l e*, the surface soil first taken out and put down at *m* is wheeled to fill up the last pit dug in *e l*. In this manner with every two rows of pits is the entire field spread over with the clay.

2128. The pits are levelled up afterwards with the adjoining soil with the plough. A little frost does the clay good by pulverising it, and makes it more ready to mix with the soil; but it is better to plough the clay in soon than allow it to become too much dried either by drought or frost.

2129. The claying of land, if the clay had to be carted upon it, would be attended with great trouble. To cover an acre of soil with only one inch deep of clay would require 180 cubic yards of it.

SPRING.

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

2130. As regards vegetation, we have seen that winter is the season of repose, of passive existence, of dormancy, though not of death. Spring, on the contrary, is the season of returning life, of passing into active exertion, of hope, and of joy—of hope, as the world of life springs into view immediately after the industrious hand has scattered the seed upon the ground—and of joy, in contemplating, with confidence, the reproductions of the herds and flocks. I am unequal to the task of describing the emotions to which this delightful season gives birth; and I would rather that you should go into the country and enjoy the pleasure for yourself; for "the chosen draught, of which every lover of nature may drink, can be had, in its freshness and purity, only at the living fountain of nature; and if we attempt to fetch it away in the clay pitchers of human description, it loses all its spirit, becomes insipid, and acquires an earthy taste from the clay."

2131. To enjoy the beauties of spring in perfection, "it is necessary to take advantage of the morning, when the beams of the newly-risen sun are nearly level with the surface of the earth; and this is the time when the morning birds are in their finest song, when the earth and the air are in their greatest freshness, and when all nature mingles in one common morning hymn of gratitude. There is something peculiarly arousing and strengthening, both to the body and the mind, in the early time of the morning; and were we always wise enough to avail ourselves of it, it is almost incredible with what ease and pleasure the labours of the most diligent life might be performed. When we take the day by the beginning, we can regulate the length of it according to our necessities; and whatever may be our professional avocations, we have time to perform them, to cultivate our minds, and to worship our Maker, without the one duty interfering with the other.

2132. "The day-spring of the morning leads us, by an easy and very natural transition, to the day-spring of human life, the morning of our sojourn upon earth; and the parallels between the commencement of the life itself, and of those successive days by which it is numbered, is a parallel the most striking. There is a freshness in young life which no experience can acquire for us at any future time, and there is a newness in every object, which is not felt after years have passed over our heads. Our bodies are light, flexible, easily moved, and not liable to be injured. Our minds, too, never become wearied or listless; and although the occupation and the thought are necessarily different from those of persons of mature age, they are far more energetic, and what is learned or done takes a more permanent hold of the memory. There are many circumstances which render the morning of life of far more importance than the morning of an individual day. It is a morning to which no to-morrow morning can follow; and, therefore, if it is neglected, all is inevitably and utterly lost. We cannot exactly make up the loss of even one morning, though we can repair it a little by our diligence in future mornings. We must bear in mind, however, that the means of doing this is a mercy to us, and not a privilege that we can command as our own. We never 'know what a day may bring forth;' and as there daily occur around us instances in which the young and the strong are at once levelled to the dust, we never can be certain that the demand shall not be made on ourselves—'this night is thy soul required of thee.' But if it is thus perilous to neglect one morning out of many, how much more perilous to neglect the one morning of a life—a life granted by a beneficent God, in a world full of the wonders of his power, capable of enjoyment, and deny him service while it lasts, and in the fulness of time entering, through the atonement of the eternal Son, a life of bliss which shall have no end."*

2133. Spring is a busy season on the farm. The cattle-man, besides continuing his attendance on the fattening cattle, has now the more delicate task of waiting on the cows at calving, and providing comfortable lairs for new-dropped calves. The dairymaid commences her labours, not in the peculiar avocations of the dairy, but in rearing calves—the support of a future herd—which, for a time, are indulged with every drop of milk the cows can yield. The farrows of pigs also claim a share of her solicitude. The shepherd, too, has his painful watchings, day and night, on the lambing ewes; and his care of the tender lambs, until they are able to gambol upon the new grass, is a task of peculiar interest, and insensibly leads to higher thoughts —"we cannot refrain from thinking of the unspeakable condescension and kindness of Him who 'feeds his flock like a shepherd, gathers the lambs into his arms and carries them in his bosom, and gently leads those that are with young.'"

2134. The condition of the fields demands attention as well as the reproduction of the stock. The day now affords as many hours for labour as are usually bestowed at any season in the field. The ploughmen, therefore, know no rest for at least twelve hours every day, from the time the harrows are yoked for the spring wheat until the turnips are sown. The turnip land, bared as the turnips are consumed by sheep, is now ridged up at once for spring wheat, should the weather be mild and the soil dry enough, or else cross-ploughed, and the ridging delayed until the barley-seed. The first sowing is the spring wheat, then the beans, and then the oat-seed. The fields containing the fallow land now receive a cross-furrow, in the order of the fallow-crops—the potatoes first, then turnips, and lastly the bare fallow. Grass seeds are now sown amongst the young autumnal wheat, as well as amongst the spring wheat and the barley. The field-workers devote their busy hours to carrying seed to the sower, turning dunghills in preparation of the manure for the potato and turnip crops, continuing the barn-work to supply litter for the stock yet confined in the steading, and to prepare the seed-corn for the fields. The hedger resumes his work of water-tabling and scouring ditches, cutting down and breasting old hedges, and taking care to release the spronting buds of the young quicks from the face of the hedge-bank, which he may have planted at the commencement and during fresh weather in winter. The steward is now on the alert, sees to the promotion of every operation, and intrusts the sowing of the crops to none but himself, except a tried hand, such as the skilful hedger, or to an experienced ploughman in managing an approved grain-sowing machine. Thus every class of labourers have their work appropriated for them at this busy season; and as the work of every one is individually defined, it is scarcely possible for so great a mistake to be committed as that any piece of work should be neglected by all.

2135. The farmer himself now feels that he must be "up and doing;" his mind becomes stored with plans for future execution; and in order to see them executed at the proper time, and in the best manner, he must now forego all visits, and remain at home for the season; or at most undertake an occasional and hasty journey to the market-town to get quit of surplus grain, when the draughts have a leisure day to deliver it. The business of the fields now requiring constant attendance, his mind as well as body becomes fatigued, and, on taking the fireside after the labours of the day are over, seeks for rest and relaxation rather than mental toil. He should at this season pay particular attention to the state of the weather, by observing the barometric and thermometric changes, and make it a point to observe every external phenomenon that has a bearing upon the changes of the atmosphere, and be guided accordingly in giving his instructions to his people.

2136. On this account the state of the

* Mudie's *Spring*, p. 12-15.

weather requires constant attention. The weather in spring, in the zone we inhabit, is exceedingly variable, alternating, at short intervals, from frost to thaw, from rain to snow, from sunshine to cloud—very different from the steady character of the arctic spring, in which the snow melts without rain, and the meads are covered with vernal flowers ere the last traces of winter have disappeared. Possessing this variability in its atmospherical phenomena, spring presents few of them having peculiarities of their own, unless we except the constant east wind which blows from March to May, and the very heavy falls of snow which occasionally occur.

2137. *Wind.*—So invariable is the phenomenon of the E. wind in spring, that every person who dwells on the east coast of Great Britain is quite familiar with it, having felt its keenness and known its aptitude to produce catarrhal affections. An explanation of this remarkable phenomenon has been given by Mr Samuel Marshall. "In Sweden and Norway," he observes, "the face of the country is covered with snow to the middle of May or longer. This frozen covering, which has been formed during winter, grows gradually shallower to the 15th or 16th of May, or until the sun has acquired 17° or 18° N. declination; while, on the other hand, the valleys and mountains of England have received an accession of 24° or 25°. On this account, when the temperature of Sweden and Norway is cooled down by snow to 32°, that of Britain is 24° or 25° higher than that of the preceding countries. Because, while the ground is covered with snow, the rays of the sun are incapable of heating the air above 32°, the freezing point. For this reason the air of England is 24° or 25° more heated than that of the before-mentioned countries. The air of Sweden and Norway will then, of course, by the law of comparative specific gravity, displace that of England, and, from the relative situation of those countries with this country, will produce a N.E. wind. The current is in common stronger by day than by night, because the variation of temperature is at that time the greatest, being frequently from 50° to 60° about noon, and sinking to 32° in the night." *

2138. All the seasons have their peculiar influence on the winds. "In *spring*," says Schouw, "E. winds are common; at certain places in March, at others in April. They diminish the force of the W. current, which, in many countries, is at that time weaker than during the rest of the year. The relation of N. to S. winds is not constant, and varies according to the localities. In some the direction is more N., in others more S. than the mean direction of the year."

2139. "When winds come from distant countries, they possess a part of the properties by which those countries are characterised," is an observation of Kaemtz. "Thus the W. winds, that blow from the sea, are much more moist than the E., which traverse continents. The latter, particularly when they are N.E., are very cold, especially in spring; and they give rise to a great number of rheumatic affections. The very opposite sensations produced by violent S. or N. winds, are much more marked in countries whose inhabitants live in the open air. I should not have noticed these differences had not these winds been characterised by particular denominations. In the S. of Europe the N. winds are celebrated for their violence and for their severity. The opposition between the elevated temperature of the Mediterranean and the Alps, covered with snow, give rise to aërial currents of extreme rapidity. If their effect is added to that of a general N. wind, there is produced a N.E. wind, having a violence of which we can form no idea. In Istria and Dalmatia this wind is known under the name of *bora*, and its force is such that it sometimes overturns horses and ploughs. It is the same up the valley of the Rhone, where a very cold S. wind often prevails, which is named *mistral*, and which is not less formidable than the N. wind known in Spain under the name of *gallego*."

2140. M. Kaemtz thus endeavours to explain the cause of the very variable nature of the wind in our countries. After having mentioned that the two great leading currents of wind on the globe are the N.E. and S.W., he observes, that "meteorological registers present to us the in-

* Brewster's *Journal of Science*, vol. viii. p. 39.

dication of a great number of winds which blow from all parts of the horizon. When we compare corresponding observations made in many localities in Europe, we are not slow in recognising that those winds involve no other causes than difference of temperature. Suppose, for instance, that a general S.W. wind occupies the upper regions, but that the W. part of Europe is very hot, whilst the E. regions remain very cold, with a clouded sky, the difference of temperature will immediately give rise to an E. wind; and when this wind meets that from the S.W. there will be a S.E. wind, which may be transformed into a true S. wind. These differences of temperature explain the existence of almost all winds. Now, suppose that a region is unusually heated, and that there is no prevailing wind, then the cold air will flow in on all sides; and according as the observer is in the N., the E., the S., or the W., he will feel a different wind blowing from the corresponding points of the horizon. However, to put the fact beyond doubt, we need corresponding observations, embracing a great number of localities."*

2141. The character of the winds in spring is, that they are very sharp, when coming from the N. or N.E. direction; and they are also frequent, blowing strongly sometimes from the E. and sometimes from the W. In the former they are piercing, even though not inclining to frost; in the latter they are strong, boisterous, squally, and rising at times into tremendous hurricanes, in which trees only escape being uprooted in consequence of their leafless state, but by which many a hapless mariner is overtaken and consigned to a watery grave, or dashed without mercy on a rocky strand.

2142. *Snow-storms.*—Very frequently snow covers the ground for a time in spring. The severest snow-storms and falls have occurred in February. The memorable falls of the 9th February 1799, and of the 7th February 1823, are yet fresh in the recollection of many persons alive, when, for weeks together, the internal communications of the country were entirely stopped. Roads opened up in one direction were again blocked up immediately after by a drift from the opposite direction. Truly awful is a storm of snow in spring amongst the hills. Here is a description of one, with all its accompanying prognostics:—"One evening, after a day of unwonted tranquillity, dense clouds appear like great snowy mountains in the western part of the horizon, while the few clouds, which lie in streaks across the setting sun, are intensely deep in their shadows, and equally bright in their lights. As the evening closes in, the clouds disappear, the stars are unusually brilliant, and there is not a breath of air stirring. The old experienced farmer goes out to take his wonted nocturnal survey of the heavens, from which long observation on the same spot has enabled him to form a tolerably correct judgment of what will be the state of the weather in the morning. Two or three meteors—brilliant, but of short duration—shoot along a quadrant of the sky, as if they were so many bright lights of the firmament, dropping from their orbits. He returns and directs his men to prepare for what may happen, as there will certainly be a change of the weather. The air is perfectly tranquil when the family retire to their early pillows, to find that repose which healthful labour sweetens and never misses,—

> Till rest, delicious, chase each transient pain,
> And new-born vigour swell in every vein.

But just at the turn of the night, the S. gives way, the N. triumphs, and the whirlwind, herald of victory, lays hold of the four corners of the house, and shakes it with the shaking of an earthquake. But the house, like its inhabitants, is made for the storm, and to stand secure and harmless; while the wind thunders in the fields around, every gust roaring louder than another amongst the leafless branches of the stately trees. In a little its sound is muffled, without being lessened, and the snow is heard battering at the windows for an entrance—but battering in vain. Morning dawns; but every lea and eddy is wreathed up; the snow still darkens the air, and reeks along the curling wreaths as if each were a furnace. For two days and two nights the storm rages with unabated violence; but on the third day the wind has veered to the E., blows rather

* Kaemtz's *Complete Course of Meteorology*, p. 50-4.

feebly, and though the snow falls as thickly, it falls uniformly over the whole surface. This continues for two or three days more; and on the evening of the last of these days, the sun, which has not been visible for nearly a week, looks out just before setting, as if promising a morning visit. The night remains clear, with keen frost, and the wind steady at N., and blowing very gently. The sun rises bright in the morning, the storm is over, and the weather remains unbroken for four or five weeks."

2143. It is a serious affliction to the ewes about to lamb, when a spring storm of snow, such as that described, occurs. The snow seldom disappears, even in the low country, until April, when the lambing season should terminate; and it remains much longer amongst the hills, where food being comparatively scanty at any time in winter, but especially in spring, the lambs are brought forth when the winter provender is about all consumed, and the grass that should support the mothers is still buried under the snow. The loss suffered by the flock is then fearful, and irremediable for some seasons to come.

2144. *Thaw.*—"When the appointed days of the snow-storm are numbered, a disturbance again takes place in the atmosphere, but it is of a different kind from the former. There are little sheets of lightning playing momentarily in the lower atmosphere, and the lustre of the stars is diminished; but still there is no cloud. The wind, however, dies away to a dead calm towards evening, and all is ready for the breaking storm. That operation is the first performed by the spring, and we shall borrow the words of the *British Naturalist* wherein to describe it:—'As the spring gets the mastery, which is aided by the condensation which takes place during the night, it rises to a wind, the sound of which cannot be mistaken. The rigidity of trees, window-frames, and other wooden fabrics, through which it passes, is relaxed; the withered grass and reeds, when these are exposed, moisten; and the rattling and thumping are succeeded by murmuring harmony, in which, compared with the other, there is a good deal of music; and as the morning advances and the animals come abroad, and man begins to be active, the hard metallic sounds are gone, and there is a softness about nature. There is always a delightful transparency about the atmosphere, because the little *spiculæ* of ice are gone, and the heat of the air is too much occupied in converting the snow and ice into water, for changing much of that into vapour. When the change is accompanied by rain, it is far more pleasant at the time, but there is a danger, almost a certain one, that the spring will be treacherous; and that, in consequence of the great heat required for melting the snow, and the evaporation of the rain together, frosts will return long before the process of thawing, so comparatively slow, is completed. The slow melting of snow by rain, compared by that of a warm atmosphere which is constantly shifting by the wind, can be easily understood, when it is remembered that the water which falls, even if it had the temperature of the greatest summer-heat, would be cooled down to the freezing point in melting half its weight in snow. But as the temperature can only be a little above freezing, the water will have the temperature of 32° before it has cooled perhaps a tenth of its weight; and as the water is a bad conductor of heat, and great part of the action of the oblique rays of the sun are reflected away from its surface, a rainy breaking of a storm is almost sure to be followed by frost, if it do not happen when the season is far advanced.' In such a situation, and under such circumstances, the storm not unfrequently passes away in what is emphatically termed a *gentle* thaw; and when this is the case, the spring comes under the most favourable circumstances. The snow is dissolved by atmospheric influence alone, without any rain from the clouds; although there are generally light clouds hovering about, ready to produce rain if a returning frost should render a contest of the elements necessary. Besides its rare pleasantness, the gentle thaw is attended with several beneficial consequences. In the first place, there is no flooding of the low grounds, and no washing of the soil from the more elevated ones; but the snow forms a trough for the discharge of the water into which it is melted, and thus the coldest of the snow-water does not reach the surface of the land. In the second place, the water pro-

APPENDIX TO WINTER.

NOTES FOR AMERICAN FARMERS.

BY JOHN P. NORTON, M.A.

PROFESSOR OF SCIENTIFIC AGRICULTURE IN YALE COLLEGE, NEW HAVEN.

In attempting even a sketch of the present condition of practical Agriculture in the United States, serious difficulties present themselves, which are not encountered in the study of British Agriculture.

Perhaps the most formidable of these arises from the immense extent of our country, combining as it does, tropical, temperate, and almost arctic climates. While in the extreme North the thermometer not unfrequently sinks to between 20 and 30 deg. below the zero of Fahrenheit, the orange trees of the South flourish and blossom through every month of the year. Such a difference of climate naturally indicates a corresponding diversity in cultivation. Accordingly, while proceeding from North to South, in each state a gradual change of practice is observed, until at last it becomes nearly entire; all of the principal crops being such as could not be successfully grown in the North. So in travelling from East to West; the practice which would be advisable in the moister climate of New England, would be wholly unfitted to the arid plains of California.

But besides the effects of climate, there are other causes which, in so widely extended and so thinly settled a country as this, produce scarcely less marked variations. Among these are distance from market, and from means of transportation. When the products of a farm must be carried a thousand miles before they can reach the nearest seaport, the single question of transportation will decide as to the most profitable form of produce.

Those who are located at such a distance, even upon the principal avenues of trade, as the Mississippi and its tributaries, or the great interior lakes, sometimes find prices so low as to render the ordinary modes of cultivation almost profitless. The wages of labor are high, and it is only attainable with difficulty. Under these disadvantages, it is obvious that the finished modes of agriculture practised in older and fully populated countries, are inadmissible.

We may well doubt if the culture of the best English or Scotch districts, can be introduced into any part of this country, without very material changes. Our farms are in reality much smaller than theirs, not in nominal extent, but in the actual amount that is cultivated thoroughly. I do not, of course, take into account the immense wheat fields and corn fields of the west, but speak here of the older states only, where land has become valuable and consequently more sub-divided. We cannot, with our prices for labor, afford to bestow that minute perfection of finish exhibited by a first class British farm. We have not, on the majority of our farms, that division of labor which is without doubt most profitable, and which is exemplified so fully in Mr. Stephens' work. Each man is ploughman, teamster, mower, &c., &c., by turns, often perhaps all in one day. This system has great defects on the score of economy, but contributes largely to that feeling of independence and self-reliance, which so strongly characterizes the humblest individual in our Northern States, where all are taught to consider honest labor honorable. Accustomed from childhood to turn their hands to any pursuit at a moment's notice, and to consider themselves equal to every enterprise in the way of work, our men carry the same spirit into other vocations; manifesting a confidence in their own resources which never flags, and which generally triumphs over all obstacles.

Other points in which our practices and customs differ, and probably will continue to differ, from those of Great Britain, will present themselves as we continue some brief notices of important departments in the work of Mr. Stephens.

This work has such a wide-spread and well deserved reputation, that I have not thought it necessary by way of preface to enter at length upon its merits.

The clear and copious details, the fulness and accuracy of information, the completeness of every illustration, have in an agricu[illegible]ral work upon practice never been equa[illegible]d. Such a work, although it treats of [illegible] things inapplicable to our agriculture, constitutes a vast fund of useful knowledge, from which may be drawn methods and examples applicable to every climate and every soil. It is my intention to assist the American farmer in making applications to his own practice from the book, to point out differences and reconcile some apparent inconsistencies in the practice of the two countries. To append a full account of American farming, would add greatly to a work already bulky: to do this well would require an extensive book by itself, and far more experience than I can pretend to possess as to the different sections of our country. My notes will form a species of running commentary upon Mr. Stephens' observations, applying them to our own improvement where it seems practicable. His work is so divided into paragraphs, these being numbered, that the most feasible way of reference to anything concerning which I may wish to explain, or from which I would dissent, will be by simply giving the number.

It is most proper and convenient to commence, as does Mr. Stephens, with winter, first devoting a few paragraphs to his introductory matter.

Paragraphs 1 to 34. The custom of sending young farmers, or young men intending to become farmers, to spend some time under the direction of skilful practical men, is gaining ground in this country, and will doubtless have an excellent effect in raising the standard of farming. It will be noticed, however, that the young men whose occupations are described by Mr. Stephens, are rather more delicately treated than they would be upon most American farms. On these they would be expected not to go about and try the ploughs alone, but after a little practice, to do a good day's work with one of them; and the idea of keeping a *horse* for their especial accommodation would be considered as quite ridiculous. The state of society is in some respects so different in the two countries, and the estimation in which labor is held on this side of the Atlantic so much more honorable, that it is difficult to institute comparisons in such matters. I am inclined to think, that for us, at least, this keeping of a young man two or three years on a farm would not be the best course; he would in my opinion run some risk of becoming a mere drudge, his *thinking* faculties would not be sufficiently exercised, unless he happened to be with a farmer of more than usual intellectual acquirements, who was willing to devote a far more than common degree of attention to him.

An attendance of two or three months in each year upon courses of lectures, relative to scientific agriculture, would expand and cultivate the mind, would open new sources of interest, and enable him to reason upon the various processes which he had observed during the summer. This would not injure him as a practical man; on the contrary, it would tend directly to his success. Labor during the usual season of occupation in the open air would invigorate the frame, as a winter's study would strengthen the mind.

Farmers may write and talk about the elevation of their class for centuries to come, as they have done in years that are past; but they may rely upon it, that education is the only true road to that which they desire. Until they are ready to provide the means of regular instruction in the art of agriculture for their sons, mental instruction as well as physical, they will always be compelled, as heretofore, to submit to the lead of lawyers, manufacturers, literary men, and members of other professions, in which a special education is considered absolutely necessary to distinguished success.

An institution which should unite practical with scientific teaching, if properly organized, would be the best of all preparatory schools; for there the union of instruction with actual work would be complete. Such establishments have hitherto, for the most part, been mere manual labor schools, with only the name of science. We may hope that a better day is coming; that we shall soon see institutions capable of imparting every description of knowledge that is to be desired by the practical man, and in addition to this so organized, that by means of extensive researches, conducted by men of undoubted ability, they may at the same time advance the range of our knowledge, and command the respect of every class in the community.

Mr. Stephens' paragraphs, 512 to 542, enumerate some of the principal agricultural seminaries and schools that have been, or are in operation, in Great Britain, and the various countries of Europe. My own inspection of some of these schools, and the accounts here given of others, have satisfied me that they are not in their organization what we need; they are either too scientific, or they are wholly practical. We want a proper union of both. It may require some years of experiment and experience to arrive at the proper medium; but there is no doubt that it may ultimately be attained. To an institution of such a nature, Mr. Stephens would, undoubtedly, lend his full approbation; and might probably be also led to concede that it afforded better advantages, than the house and farm of any merely practical man could offer.

The list of sciences mentioned from paragraph 70 to 511, may be somewhat appalling to the plain agriculturist, who sits down intending to work his way, for a short distance, into this unknown land of book farming. He might well be excused for wiping the perspiration from his brow at such a prospect.

Let me, however, in all due deference to higher authorities, relieve him by stating that there is no absolute necessity for his becoming learned in all of these sciences, an accomplished mathematician, chemist, optician, zoologist, mechanician, botanist, anatomist, and geologist. The present paragraphs to which I refer, compose an excellent comprehensive treatise on these and other scientific subjects, which is just what most farmers need. It is a general knowledge of these sciences that practical men require, such a knowledge as may be gained by reading popular works, and understanding leading principles. A careful perusal of the matter under the separate heads named above, will convince the reader that here, at least, is nothing incomprehensible; but on the contrary, a great amount of information calculated to be directly practical and useful. Such a compilation as we here find of general scientific results, and leading principles, in all branches of science applied to agriculture, is, alone, worth far more to the farmer than the whole cost of the work; it is valuable as a study, first, and afterwards as a reference from which he may constantly glean information, and derive valuable assistance. It is a great object to have simple outlines of these sciences, as applied to agriculture, collected and arranged in a convenient form. The farmer has thus an available book always near him, in place of being obliged to search through whole libraries for what he needs. If the hints and outlines given here, interest the mind in any particular department of scientific inquiry, and excite it to pursue that subject farther, the books referred to as authorities, will furnish ample means for so doing.

569. The recommendations in this and succeeding paragraphs, as to keeping strict accounts of the crops, the manures, and the cultivation, in each particular field, are well worthy of notice. The farmer who keeps such accounts, and registers them in a proper book during the leisure of winter, will be able at a glance to know the state of his farm compared to what it was ten or twenty years before; he can see what course of cropping, what quantity, and what kind of manures have been most beneficial, or most injurious, and can regulate his cultivation accordingly. In order to accomplish this satisfactorily, everything should be done by weight and measure. I have seen farm books kept on such a plan, and the record they afforded was most instructive. A meteorological register is also calculated to be of use, inasmuch as it familiarizes the farmer with every appearance of the weather, and enables him to predict its probable changes with some certainty.

The occupations of winter, upon which Mr. Stephens commences at p. 578, will of course only apply to some of our middle states, there being no out of door field labor practicable in the extreme northern states, during that season. I shall, however, for the sake of convenience, follow the order which he has adopted, and comment upon the labors of the various seasons, without regarding their applicability to any particular month or time here.

596. Winter is not alone the season of domestic enjoyment, or at least it should not be devoted to that alone. It is a period in which the inquiring mind, by reading, writing, and reflection, can lay up stores of useful knowledge, and can form intelligent plans for the coming seasons. The long winter evenings, if only one or two hours of each were occupied by reading, would enable the farmer to acquaint himself with all scientific branches of knowledge relative to his profession. Clubs, meeting once in a week or fortnight to pass an evening together, and to discuss subjects of mutual interest, would be very advantageous to any neighborhood. The proceedings might be varied by one of the number reading extracts from some such work as the "Farmer's Guide," or Johnston's Lectures, for an hour, and then all discussing the merits of what they had heard. Such meetings would encourage friendly feelings in each district, and lead to a strong spirit of improvement.

626. The uses of snow in protecting the soil are well known in this country, and are even more marked than in England. When the ground has been well covered during the winter the spring is earlier, because the frost has not gone so deep; winter grain is not thrown out by alternate freezing and thawing, manure is not exposed to atmospheric action, or to be washed away during every slight thaw. A heavy coating of snow being so porous and perfect a non-conductor, has been likened to a thick warm blanket thrown over the soil. Another benefit which results from a covering of snow, is caused by a small quantity of ammonia which it seems invariably to contain. The flakes probably absorb it in their passage through the air. For this reason it is said, grass and grain always have a bright lively color when they have lain under snow, having been benefited by its gradual melting. Rain contains some ammonia as well as snow, but usually not so much; and its influence does not seem to be so marked upon plants.

661. The iron plough has not yet found much favor in this country. When these ploughs have the length that is now given to the best implements, such as those of Ruggles, Nourse, & Mason, Prouty & Mears, Delano, and others, the weight becomes more than our ploughmen like to manage. Wood is cheap, light, and sufficiently strong, so that I do not see the advantage to be derived at

present from a change in this respect. The remarkable difference in price between the Scotch and American ploughs, is worthy of notice. I am inclined to think that the best American implements of this class, such as those named above, are equal to any made, and have known cases where Scotch ploughmen in this country have after a time laid aside their own favorite ploughs, and taken one of these in preference; they lay the furrow well, pulverize it thoroughly, and move steadily. It is to be borne in mind that ease of draught, with depth and width of furrow, is not all that is to be sought in a plough. It may slip through the ground easily, but the question then comes up, does it pulverize the soil as it goes; this is a point sometimes neglected during our trials of ploughs, the sole object seeming to be ease of draught. As Mr. Stephens says, ploughing is intended to imitate, as far as possible, the process of spading; the farther then, that we remove from a thorough and complete crumbling and cracking of the soil, the poorer our work. In order to accomplish this object of pulverization there must necessarily be a large amount of friction: it therefore seems clear to me that too much attention may be given to this question of lessening friction, that it may be reduced so far as to injure the true efficiency of the plough. The very short ploughs still so common among us, are well fitted for use among stones and stumps, where it is necessary to be constantly bobbing in and out of the ground; but they cannot make handsome or perfect work in open, smooth fields. The clevis, figured in figs. 2, 3, and 4, is worthy of attention; it is simple, and yet admits of draught from a great number of different points. I do not know that it is any better than the dial clevis of Messrs. Ruggles, Nourse & Mason. The plough staff, or plough spade, fig. 5, would be a convenient addition to our ploughs, and would save many a stoppage to clear away weeds; it might, by a bracket and socket, be easily attached to the plough handle.

676. The collars used in Scotland and England for work horses, have always seemed to me unnecessarily large and heavy, and the large capes which project from them, adding so materially to their clumsy appearance, are nearly useless. Fig. 12, is the only form that can be of much service. Such protections are more necessary in the wet climate of Scotland, where out of door operations must, I had almost said *generally*, be done in the rain, if done at all. With us they are scarcely needed, and we certainly should not inflict Fig. 13 upon our horses, with any idea of its being ornamental.

686. The simplicity, united with strength, shown in this harness, is remarkable. We too often see horses ploughing in wagon harness: this is not only heating and distressing them, by imposing additional covering and weight, but is poor economy, where a so much cheaper and more simple harness will do the work equally well.

702 and '3. It is to be noticed that in neither of these, nor in any subsequent figures, are the furrows laid flat. There is no doubt that when furrows are set upon edge, the land lies more mellow and loosely, and that the beneficial effects of air, moisture, frost, decomposition, &c., are more readily attained. The practice of turning the furrows flat seems to be losing ground in this country at present, though there are still many societies who award premiums to this kind of work in preference. In certain situations and circumstances the flat furrows are preferable. The tempering of plough irons, upon which so much stress is laid in 708, '9, '10, and '11, is something almost unknown in this country, our shares being seldom taken off until worn out. The cast steel points, with the chilling of the mould board and land side, now so prevalent in our best manufactories, render all the daily sharpening and setting here spoken of, quite unnecessary. We cannot, however, attain the perfection of work to be found in Great Britain, until we in some degree imitate the great care with which they attend to the straightness, the depth, and the width of their furrows; in very few, even of our ploughing matches, is uniformity in all of these respects sufficiently insisted upon.

720. The facts given in this and several subsequent paragraphs, ought to be made known to all American farmers who are quietly going on cultivating their one, two, and three acre fields, keeping up expensive fences around them, losing time in ploughing by frequent turns, losing ground near the fences which they cannot approach, and preserving this useless ground as a nursery for weeds. The time annually lost in taking out and putting in bars, or in opening and shutting gates, might also be brought into the account.

729. It should, I think, be also a rule in American ploughing matches, that each ploughman should lay off his own work, stakes being previously placed and numbered to show its boundaries. This is one of the best tests of skill, and, moreover, one that would prove quite trying to many men who could work quite passably with a straight furrow ready made for them to commence upon. The bare knowledge of such a requirement would improve most competitors wonderfully, by leading them to practise in advance.

733. It would be highly advantageous, if the leading state and other societies could, after mature consultation, agree upon some code of rules with regard to depth, width, and general character of furrows in different soils. This would tend to produce uniformity, and

it is to be hoped would do away with the variety of regulations, which we now find among the societies of different sections.

741. The *feering* poles mentioned here, would be of much use in insuring accuracy: they are not expensive, and would be much more certain objects than fence posts or trees, which are the usual marks steered for. Half an hour spent in setting up such poles, at the commencement of operations, would both save time subsequently, and facilitate the accuracy of the work.

The different kinds of ploughing noticed from p. 749, to p. 793, and the various figures given, will enable the ploughman who is desirous of improving, to study examples which will serve as standards, by which to measure his advance towards perfection. Particular notice should be taken of the fact that *shallow* ploughing is only considered admissible in certain rare cases, and is even then to give way under a system of gradual deepening.

808. The pulling and storing of root crops, turnips, beets, carrots, &c., has not the immense importance in this country that it has in England and Scotland. In our northern states, the severity of the winters interposes an obstacle to feeding off upon the land, which is there a leading feature in root culture. Fifteen, twenty, and thirty acres, are not an uncommon number to be occupied by turnips. Providing store room for such quantities as these, is clearly out of the question; and if they were placed in heaps out of doors, the covering would require to be much more thick and warm than that which answers in a comparatively mild climate. We cannot feed off in the field, neither can we leave roots in the ground, to be brought into the cattle yards at convenient periods through the winter. These difficulties do not occur in the middle states, and there the culture of roots may, as farming improves, gradually assume more nearly the proportion to other crops which it bears in Great Britain. In the south, too, they may with advantage be far more extensively introduced than at present. When we come to speak of rotations, it will be seen that the occasional introduction of such crops is calculated to be of very decided benefit to the soil, as they require a different class of inorganic food from the more ordinarily cultivated plants. The turnip, beet, mangold wurtzel, parsnip, and carrot, all contain more water than is found in any other crop, it amounting in most of them, to about 90 per cent. Our farmers will exclaim against such watery food, but a slight consideration of the subject will cause them to take a different view of the matter. The dry substance of turnips, is about equal in nutritive qualities to the dry substance of wheat. Now, if we take a heavy crop of wheat, say 45 bushels, at 60 lbs. to the bushel, the weight of grain per acre would be 2,700lbs. Land that would grow 45 bushels of wheat to the acre ought, sec. 845 and 848, to produce at least 30 tons of turnips. At 10lbs. in the hundred, these would contain in each ton 200lbs. of dry matter, and consequently, 6000lbs. per acre, or more than twice as much as was given by 45 bushels of wheat. An acre of good turnips, is calculated in Scotland to keep four bullocks; the wheat from an acre would not do this. Indian corn compares better with turnips: an acre of land producing such crops as the above, ought to give 70 bushels of corn, and this, at 60lbs. to the bushel, would give 4,900lbs. to the acre, of food superior either to turnips or wheat for feeding purposes. If the stalks were well cured, and added to the grain, I am inclined to think that the nutritive matter from an acre of this grain, would not fall short of that from turnips. It would, however, still be of advantage to cultivate turnips, as a change for the soil. The other root crops give nearly as large a yield as turnips, and one or two are, from several late analyses, somewhat superior in nutritious qualities. The sugar beet is an admirable food for milch cows in winter, causing butter to retain its color and flavor in a remarkable degree. Carrots, parsnips, and mangold wurtzel have, to a certain extent, the same effect. The culture of these crops has not progressed so rapidly in this country as might have been expected, and this for a variety of reasons. Among these, one of the most prominent, is the high price of labor. All root crops require a great amount of manual labor to keep them clear from weeds, and to thin them out to proper distances in the rows. In Great Britain, women and children take this work at low wages; by dint of practice they become very expert, and do it with a rapidity which is quite astonishing to those who are unaccustomed to the business. Here it must be done by men, at high wages. They are clumsy in the performance of their task from want of practice, and almost invariably dislike it more than any work at which they may be employed. The slowness with which the weeding operation goes on, is a serious drawback upon the profit of this cultivation. Another cause is to be found in an imperfect preparation of the soil. For these crops, it should be mellow and deep, free from clods, stumps, stones, and all obstructions which would impede the action of a drilling machine, or interfere with subsequent hoeing and cultivation. Want of attention to these particulars, and scanty supplies of manure, have caused the failure of root crops in a majority of cases. These evils are in progress of correction, and will, in time, as superior cultivation progresses, cease to operate. It, however, remains still to be shown, whether our cli-

mate is, equally with that of England, adapted to the production of these crops. The droughts of summer are a serious hindrance to the proper development of the young plants, and often destroy them altogether. The fly is also very injurious. Experience alone can test the question, whether these are fatal obstacles or not. Variations in the time of sowing might be tried with advantage, in the hope of avoiding such difficulties.

824. The Scotch method of storing might be found very convenient here, where large quantities of roots are grown. It would be necessary to cover the heaps much more thickly than is represented in Fig. 37, in order to prevent access of frost. Roots stored in fields are apt to decay, and in cellars also, unless they are both dry and cool.

879–880. The modes of measuring, or rather it should be said of *magnifying* crops, mentioned here with regard to turnips, have been too common in this country as applied to all crops. No just estimate as to the quantity per acre, can be formed by weighing or measuring the yield of a few square feet; many enormous crops reported upon such data, would dwindle wonderfully when subjected to accurate weighing, or measurement, of each load. Now that such associations as the New York State Agricultural Society, refuse to give a premium unless the whole produce has been actually measured by a sworn surveyor, we may hope for more accurate and really valuable information as to the amount of crops.

901. Feeding of sheep on turnips. The observations here given relative to the various forms of hurdles, net fences, &c., for inclosing sheep in successive portions of a field, will be found valuable for all those sections of the country where the season will permit of feeding off turnips, &c., during winter in the open air.

These cheap fences would also be well calculated for temporary inclosures, on meadows in autumn, when it is often desirable to confine stock to one particular portion of the field.

982. I think that in our agricultural papers there are drawings of several forms of racks, that are much cheaper and equally efficient with this, made from plain boards.

The turnip-slicer, Fig. 47, is not unlike some machines for the same purpose, that are made in this country. The simple lever-slicer, Fig. 48, is an effective implement, and is quite equal to the cutting of a moderate farm. Cutting turnips or roots generally, is good economy, as then the animal is able to eat them more readily and more entirely, there being no refuse shells and fragments left to rot.

943. By far the greater portion of the oil-cake made in this country, goes to Europe, chiefly to England and Scotland, where it brings a high price, and is universally regarded as a most valuable article of food for stock. The following table from Prof. Johnston's lectures, shows the composition of American linseed cake:—

Water	10.07
Mucilage	36.25
Albumen and Gluten	22.26
Oil	12.38
Husk	12.69
Ash	6.35
	100.

On comparing such an analysis as this with those of wheat, Indian corn, &c., we find that the fattening properties of oil-cake must be remarkable; and from the large quantities of albumen, &c., which it contains, that it must also be admirably adapted to the formation of muscle. A variety of food so rich and nutritious as this, will not be exported when our farmers are convinced of its value, and understand how to use it.

956. The various facts given under this and ensuing heads, as to the relative profits of feeding under shelter, and in the open air, are well worthy of attention. It is shown that with less food, the sheltered sheep gain more. Fortunately wood is so cheap in this country, that no farmer is able to keep a large flock of sheep, but can afford to provide them suitable shelter. Long sheds, open to the south, and having hay stored above, seem to be the favorite erections. A yard attached, affords the sheep room for exercise, and the shed gives them protection in case of storms.

1009. In a country so well wooded as are the Eastern and Northern states, sheep can usually find natural shelter from sudden storms late in autumn, or early in spring, the only ones to which they are exposed. On the prairies of the west, some of the varieties of *stells*, mentioned here, might be found highly beneficial. On all bleak hill farms, it would be an excellent plan to surround the barns and sheds with a belt of plantation, on the north and west; this would break the winds, and protect the inclosures from the coldest storms. In Great Britain wood is so valuable, that these stells, after the wood has grown, constitute an important and lucrative property.

1114. The liquid manure tank is as yet a rare appendage to American farm-yards; it is, however, one of such absolute necessity, that its general introduction will not be delayed, when our farmers begin to appreciate the true value of manure. As too many of our yards are now managed, a very considerable portion of the liquid manure, including washings from the solid matter, as well as the urine, is lost. When conducted immediately upon the land through a small ditch, as is frequently the case, it does harm rather than good, by rendering the small portion of land which it reaches quite too rich.

One chief objection that I have heard urged against these tanks is, that they would be liable to fill up and overflow, with the large quantity of water which would be poured into them from the roofs, &c. It will be noticed that Mr. Stephens only intends them to receive the drainings of the yard, and of the manure itself; as he arranges to conduct away all water from the roof and spouts, by means of separate drains. The tank would thus be able to contain all that might run in from the yard alone. The liquid could be pumped out as described in 1115, or mixed with peat, ashes, &c., &c., in the tank itself. An excellent pump would be that consisting of an endless chain, with metallic plates attached at regular distances, revolving in a wooden tube. This would draw well, and not be easily choked. Urine, and liquid manure generally, soon begins to ferment, and then a loss of ammonia ensues. As the retention of this is very important, it is best to mix frequently in warm weather, a little sulphate of lime (gypsum), or a small quantity of sulphuric acid. In both cases sulphate of ammonia is formed, a salt which is not readily volatilized nor decomposed. A tank may be built in a very cheap way to answer every necessary purpose, and will soon pay for itself in the quality of the manure it will furnish. Professor Johnston states, that in Flanders the urine of a single cow is worth about $10 a year for manure. If we take half only of this sum, what an immense aggregate value in each year, is for the greater part entirely lost.

The plan usually pursued, is to build the tank in some convenient situation, either in one corner, or just outside of the yard. The ground in the yard is so sloped that all of the liquid runs to a common centre, where a drain receives it, and carries it under ground to the tank. This may be built of brick or stone laid in cement with a smooth floor, or for temporary purposes of plank, lined at the back with clay. A tank can be made very cheaply in this latter way from old refuse lumber, and by the time that it has worn out, the farmer will be quite willing to build a permanent one of stone or brick, from experience of its benefits. In some cases drains are laid under the stables, where large stocks are kept, for the purpose of conducting the urine to the main drain, and finally, into the tank. Considerable quantities may be collected in this way if the floors are tight. A few pailfuls of water occasionally dashed through these drains for manure, would sweep away the thick deposit which might accumulate and gradually threaten to choke them. They should all be defended at their entrances by grating, so that straw, and manure of a solid kind, cannot wash in. All of these precautions may seem like unnecessary trouble; but in reality there are few things which pay so well and so soon, as some extra labor in collecting and preserving manure of every description, whether liquid or solid. Well protected, and well kept manure, is worth the double of that which has been soaked with rain, and bleached by the sun, during an entire season. In situations where it is not desirable to build a tank, it might be found a good plan to pave a shallow excavation in the centre of the yard, into which the drainings might flow, and be absorbed by long straw, chaff, &c., thrown in for that purpose. In this case also the rain water should be carried away in another direction, as otherwise there would be a stagnant pond formed. Such holes ought to be walled around for the purpose of preventing cattle from getting into them.

I have seen receptacles of this kind in Scotland, and found that they seemed to answer the intended purpose very well.

1132. The method of fastening cattle here recommended, is a very excellent one, quite superior to that in vogue in many parts of this country. Such a method may possibly be common in some districts among us, but I have seldom seen it.

1165 and 1168. Attention is called to these implements, for the reason that they are so inferior in elegance of form, and in lightness, to our own. The reality of these and of the British *hand* tools generally, that are most employed on the farm, as forks, rakes, hoes, &c., is far worse than the above pictures. Their machines are so well and so handsomely made, that their hand tools were always a subject of wonder to me, being both heavy and clumsy in appearance and in practice.

1171. The turnip slicer, fig. 86, is a remarkably useful implement, not easily got out of order, and very effective. It may be used for cutting all roots of large size; and if the knives were set closer together, even for potatoes. I have seen these cutters in operation; with one person to feed steadily, and another to work the lever, they accomplish a large amount of work.

The regular apportionment of the day here given, is worthy of notice and of attentive perusal, for although there may be no person who would be inclined to pursue such a system in full, yet the lesson is a good one, as inculcating regularity, order, and economy of time. Every farmer has heard his animals complain when their food was delayed beyond its accustomed hour.

1219. The statements here made, relative to the weight of turnips eaten by a fattening ox during each day, and during the whole winter, will excite some astonishment. The space necessary to store such quantities, and the labor requisite, even in the comparatively easy stage of feeding them to cattle, are so great as to be a very serious drawback upon their usefulness. The carrying, cutting, and feeding of 150lbs. of turnips, per day, to each ox, is in itself no slight amount of labor.

Turnips are not usually given to cows here, for the reason that they are said to communicate a disagreeable flavor to the milk. No trouble of this kind seems to be experienced in England.

1226 and 1228. The principle of the straw cutter, fig. 91, is largely employed among us, but it is usual to set the cutter *r*, instead of at right angles, so to form obtuse and acute angles with the cutter wheels *k*. The cutters then have a drawing motion, which increases their efficiency very greatly. I doubt if fig. 92 has any right to the title of *Canadian* straw-cutter, supposing that it was originally introduced to Canada from the States. The disk straw-cutter is also much used in this country, and besides these a very great variety of others. The high price of these English implements is curious, ranging from $32 to $45.

1246. I call attention to this paragraph, for the purpose of showing how important it is to bring all of our buildings into a compact form. We too often see them scattered about the premises in most inconvenient places. A person when feeding animals, must spend a large part of his time in going from one building to another, and collecting the things of which he is in need. The time lost in these unnecessary journeys, amounts to a very serious item. A little forethought and contrivance, while the building is planning, will render it easy to feed all of the animals quickly, giving comparatively little food at a time, and fresh quantities at shorter intervals. As to the proper exposure, I have already mentioned its effects under another head. The large farm buildings that are to be seen in various sections, are capable of uniting many conveniences under the same roof, thus making work easy and simple. Where the nature of the ground admits of building upon a side hill, a degree of perfection in arrangement can be contrived, that is scarcely attainable in any other way. Manure kept under such barns as these becomes occasionally too dry, so that it does not decompose readily when turned into the soil. This is particularly the case with horse and sheep manure. I have seen both of these much injured by having been excluded from moisture, having become quite dry and mouldy. In such situations, some of the liquid manures or drainings might often be applied with much advantage.

1256 to 1504. The information here collected, regarding the different kinds of food, both as to their composition and feeding properties, is both valuable and interesting. The analyses given under 1303 and 1304, are not the latest, the results recently obtained by Mr. Salisbury, not being known in England. Payen must have had some inferior variety, or the European corn is not equal in nutritive properties to ours. I will insert here some of Mr. Salisbury's determinations. These were made upon a large number of kinds, and were carried out not only in the grain, but the cob, the stalk, and the leaves from an early period of growth to entire ripeness.

The following table gives the results of three analyses.

	No. 1.	No. 2	No. 3.
Starch,	56·10	53·08	61·52
Sugar and extractive matter,	9·92	11·72	12·43
Woody fibre,	6·95	5·10	5·32
Nitrogenous substances like gluten,	16·54	18·46	10·05
Oil,	5.09	4·96	5·02
Gum,	5·35	6·67	5.66
	99·95	99·99	100·00

These are selections from a large number, and indicate a much more nutritious food than that mentioned by Payen. The stalk of this grain, according to Mr. Salisbury, is also quite rich in substances containing nitrogen. He gives additional analyses, which show that the cob has so much of these bodies as to be of some value in feeding. The above analyses may possibly be a little high in their per centage of gluten, &c., as from the nature of these bodies, their proportion can only be determined by an ultimate analysis. Even if it should prove necessary to reduce their percentage a little, this grain would still be both more nutritious, and more fattening, than any of the other cultivated grains. The composition of ash, given by Mr. Stephens, does not differ greatly from that of the varieties examined by Mr. Salisbury. The phosphoric acid in the ash of the grain amounts to about half of its weight; potash and soda being about thirty per cent. of the remainder. The phosphoric acid in the ash of the cob is also quite large, being from twelve to fifteen per cent., with even more potash and soda than in the grain. These substances in the ash, are an additional reason why the cob may profitably be employed in feeding. It also serves the purpose of distending the stomach, thus saving an equivalent amount of straw or hay.

1313. These corn bruising machines are, when worked by hand, occasionally efficient for preparing small quantities of grain: but for work on a large scale they are worth little. They operate slowly, the one here named only bruising four bushels of oats per hour, and moreover go so hard that men dislike the work. In any situation where water or steam mills are within a reasonable distance, it is far cheaper, in my opinion, to get grinding done there. If the machine be contrived as 1314, for attaching a horse power, it may be more advantageously used, although I doubt if there would be much economy in it even then, except possibly in remote settlements.

1325. This and succeeding paragraphs, possess much interest to the practical man. I do not consider the experiments made upon steamed food as conclusive, with regard to our practice, since they were made almost entirely upon turnips. We want much, some carefully conducted experiments upon the cooking of Indian meal. Some of the results from the use of prepared food, of linseed, of cut straw, &c., are quite remarkable; the prominent place given to linseed in all of these preparations is worthy of notice, and may lead to its profitable employment in those sections where linseed is cultivated. There seems no reason why the use of compounds should not become quite common in this country, particularly where fuel is cheap. For hogs the cooking of food is already very extensively adapted, and it is found that they do remarkably well on that which has even become sour. The generally superior efficacy of cooked food is in a great degree owing to a change which is effected by heat, of a portion of the starch into gum and sugar; it is thus more easily digested. In souring, at least in the first stages, this process is carried still farther, the food thus becoming more and more digestible until the sugar undergoes a second change, and fermentation begins, resulting in the production of alcohol. The difficulty in practice is, that no animal but the hog will eat food in the sour state.

It is to be remembered, that experiments in feeding always require to be conducted with very great caution, as they are extremely liable to be affected by causes of which the common observer can know but little. Differences in the temperature of the stables, in the ability of the animals to stand cold or heat, in their individual constitution, in the quality or cleanliness of their food, might each or all influence most materially the result of an experiment. A great number of points require attention in order to produce results worthy of entire confidence, and many of these are little likely to occur to those who have never made such matters their study. Hence we see multitudes of apparently discordant statements, constantly appearing in our publications. If the whole truth in every particular were known, it is altogether probable that these very experiments might coincide rather than disagree. The same reasoning applies to experiments in all agricultural departments. Those who wish to fully comprehend some of the difficulties that are to be encountered in attempting to increase our knowledge on these points, will do well to read a few of the first pages in a new work by Prof. Johnston, entitled " Experiments in Practical Agriculture."

1395. The high racks are, I think, almost universal in this country. The mangers are elevated to about a level with the horse's breast, and the rack is immediately above. When the hay, as is most common, is stored above the stable, this form of rack is by far most convenient, as then the hay can be thrust into the top of it without any trouble. It does not seem as if this situation of the rack would cause any serious inconvenience to the horse, as it takes but a moment to pull out each mouthful, and he can then eat it in his natural position at leisure. I have never seen stone mangers in this country; made of iron they would be lighter and better than stone in every respect.

1403. The method of ventilation here described, by means of small windows, is that which is most commonly employed in this country; small slits being cut through the walls close to the animals' heads. If the building be of wood, it is common to see a small square opening with a sliding door. Wood is the usual flooring material; and so long as it remains cheap, is probably, all things considered, the best. It is soft and warm in comparison with stone, and is easily and cheaply renewed. In cow, cattle, and sheep stables, plank will last a long time, but horses wear them out more quickly, being more restless and having their feet shod with iron. Some persons advocate keeping stock on the ground, but I can see no advantage to be derived from such a practice, excepting cheapness in the first outlay. The disadvantages, however, are considerable. If much straw for litter were not constantly at hand, the ground would soon become poached and muddy; this being in fact the condition of most such stables that I have visited. Even if covered with straw so as to prevent this, it would grow damp and unhealthy by the exhalations which would rise. A large portion of the liquid manure would necessarily be lost by soaking into the ground, and it would soon become exceedingly difficult to maintain a proper degree of cleanliness and freedom from hurtful fumes. Winter being in the Northern States a season of such cold as forbids all cultivation of the soil, many of the matters here treated of may seem to be, and actually are, for those states, more appropriate to other seasons of the year. This, however, does not hinder the applications of the principles explained, when the proper time does come. Our winter feeding must always be of a different character from that practised in England; animals can obtain little or no support, except from stores laid up by the farmer, and can nowhere find the shelter which they need from extreme cold, except in the buildings which he has provided for them. These facts point out a serious disadvantage and burden, under which the farmer in northern climates labors, in the extent of buildings which he has to furnish and keep in repair, for the accommodation of large stocks of animals. and for the storage of their food. This disadvantage is one which will increase as the country becomes more densely settled, as lumber and various other building materials become augmented in price. When more capital comes to be employed in farming, as the number of acres upon each farm that are *thoroughly* cultivated increases, so will the crop become more and more bulky, calling for a corresponding enlargement of store-houses. Men cannot much longer, in the older states, afford to hold two or three hundred acres of land which is only tilled so far as their individual labor, with that of one or two assistants, can accomplish it. The expense of farming so much half cultivated land, and the interest on its augmenting value, will more than swallow up their profits; thus they will be compelled either to employ more capital, or to subdivide until their land is reduced to such an extent as they can manage properly. This will not, however, remove the difficulties attending the questions of storage, and room for stock, as the small farm well attended to will, undoubtedly, produce more than all of the large one used to do, upon its poor, neglected fields. Climate we cannot hope to alter by means of chemical or scientific improvements, and our attention must then be turned to other means of escaping from the evil under consideration. One of these will, I think, ultimately be found in the stack yard. Our ideas of stacks must not be drawn from the caricatures usually seen in this country, made of bog hay, of dry worthless corn stalks, or some other material on which little value is placed; but from such descriptions as will be given in a subsequent part of this work. Stacks put up in the manner there described, resist perfectly the damp, trying climate of Great Britain, and would unquestionably be found efficacious here. They are made of different sizes in different districts, and I have seen them from such as would contain 50 bushels of grain, to such as would yield 5 and 600 bushels. In these stacks, if well covered and occasionally inspected as to the thatch, grain will keep entirely sound for years, only subject to the ravages of rats and mice, which would be equally if not more destructive in a barn. The small stacks of Scotland, are set upon posts so as to obviate this difficulty also. It is surprising to see how little rain or moisture, even from melting snow, penetrates a well made stack. The great objection to their extensive use in this country, is the inexperience of our workmen in building them. It also requires more time to dispose of a load in a stack than to pitch it upon a mow or throw it off into a bay; this is an item of some consequence in the hurry of harvest. Where materials are sufficiently low, it is probably the best economy at present to run up cheap barracks; but where they are not it would be better for the farmer to study Mr. Stephens, and learn how to build stacks. Where new cattle sheds are wanting, the additional height of frame and covering for the sides, and of boards necessary for the floor of a loft, bear in ordinary cases a small proportion to the whole cost.

Another means of improvement would be to feed more on concentrated forms of food, as meal, oil-cake, linseed, or prepared cake. Small portions of these cause the animal to thrive better, while the quantity of bulky food necessary is greatly diminished, and so of course the supply requisite to be stored away for winter. Much importance should be attached, in this respect, to the cutting of food, as being highly economical, and at the same time a more satisfactory practice for the farmer. Judging from the multitude of cutting machines now annually produced, the demand for them must be large, and it is to be hoped that it may still greatly increase. The New England farmer cannot, like the British, convert his straw into manure with facility, by making litter in his barn-yard in winter, for the whole soon becomes a mass of mingled snow and ice, so that the straw often comes out in spring, bright and long, as if just threshed. It is then best for him to make as much manure as possible, by indoor littering, and by consumption, as cut stuff.

Although the northern farmer is precluded from ploughing and sowing during the winter months, and although his time for actual field operations is thus materially shortened, his condition during the cold season is by no means tedious or unpleasant. He is able to give his undivided attention to the feeding and well-being of his stock, and *ought* to study their nature thoroughly, as well as observe carefully the effects of various kinds or preparations of food upon them. His reduced force may thresh out the grain at their leisure; all tools should be put in the best possible order for the coming campaign, also carts, wagons, and harnesses repaired, so that they will not be likely to fail at any critical juncture. It is the time, too, for making out and balancing farm accounts, writing up records from notes of past experiments, and devising new or confirmatory ones for the coming season. These are fit occupations for the long evenings. But, more than this, he has abundant time for study and reading. It is a common complaint among practical men, that they cannot understand scientific books, or what scientific men say. This is certainly their own fault, for there are few farmers who could not, by a little study and perseverance, get enough instruction to be of very great advantage to them in these respects. It is the improvement of leisure hours, by reading and reflection, that produces the clear-headed, sound-thinking men, a few of whom are to be found taking the lead in nearly all of our country villages. Their aim, however, has hitherto been chiefly to increase their stock of historical and political knowledge, or of general information. They ought now, in addition to these, to devote attention seriously to science in connexion with agriculture. Such works as the present, as those of Professor Johnston, of Liebig, of Boussingault, and others, are not only instructive, but highly interesting. A far better mode of obtaining this kind of knowledge, is to attend courses of lectures referring to the various subjects of which the above works treat. But this cannot be done by all; and those who read attentively will gather much information from the books themselves, although they may not be able to understand everything. The manufacturer, the mechanic, the engineer, who could not tell why he employed such and such machinery, or invented certain new arrangements, or point out with distinctness the results to be arrived at by certain combinations, with the reasons therefor, would be considered but poorly acquainted with his business; and yet, how many farmers are to be seen every day, who do not even know what one of their crops contains, what their land is made of, or what is the necessity for applying manure, so far as to explain its effects. Let us hope that this state of things will not long continue; that farmers as a body will rapidly improve under the spirit which now begins to prevail among them; that they will soon understand their own profession, both practically and theoretically, as do those who engage in other pursuits. It is true that the farmer has a wider field of knowledge to travel over than have men in most other occupations, but then he has more leisure than they have in which to accomplish his journey.

In the middle States, more of the British practice may be introduced, on account of the similarity of climate. In order to the full prosecution of the most improved British system, the introduction of sheep husbandry to a far greater extent than it has ever prevailed, is a necessary change. When the south downs, cheviots, black-faced, and other breeds, famous for the quality of their mutton, are more generally known and introduced; the reputation of mutton, now so low in many parts of the country, will be increased, and the demand for it as an article of consumption become greatly augmented. Flocks will be kept to supply the markets with mutton, the wool being a secondary consideration, considerable in quantity, but of medium quality.

Turnip culture, and feeding off, for at least a large part of the winter, in the open-field, after the method described in this part, will be found the most economical mode of fattening for market. Probably no other crop will fatten an equal number of sheep per acre; and if, according to some of the practices to which attention was drawn, small portions of linseed or oil-cake, or in this country, Indian meal, were given daily with the turnips, their growth would be rapid. The benefits of feeding sheep in this way are not confined to their increase in weight; the land also improves very greatly. Feeding off with sheep is one of the most effective and speedy methods of bringing up a light poor soil. It is compacted by their treading, in a manner more effectual than by folding with any other animals. At the same time, they cover it with a coat of manure that is evenly distributed, not left in large masses like that of other stock, and which is very ready to decompose, when ploughed under the surface. As sheep fattening for market are mostly well grown, their frames, being of full size, would only require extra flesh and fat laid upon them. The phosphates, &c., of the food, which would be retained by the young animal to form part of its increasing bones, are here mostly returned to the soil in the manure. Thus, the soil would not lose much of its organic matter in such a case; and if oil-cake, &c., were given, as recommended above, it would probably improve in its inorganic part, as those varieties of food not only tend to lay on muscle and fat, but also contain much phosphates, &c., which would go to the soil. Thus sheep husbandry, as connected with turnip culture, becomes a valuable mode of enriching the soil. Many light lands, in different parts of England, have been entirely renovated by such treatment, coming once in every rotation. The nicety in the cultivation of this root, which will in a subsequent part be recommended, cannot as yet be profitably attained in this new country; but that good crops of turnips can be grown is beyond a doubt, and that with reasonable expense. The only question, as I have before observed, is that of adaptedness of climate. This can be settled decisively by trial alone, and it is probable, may be modified by changes in the time of sowing and method of cultivation, as experience shall indicate. In the middle States then, it is quite possible that turnips may become a leading crop; in the northern, for reasons already stated, I think that they must always hold a secondary rank to less bulky and more nutritious crops. I have spoken of turnips as the type of a class. Several of the other roots are more valuable as food, weight for weight; and it may turn out that some of them are better adapted to our warmer and dryer climate. They are all more difficult of extraction from the ground than turnips, growing less above the surface, and hence, they would have to be pulled up in some way before sheep could get at them with much success.

It may be thought that these volumes are not adapted in any way for the use of the agriculturist in the Southern states. Sugar cane, tobacco, cotton. Indian corn, their great staples, are not treated of at all; the composition of Indian corn is merely noticed in a single paragraph. This is all true, and yet the conclusion that the work will be of no use in the south, is, I think, quite incorrect.

All that relates to ploughing, for instance, and working the soil, is important. The best form for a plough-share; the best shape of furrow; the complete pulverization of the soil; the general perfection of work, are as necessary to the southern planter, as to the northern farmer. He does not, it is true, do the work with his own hands; but he can encourage good work among his people.

The general character of southern agriculture, judging from the representations of southern men, not from personal experience, is somewhat rude and unfinished. The land seems to be mostly under an exhausting system, much being taken off, and little returned. I know this to be largely true at the north, and yet have no doubt that we are far in advance of many southern districts. It is then desirable that a knowledge of better systems should be widely spread; that examples of careful and finished cultivation should be given; so that in any case, they and we may know what our farming ought to be, and may constantly aim at improvement.

The southern planters are, many of them, men of large capital, employing from 150 to 300 and 400 slaves, and even upwards. Men with such means, have the ability to move more rapidly in the march of improvement than the farmer at the north, whose only wealth lies in his land, and must be extracted thence by the energies of his own arm. On these large plantations, we ought to see methodical systems of working; that perfect division of labor which constitutes the advantage of large manufactories over small ones; that method Mr. Stephens so constantly recommends, and so clearly illustrates. This we find on large English and Scotch farms; each class of laborers has distinct employments, in these they usually continue during the whole season or year, thereby acquiring a dexterity and readiness, combined with an excellence in execution, that can only be attained by constant practice. On northern farms, with few laborers, this, as has been said, cannot be done; on southern, however, it must be practicable to a large extent, and is doubtless understood, in a certain degree at least, by the best planters. Particular hands always at the plough for instance, would in time do their work in an admirable manner, if proper implements were furnished them. Good ploughing cannot be done with such ploughs as are, in too many cases, sent south; an article distinctly and confessedly inferior being manufactured expressly for that market. Until the demand in that region for cheapness of tools, without much regard to quality, is over, the work cannot be of the best character.

In some of the southern uplands, where Indian corn and rice are the chief crops, it is quite possible that most other crops might be grown to advantage. It is said that fine woolled sheep deteriorate there as to the quality of their fleece: but it would be profitable to produce good mutton. Many of these uplands are of a light poor character; if root crops were grown on them, and subsequently fed off in the field by sheep, the consolidation of the soil, and the coat of manure left upon it, would prepare it for a heavy green crop; this in turn, ploughed under, would enable the soil to produce an increased crop of roots. Continuing in such a system, and aiding it by feeding the sheep with small quantities of meal, &c., as mentioned above, such land might be increased in value very rapidly.

From all that I can learn, the present cultivation in many of the upland districts, is of the most rude and primitive description, scarcely worthy the name of farming. In such regions a work of this nature is not likely to be appreciated; but at the same time, they are the very places where its instruction is most needed.

The southern planter has not the winter season of comparative leisure which the northern farmer enjoys; his winter is a time of most pressing occupation; and his season of activity continues through the whole year. Planting or sowing of one crop, goes on simultaneously with the harvesting of another; and so each season has its full complement of cares. But the planter has an advantage in one respect: his operations are upon such a large scale that all he has to do is to plan out and direct the employment of his forces and the manner in which the several fields shall be cropped. Such general dispositions being made, all of the details are carried on by his steward or overseer. The eye of the master must, it is true, keep the movements of the subordinate in check: must hold him diligent and faithful: but after all, he will have abundant time for the improvement of his mind, and the increase of his knowledge, by studying works connected with the scientific and practical advancement of agriculture in its various departments. He has the means and the force necessary to carry out what seem to be reasonable changes in practice, and may by judicious efforts better his own condition, while his example will prove beneficial to all around him. It seems then that, in both northern and southern farming, there is leisure time which may be usefully employed in studies and reading relative to improved agriculture.

The commencement is all that is required: a man accustomed to active life, often dreads to begin the reading of a serious, or a long article, even upon an interesting subject. It is easier, and calls for less mental effort, to spend his leisure hours in visiting and talking, or in some active out-door amusement. When, however, the book or the study is fairly commenced, and the mind becomes aroused, his interest is in no danger of flagging, and he requires no more urging to pursue the subject. I have seen repeated instances of this, and have noticed how close is the connexion between a course of sound useful reading, and a growing inclination to cast aside old prejudices, and to consider proposed improvements in agriculture as a merchant considers a novel venture in trade; not with contempt because it is new, but with a desire to investigate, and see if there is not something to be gained by embarking in it.

1434 to 1437. The facts developed in these paragraphs, as to the feeding of horses entirely upon cooked grain, are interesting and instructive. More experiments are required, before we can consider the question entirely settled. It may well be that for working animals, cooked food of this description is too easy in its digestion, passing through the body before a proper degree of nutrition has been drawn from it. The bruising of the grain seems clearly an advantage; and it is obvious, from the facts noticed in 1444 and succeeding paragraphs, that the oats and Indian corn ground together, a mixture which has been gaining in favor here during the last few years, is a most admirable food. My own impression is, that a mixture of this kind dusted over cut-straw and hay, previously a little wetted so as to make the meal stick, is the best regular food that can be given to horses. This seems to coincide with the results arrived at by Mr. Stephens. Bean meal is not used in this country, for the reason that beans as a field crop are but little known; it is an extremely nutritious food, but I think not equal for our purposes, all things considered, to Indian meal.

1453. The method of feeding here indicated, I should think well worthy of trial. Sheaves of oats cut in this way, would not only form an excellent food, but would supersede the necessity of almost any other. The expense of threshing would be saved, the straw all eaten in place of hay, and according to these experiments the quantity of oats eaten was reduced; while, at the same time, the animal was kept in good working condition. Such a practice is easily tried by all who have a cutting machine, and may be found highly worthy of introduction. The oats being mixed so thoroughly with the straw in the stomach, could not pass through the animal undigested, as a large portion of them often do. If the crop were cut before the straw was fully ripe, this would be a food of great value.

1456. The apparatus represented by fig. 113, is very perfect in its working, and is, for large farms, probably by far the most convenient one that is known. For small farms it would be too expensive an investment, unless simplified and cheapened. It is a great and well founded complaint against boilers of the common construction, as fig. 114, that the frequent emptying by dipping out their contents, is both troublesome and tedious. There is, besides, difficulty in cleaning them thoroughly; so that a little liquid or solid is often left in the bottom. This residue sours, and communicates a disagreeable taste to the whole boiling, when the kettle is next filled. The barrels in fig. 113 can be inverted and emptied of their contents in a moment, and can be washed with equal facility. Steamed food, if the vessels are in good order, is always clean and sweet. Where many hogs are kept, such an apparatus would be extremely valuable, both as a means of furnishing them with excellent food, and of economy in the labor of preparing it. The pressure of steam need not be large, and consequently, any old second hand boiler of small size, would answer for such a purpose. A safety-valve, however, as Mr. Stephens recommends, should always be considered indispensable.

1507 and 1508. Hair, horn, and wool, are among the most valuable and powerful of manures. The substance which is here mentioned, as resembling gluten, and constituting a large portion of their bulk, abounds in nitrogen, and is consequently a most efficient fertiliser. Their ash is also rich in phosphates, and other valuable constituents. Wool, or woollen cloth, decays slowly in the soil, and hence affords nutritive matter to the crops for a long period of time. The refuse rags and sweepings of woollen mills, are valued very highly in England; Johnston states that a price of $16 to $20 per ton for them, is the usual rate. The best way to apply horns, which have much the same composition as bones, is to dissolve them in sulphuric acid. These three kinds of valuable manure have hitherto been almost entirely neglected in this country; immense quantities have been, and still are, entirely wasted.

1553. This paragraph indicates a very important fact, and one that, among others, should lead the farmer to think of the cultivation of root crops; not alone as a change among other crops, but as an excellent and cheap article of food. If carrots and parsnips, cut up with hay and chaff, can be profitably substituted for grain in feeding horses, either wholly or in great part, a very important saving may be effected; for an acre of good carrots or parsnips would maintain as many horses as would four or five acres of oats. Horses are extremely fond of both these varieties of roots. Another advantage is, that so far as yet tried they seem to bear our climate quite as well, and in many cases much better, than turnips; their roots go deeper beneath the surface than those of turnips, and consequently obtain more moisture to withstand the dry summers. This form of root, however, renders deep ploughing necessary, as they require a mellow and deep soil in order to attain their full length. The most recent analyses of carrots and parsnips, seem to show their superiority over turnips in nutritive qualities; they contain less water, and the solid matter, besides being thus larger in quantity, is somewhat richer in quality. The mangold wurtzel would probably be equally palatable to animals, and it is said by most authors to surpass either of the above named roots, for feeding. It is hardy, and returns an abundant yield.

1544 to 1556. These paragraphs form an excellent and comprehensive treatise, upon the theory and practice involved in the shoeing of horses. All who keep horses, or have much to do with them, know how often they are lamed, and their efficiency destroyed, by bad shoeing; the hoof is pared too much, the nails are driven in the wrong place, or too near the edge of the hoof, the shoe is too tight, &c., &c., all arising from a want of skill and care in the person who performed the operation. By reading these paragraphs, and studying the cuts, every farmer can understand for himself how the business ought to be done; and can oversee it, or give proper directions for its performance. It will be noticed, that the number of nails recommended as amply sufficient, is much less than what are considered absolutely necessary by most of our smiths. Probably the degree of care in shaping the shoe, and of attention in fitting it, as recommended by Mr. Stephens, obviates the necessity for many nails.

1574 to 1577. The paragraphs here noted, show a different mode of keeping swine, from that practised in our Eastern and Northern states. The universal practice in these states, is to keep them in pens, even where the stock is large. There are several good reasons for this; one is that there is no difficulty in having litters of pigs, and rearing them properly, at any time of the year. We are not confined to warm weather alone, as here recommended, because the young pigs can always be made warm and comfortable in the pens. When kept in pens, they can also be located in a convenient position; where the refuse from the house and the dairy, and food from the granary, can be furnished them with least trouble. It is easy to have a root cellar and a boiler near by, for their especial accommodation. If a steaming apparatus like that in fig. 113, be used, and properly situated, a very convenient arrangement might be made.

1584 and 1585. The remarks in these paragraphs bearing upon the cooking of food, and the experiments detailed in 1591 and 1592, come with additional force after what has been said relative to steaming apparatus, and other arrangements for cooking. The soured food mentioned in 1586, has been tried with great success by some feeders. It is probable, that the lactic acid found in the first stages of fermentation, acts upon the starch, and perhaps in a degree upon the woody fibre also; bringing them into a soluble state, forming sugar or gum, and thus fitting them for more easy digestion and assimilation in the animal economy. If the fermentation and souring be allowed to go too far, alcohol is formed by the vinous fermentation; the mass then rapidly proceeds to the acetous fermentation, in which vinegar is formed; by this time its value for food is quite destroyed.

1598 to 1643. The remarks and instructions under this division, upon the breeding and management of fowls, will be found both interesting and profitable, to all who take pleasure in that branch of domestic pursuits. Even if fowls do no more than pay for their keeping, there is a profit to the farmer in the cheap luxuries which are always at hand, to vary his table during a large part of the year. But it seems to be agreed by all who have tested the matter thoroughly, that the breeding of poultry for market, and the selling of eggs, can be made one of the most lucrative departments of the farm, in proportion to the amount of capital invested.

It is worthy of note on p. 1615, that they do not understand Indian corn in Scotland, so well as our hens, ducks, pigeons, &c., do; for these fowls certainly disregard in a most flagrant manner the assertion there made, that the grains of Indian corn are too large to be swallowed by them, unless previously crushed or cracked.

1668. There seems to be no doubt but that a part of the food taken into the stomach, is burned, so to speak, in the lungs, as well as in the capillary vessels of the extremities and other parts of the animal. Thus there are two sources of heat in this consumption of food; one in the tissues or cells in the extremes and other parts of the body, keeping up the vital heat, and at the same time assisting in the necessary transformation and reformation of the various tissues; the other in the lungs, to maintain their warmth. In a part of the body so exposed to chills as the lungs, owing to the constant inhalation of cold air, the combustion requisite to maintain their high and equable temperature, must be powerful and steady.

1674. To the points specified as to the quality of food best adapted for fattening, and as to the advantage of rest and quiet; there should be added a third important requisite, which is warmth. Without this, as has been explained, the animal consumes a very large portion of its food in keeping up the heat of its body. All that is used in this way, adds of course nothing to its bulk; hence the true economy of furnishing proper shelter.

1692. The details given in this, and succeeding paragraphs, are full and satisfactory explanations as to the construction of Scotch and English threshing machines. These are usually more substantial and expensive in their structure, than those employed in this country. In many sections, particularly of the West, parties travel about the country with machines, and do the threshing for the farmers at so much per bushel, or by a contract for the entire job. These travelling machines are usually worked by from six to eight horses. The under-foot wheels spoken of in par. 1715, are decidedly the favorites in this country; such a preference may perhaps be owing to the prevalence of travelling machines, the under-foot wheel being the only convenient form for them. In cases where farmers own a machine, and have it permanently placed, the overhead wheel is sometimes employed. Steam power may be said to be almost entirely unknown for farm purposes, in the Northern states. Advantage can, on many farms, be taken of water power, and much expense thereby avoided. The directions given in paragraphs 1721 to 1733, will be found of much value, to all who have an opportunity to use water for propelling their machinery. The turbine wheels lately introduced, enable water power to be employed with effect, under circumstances of quantity of flow, and height of fall, in which a breast or an undershot wheel would be of little service. The American machines used for threshing, seem to compare well in efficiency with any that are used in Great Britain. 50 to 60 bushels of wheat per hour, with 6 to 8 horses, is not very uncommon work. The horses being lighter, are more numerous than in the British machines. All of the best machines both clean and thresh the grain.

Those made by John A. Pitts, of Rochester, N. Y., have a high reputation, and are extensively employed. In the construction of our beater or thresher, there is, I think, an advantage over either the English or Scotch machines. There are spikes, or beaters, not only upon the drum, but upon the concave; and so arranged in an alternating manner, that they produce a rubbing as well as a beating motion. These beaters are frequently made of round iron, but the principle of having them wedge-shaped seems to be most approved at present.

1821. The machine here figured and described, is worthy of a moment's notice, as being so inferior for all practical purposes, to the platform scales, now so universal in this country; such as those of Fairbanks' and others.

These are quite portable, far lighter and simpler than the Scotch machine, and will weigh much quicker: this for the reason that being upon the steelyard principle, the great and unnecessary labor of lifting a weight equal to whatever is to be weighed is avoided. The Fairbanks platform scale is also much more compact, occupying scarcely half the room. The price is not more than half that named for the best construction of the above machines.

1846. This, and succeeding paragraphs, relative to the classification of wheat, will possess interest for those who are curious in varieties of that grain. It is evident, that there is a degree of discrimination exercised regarding the character of different samples of grain, and their fitness for particular purposes, that is almost unknown here. Our bakers supply themselves with flour in the barrel, ground perhaps 500 or 600 miles away, and unless I am misinformed, consider themselves able to pronounce upon its fitness for bread-making purposes with much certainty. The distinctions in the varieties of wheat do not by any means receive so much attention as in Great Britain, and the information that most farmers are able to afford on such points, is of a very indefinite character. There is no doubt but the character of our wheat would be improved by care as to the selection, and as to the purity of seed: not only this, but the yield would in many cases be increased, for it is a well established fact, that of two varieties of white wheat, for instance, grown on the same soil, one will outyield the other. Care upon these points then, may be *profitably* exercised, and the subject is not to be set aside as only interesting to book farmers and amateurs.

1887. The process here mentioned, has been recommended in this country, and somewhat extensively practised. There is no question but that good bread can be made in this way, and without the necessary loss, which ensues from the destruction of a portion of the bread itself, during the ordinary process of fermentation. The experiments of Dr. Thomson, par. 1888, show a very considerable gain by this method. These, however, do not settle the question, as it may be that the mixture of these chemical materials causes the bread to retain more water than usual, and in this way increases its bulk. We need some experiments on this particular point. Bread one day old, contains, according to Dumas and Johnston, from 40 to 45 per cent. of water. Small additions of certain chemical substances, are capable of making the bread retain several pounds more in the hundred, of water.

1896. I shall show, in referring to Indian corn, that this grain, although it does not contain gluten, contains so much of a substance which is quite equal to the gluten of wheat in its nutritive qualities, as to render it the superior grain of the two.

1901. There should be a distinction drawn, with regard to the observations in this paragraph, relative to Prof. Johnston's analyses. I consider the principle mentioned as adopted by Liebig, and other leading chemists, that the amount of nitrogenous substance in any kind of food determines its nutritive value, to be in the main correct. We find on analysing any concentrated food, a small portion of which will sustain life for a long time, that it is invariably exceedingly rich in nitrogen; and thus prove incontestably, that this is the most important element, when we are considering what food is most nutritious. I do not speak here of food for fattening animals, that must have an excess of carbon, but simply of that which is best adapted to the formation of solid muscle.

In this view, Prof. Johnston is correct in saying, that the wheat which contained most nitrogen was most nutritious. Whether the bread was heavy or light, makes no difference whatever. The light bread might be more easily digested, it is true, but that does not show that it contains more nutritive matter than the other; rice, arrow-root, and tapioca, are more easily digested than meat, but it does not thence follow that they are more nourishing. I do not believe that any baker, or grain merchant, can tell from the exterior appearance of wheat, its relative nutritive qualities. He may say with certainty which will make the lightest and most palatable bread, but cannot know that this bread will be the most nutritious.

We shall mention some of the varieties of wheat best known in this country, when treating more particularly of winter and spring wheat, under their respective heads.

1906. Barley is a crop less cultivated in this country, than any of the other grains. The State of New York, according to the statistical returns, grows more than all of the other states together. Its use is chiefly for malting; and the great falling off in the consumption of beer, occasioned by the temperance reformation, has lessened the demand for it.

As an article of food for man, barley is almost unknown; indeed in many districts, you may travel for hundreds of miles, and never see a single field of it. Barley meal, however, does really make an agreeable and nutritious food. The fact that it contains less gluten than wheat, must not be considered as conclusively deciding that it is greatly inferior to that grain. In place of gluten, it has another nitrogenous body, of nearly similar composition, and quite equal in value. Thus we see that the proportion of nitrogenous or protein bodies in barley, given in par. 1919, comes fully up to the highest percentage mentioned under the head of wheat.

With regard to these analyses, it may be proper here to say a few words in explanation. The farmer should read attentively the various analyses, given under these and succeeding paragraphs; for after careful study, he will not fail to draw many valuable practical conclusions from them. It should be remembered at the same time that all researches hitherto made into the composition of plants, have shown a difference in the constituent parts of the same plants, when grown in different situations, or fed with different manures.

We do not as yet know how far these variations may be carried, but the fact that they are considerable, is fully established. This does not affect, however, the *general* character of either the organic or inorganic part; in a grain (such as rice) abounding in starch, that will always continue to be the predominating substance, though its exact proportion does not remain the same, by perhaps a variation of several per cent. So in the ash; if the alkalies have been the characteristic ingredient, as in the potatoe, they will still predominate over everything else, though often modified in their proportions; sometimes one of them may even entirely replace the other, and still the plant be healthy.

I speak only of perfect plants and seeds, it is to be observed, for although plants have thus a certain power of adaptation to circumstances, that power has its limit; when that limit is passed, we either have an imperfect stalk or seed, or an utter inability to make any growth whatever.

According to the above remarks, the analyses given here are to be considered, not as representing the exact composition of the various grains under all circumstances; but as approximations to the general characteristics of each species. The same thing is to be said relative to the figures purporting to show the amount taken from the soil by any one crop, as in p. 1903. They are probably correct within a few pounds, and are useful in a high degree, although not entirely accurate.

The malting of barley is an interesting process to the farmer, as it illustrates beautifully the general process of germination in seeds, here witnessed on a large scale. The commencement of germination, is characterized by the formation of a peculiar substance called diastase. This has the power of changing the starch, and like insoluble substances of the seed, into sugar and a species of gum. These are both soluble, and are thus prepared for the purpose of affording nourishment to the young shoot. The growth is arrested by drying the barley, before the shoot has absorbed a great quantity; the grain is then sweet to the taste, its sugar being made use of to furnish alcohol for the beer, by its subsequent vinous fermentation.

The same varieties of barley seem to be cultivated in this country as in England, the Chevalier variety being considered one of the best.

1925. The oats cultivated in the Northern States, are not usually of any very definite variety, the majority having, however, more likeness to fig. 184, than to fig. 183. Oats as heavy as the best Scotch potatoe oats, are seldom, if ever, seen in this country; the average weight of our crops being several pounds less in the bushel, than those grown in Great Britain. In the number of bushels we fully equal them, but fall short in weight. I am inclined to think that this is an effect of climate. The springs and summers of Scotland are much longer than ours, but not so dry and warm. Their oats grow and ripen slowly, in a cool moist atmosphere, while ours grow and ripen very rapidly in a hot dry air. I imagine that the first circumstances suit this crop best. Such a view is strengthened by the fact, that as we go south the oats become lighter and lighter; the inference being that the climate becomes more and more unfavorable to their perfect development.

Probably this inferior character of our oats is one reason why oatmeal is not more used as an article of human food, in this country. It is, with the single exception of Indian corn, more nourishing than any of the grains; I have never seen a finer race of men than the Scotch ploughmen, who live on it entirely.

The liking of oatmeal is an acquired taste, as it is usually quite disagreeable to those who have never eaten it. After a short time however, it becomes a very favorite variety of food, better, I think, as a constant article of diet, than any preparation of Indian meal.

1940. Rye is an important crop in this country, more important now than it will be when our cultivation is better. It is a crop that will grow and produce a fair return, on poor light land, where the other grains would scarcely succeed at all.

A favorite practice with too many farmers, is to grow rye year after year on such land, till they scarcely get more than their seed. They then desist for a time, and let the land lie idle for some years, till it has regained strength to produce a few more scanty crops. Thousands of acres are cultivated, or it should rather be said destroyed, on this system.

As an article of food, rye is agreeable and nutritious. In some of its qualities its flour more nearly resembles that of wheat, than that of any other grain, containing as it does considerable quantities of gluten.

1950 and 1958. Beans and Peas, as a field crop, are almost unknown here; but these paragraphs show that they are a remarkably valuable article of food. The analysis given of the bean, par. 1954, does not do its nutritive qualities justice; in par. 1960, we see that the pea has about 26 per cent. of albumen, legumin, &c., that is of substances containing nitrogen; the latest examinations indicate about the same percentage in beans. Both then are more nutritious than any of the other grains mentioned.

Indian corn is, doubtless, a much more economical food than either of these in this country; but it may be ultimately found best to introduce their field culture somewhat extensively, as a change to a different class of plants in a rotation of crops.

Mr. Stephens has said nothing of rice (oryza sativa), a grain which is very largely produced in the southern parts of this continent.

It contains only one per cent. of ash, the composition of which, according to Johnston, is as follows:

Potash,	18.48
Soda,	10.67
Lime,	1.27
Magnesia,	11.69
Ox. of Iron,	0.45
Phosphoric Acid,	53.36
Chlorine,	0.27
Silica,	3.35
	99.54

The character of this ash seems to be not dissimilar to that from all of the grains previously named; phosphoric acid predominating over every other ingredient, the alkalies amounting to from 20 to 30 per cent., and magnesia being larger in quantity than lime. The following analysis, by Payen, represents the composition of the organic part of this grain.

Starch,	86.9
Gluten, &c.,	7.5
Fatty matter,	0.8
Sugar and Gum,	0.5
Epidermis,	3.4
Ash,	0.9
	100

Here is a far larger proportion of starch, than has been instanced in any previous analyses in this class of crops. The proportion of gluten, &c., of fat, and of sugar, is most materially diminished. To produce an equal effect then, it is necessary to eat a greatly increased quantity.

Buckwheat (Polygonum Fagopyrum) has also been passed over, although it is a product of much value here. An analysis of its ash by Bichon, is given by Prof. Johnston. It will be seen to have the same characters as the ash last noticed.

ASH OF BUCKWHEAT.

Potash,	8.74
Soda,	20.10
Lime,	6.66
Magnesia,	10.38
Ox. of Iron,	1.05

Phosphoric Acid,	50.07
Sulphuric Acid,	2.16
Silica,	0.69
	99.85

We have no very good analysis of the organic part; the best that is known I take from Johnston.

Husk,	26.9
Gluten, &c.,	10.7
Starch,	52.3
Sugar and Gum,	8.3
Fatty matter,	0.4
	98.6

This was made with the husk remaining on the grain; taking this away, its composition and nutritive value would be much like that of rice flour. The gluten, &c., in the above, is too high. Prof. Horsford, of Harvard College, has determined the nitrogen of buckwheat directly, and found it about the same as in rice.

Last, but most important of all, Indian corn, or maize (Zea Mays), requires a separate notice, more full than the partial one above given; as the largest and most universally diffused crop on this continent. It is cultivated from the extreme Northern point where grain will grow, to the extreme South, producing everywhere abundantly, and being a chief reliance for food to man and beast. Maize is the finest in appearance of all the cereal grasses; it is considered to have been a native of this continent, and is supposed to have been introduced in the South of Europe, at about the beginning of the Sixteenth Century. It probably supplies food to a greater number of the human race than any other grain, with perhaps the single exception of rice.

In regard to the exact composition of this most valuable grain, we are still in want of perfectly precise and reliable information, both as to its organic and inorganic part. The analyses made in Europe have been for the most part imperfect; those that are complete must, if accurate, have been made upon samples greatly inferior to our best varieties. Some of them make it little more nutritious than rice, or buckwheat.

The most important and extended researches that have yet been made, are those of Prof. Emmons and Mr. Salisbury. The latter, more particularly, has devoted himself to this subject, and has given us a great mass of results, from which may be derived much useful information. In regard to the organic analyses to be cited, they are all proximate analyses, in which the attempt to determine several distinct nitrogenous constituents, has been made. Such determinations lose much of their value, when not supported by ultimate analyses, in which the quantity of the nitrogen is determined directly and certainly.

This is no discredit to the exertions of Mr. Salisbury, who did all that could be done by industry, in the time allotted to his research. This department, however, is yet to be cleared up. There is a nitrogenous body peculiar to maize, which has been called gladiadin or zein; it is quite desirable that the exact nature and composition of this, should be known. It is probably much like gluten, casein, and other bodies of the protein class.

From the numerous organic analyses given by Mr. Salisbury and Prof. Emmons, I have selected seven, and from these have deduced a mean, which is here inserted as the best that the present state of our knowledge will afford. I have united all of the distinct nitrogenous substances which they mention, under one head. The analysis is as follows:

Starch,	52.32
Sugar and ext. matter,	16.64
Gluten, &c.,	15.70
Oil,	5.31
Woody fibre,	10.03
	100

The proportion of real sugar, in the above 16.64 per cent., is probably quite small. What the extractive matter really is, we are not informed; it may contain some oil, or some nitrogen. The percentage of nitrogenous substances, it will be noticed, is larger than that in any of the other grains, and indicates truly the great feeding properties of this grain. The oil also is so large in quantity, as to explain its remarkable superiority for the purposes of fattening.

I find in Mr. Salisbury's paper, an analysis of the sweet corn, which is worthy of notice. It is as follows:

Starch,	16.76
Sugar and ext. matter,	36.58
Gluten, &c.,	23.32
Oil,	10.94
Woody fibre,	14.39
	100

If this analysis should be confirmed by subsequent ones, we have in this sweet corn, one of the most nutritious kinds of food known. The quantity of starch is small; of sugar, large, as might be expected; and of substances containing nitrogen almost unprecedented. The proportion of oil, too, is quite remarkable. If this kind of corn yields well on a large scale, it might be of advantage to test its value, as it would be according to the above analyses, an unequalled article of food, nutritious and fattening in a most eminent degree.

From the same source as the above, I have selected a number of inorganic analyses, and have again taken a mean; with the view of obtaining at least an approximation to the general composition of the ash. With these analyses I have also ventured to take some liberties, in calculating them without an item called *organic acids.* These can have nothing to do with the real ash, and I am unable to understand how they should be present at all. With these organic acids left out, the mean composition of several samples of ash, is given in the following table:

ASH OF INDIAN CORN, OR MAIZE.

Potash,	16.87
Soda,	12.63
Lime,	0.26
Magnesia,	15.02
Chloride of Sodium,	0.40
Sulphuric Acid,	0.31
Phosphoric Acid,	52.54
Silica,	1.97
	100.00

The greater part of this ash, it will be noticed, is phosphoric acid, so that it corresponds in this respect with the ash of the other grains. The quantities of potash, soda, and magnesia, also come so near as to increase the likeness of this ash to the class that I have named.

The cob of Indian corn forms so large a portion of the ear, that it becomes a matter of importance to know what, if any, is its nutritious value. Mr. Salisbury has examined this part of the plant also, and I instance some of his results, as the only ones of much value that we now possess. They stand alone; and of course require other results both for confirmation and comparison, before we can speak with much confidence as to the mean composition of this part. In the following table is given one of his examinations of the organic part.

Sugar, &c.,	2.49
Woody fibre,	90.80
Nitrogenous substances,	2.19
Gummy substance,	4.52
	100.00

This analysis indicates a considerable amount of various nutritive substances, in this portion of the plant, and probably explains in part, some of the results which have been obtained, by feeding it ground with the kernels.

Mr. Salisbury has examined the ash from the cob, and has shown that also to contain valuable substances for feeding, as may be seen by the annexed analysis.

Carbonic Acid,	10.05
Sulphuric Acid,	21.42
Phosphoric Acid,	14.84
Silica,	12.83
Lime,	4.19
Magnesia,	7.32
Potash,	36.82
Soda,	12.33
	99.10

This ash abounds in the alkalies, and in phosphoric acid; they together making up more than half of its weight. All of the other substances, excepting only the silica, are directly valuable. This is a composition of ash, differing remarkably from that of the straws generally, and has beyond question much influence upon the value of the cob as food.

1764, '66, &c. Here I shall bring in the ash from maize again, to complete the notice of this part also, among the various straws and stalks. In all, except the bean and peas stalks, it will be noticed that silica is the leading substance. The succeeding analysis shows a decided difference, in the composition of the ash from Indian corn stalks.

Potash,	36.82
Soda,	12.33
Lime,	4.19
Magnesia,	7.32
Phosphoric Acid,	14.84
Sulphuric Acid,	1.42
Carbonic Acid,	10.05
Silica,	12.13
	99.10

Silica, in this ash, instead of being more than half, as in wheat straw ash, and others of the same class, is but little more than a tenth. The alkalies are abundant, so also is phosphoric acid. The ash is in its composition, between that of the common straws, and that of peas and bean stalks. For fodder it is worth far more than any of the other kinds; it is considered by many good farmers, when in its best condition, to be nearly equal to good hay.

1999 to 2056. On the forming of manure heaps, and the management of manures in winter. These paragraphs deserve reading with great attention, as they contain much information of a valuable character, with regard to the fermentation and preservation of manures. There are comparatively few farmers in this country, who are aware how great is the loss of substance, during unchecked fermentation. Nitrogen in the form of ammonia, may be detected passing off in large quantities; besides this, carbonic acid, and other products, are continually liberated. The directions given for the prevention of such a loss, under these various paragraphs, are so particular that no farmer need suffer it any longer. It is not necessary for him to build a shed in every field, or over the whole of his yards, but he can introduce more careful management. Mr. Stephens omits to mention here, one of the best methods for arresting the escape of ammonia during fermentation; it is to sprinkle gypsum occasionally over the surface of the heaps or yards. The quantity used, need not be more than a few handfuls at a time.

2037 to 3061. The subject of making composts, is one which attracts a great and increasing degree of attention among American farmers. Nearly all good farmers are now convinced, that this is one of the most advantageous modes of applying manure. By making a compost of absorbent materials.

scarcely any of the valuable parts of the manure can escape. Large quantities of refuse too, that would otherwise decay very slowly, and produce little effect, are decomposed in composts, and thus brought into forms valuable for assisting the growth of plants. All of the materials mentioned in these paragraphs, should be carefully preserved, and even sought after. Many of them are totally neglected in most districts, and can be had for the merest trifle, in many cases for the mere expense of carting. The fish refuse, the dung of pigeons and other birds, the woollen waste, and the animal flesh; are among the most powerful and concentrated manures known. The farmer who systematically collects every species of refuse, and every available vegetable substance, can increase his stock of manure to a very considerable extent and without material expense.

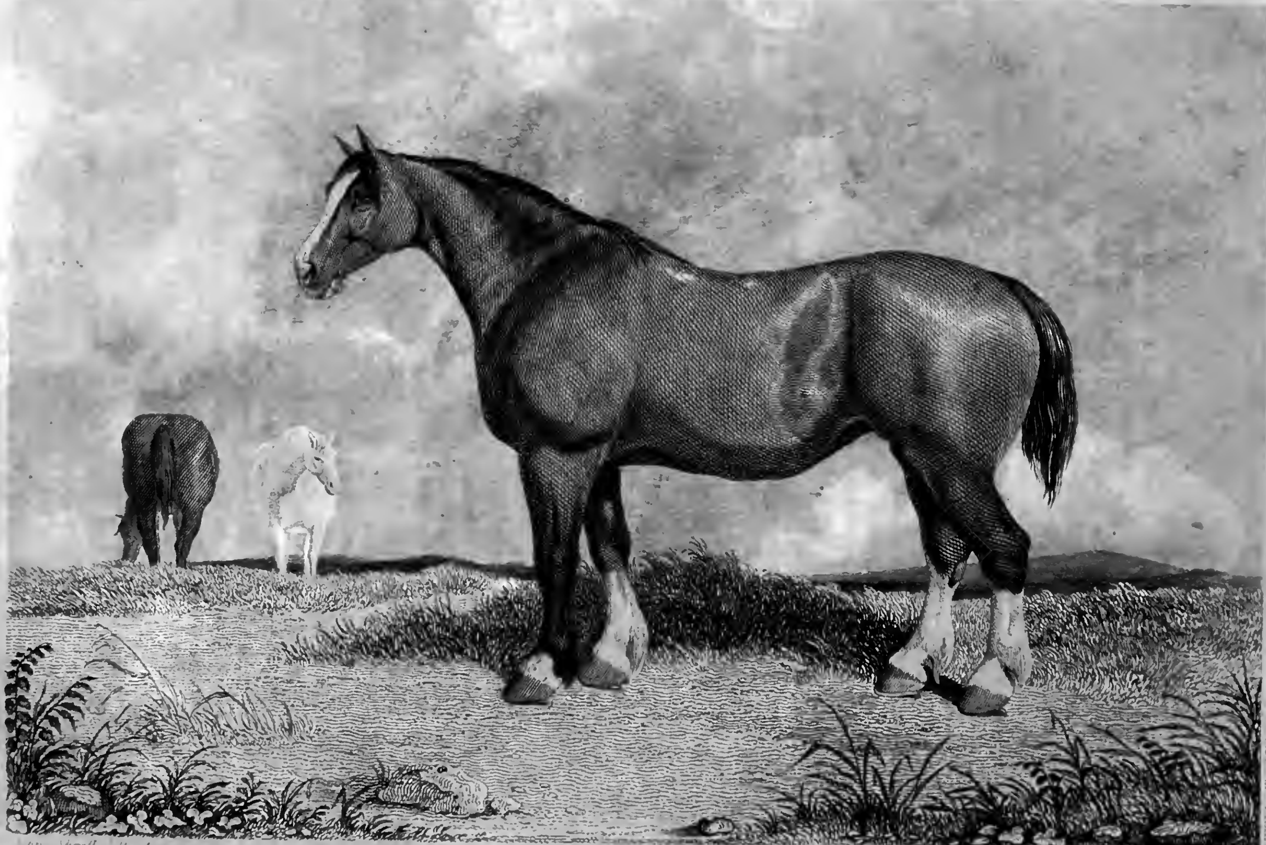
2062 to 2084. The subject of liquid manure tanks, is also one that is beginning to attract much notice in this country. Farmers find that they cannot afford to let a large part of their manure wash away, either into the road, or upon a small part of some one field. The consequence of this is, that the construction of tanks has been commenced, and has, I believe, been attended with the happiest results. The remarks in par. 2063, show that a tank is not necessary for all farms: but wherever it is found that much drainage takes place from the yard, something of the kind is necessary. It need not be large, nor expensive. The only object is to have a tight receptacle, which shall receive and retain the liquid, till it can be applied to some useful purpose. For a temporary end, and to try the value of tanks, one could be made from old boards, or plank, packed with clay behind, so as to be tight. By the time that it should fail, the farmer would probably be ready to build a stone or brick one. The liquid may be pumped out, and used with a water cart as described in fig. 194, or pumped upon a compost heap. Others prefer to throw ashes, plaster, peat, &c., into the tank, to soak up the liquid. In this way they obtain a strong and excellent manure. If too much water runs into the tank, so as to overflow it, drains must be made in such a manner that all water falling from the eaves of the farm buildings, may be conducted away in another direction. A tank 1-7th as long as that mentioned in par. 2068, or 10 feet long, and 6 feet wide, would be quite large enough for the majority of farms in the country. They should always be covered over, as much less is then lost by evaporation. It is an excellent practice to add occasionally, a small quantity of sulphuric acid (oil of vitriol), to the liquid in the tank; this prevents the escape of ammonia almost entirely, and forms with it a valuable fertilizing compound. Sulphuric acid is not an expensive article, being from 2½ to 3 cts. per lb. when purchased by the carboy.

2085. I doubt the entire correctness of the statements in this paragraph, as to the loss of fertilizing substance by washing away from manure heaps. If the heaps are of good size, and properly made, so that rain water may soak into them, instead of immediately running off; and if placed in a proper situation, then it is probably correct that little is lost by leakage; but if piled up in a scattered, heedless manner, and located on a slope near a ditch or brook, the loss is inevitably quite large. I have seen the water of ditches colored nearly black, for a distance of many feet, by the oozing from a manure heap. A very good plan to prevent all possible loss, would be to cut a small ditch round the lower sides of the heap, conducting the drainings to the lowest point, and discharging them there into a sunk barrel, from which they could be pumped up, and used as might be most advantageous.

2086. The leakage of valuable manure, from improperly located, or badly constructed yards, is, in this country, a most important item of loss. In many cases that I have seen, nearly everything soluble is washed away into the nearest road or stream; the manure is left in a bleached condition, having lost in some instances at least half of its value. Some farmers attempt to save these drainings from their yards, by conducting them upon their meadow land. The usual result of this is, that but a small portion of the grass is reached, and that is so much over manured, that it is a coarse and unpalatable food. The only economical way to avoid this loss, is to be found in the construction of tanks, as recommended in preceding paragraphs.

2107 to 2118. The sea coast of this country is so extensive, that sea weed becomes a manure of much importance. There are, however, many long stretches of coast, where very little, or none, is cast up by the sea. This is because there are in the neighborhood of these beaches, more of the reefs, and rocks, upon which the weed delights to grow. The composition of ash from sea weed, as given in par. 2117, shows that this part abounds in substances that are exceedingly important to all of our crops; and likely to be particularly beneficial to those crops that are rich in alkaline compounds. The proportion of this ash in the dry weed, is greater than in dry straw. Sea weed decays very readily, from the large proportion of water which it contains; for this reason, and also from the soluble quality of its ash, it cannot be considered a very lasting manure. If allowed to dry thoroughly, it will remain unchanged for a long time, even when buried in the soil.

PLATE VII.



DRAUGHT-MARE

THE PROPERTY OF Mr BA[illegible]IE, MONKTON [illegible] duced by the melting of the snow sinks gradually into the earth, and the earth has been opened to receive a greater store than if it had been pelted by rain during winter. This is occasioned by the radiation of the heat from the lower strata of the earth, which is confined by the snow, and turned back again to act upon the earth. In the third place, this last circumstance produces a beginning of the spring under the shelter of the snow, which could not have taken place with free exposure to the atmosphere. The blade of the plant is protected, and the roots have heat and moisture, and the air is excluded from them. They are thus placed under the most favourable circumstances, and they are stimulated accordingly. The difference in this respect is very considerable; for if, owing to the action of the wind during the fall, or to any other cause, one portion of a field has been exposed to the air while the frost continued, and another covered by the snow, it will be found that vegetation upon the part which the snow covered will be fresh, green, and vigorous, long before that upon the exposed part shows any decided signs of action. This, by the way, is the real cause why spring is so rapid, and meets with so few reverses, where the winter is firm and decided, but of moderate length, than it does when the winter is variable. In such a place as we are alluding to, the spring-wind usually freshens as the snow disappears; and this latter quickens the melting of the snow, and dries the surface of the ground. When the clods begin to dry, the lark soars aloft at the streak of dawn, calling the ploughmen to their labours. Nor are they backward to obey; for they and their teams have been rested during the storm, and then return to their labour with fresh vigour."*

2145. "In the middle of the hill-country, snow does not fall so heavily as in the low on either side, the storm being exhausted before reaching that distance from the sea. In that case, the stock of sheep are not so long deprived of grass as might be expected."†

2146. *Clouds.*—The prevailing clouds in spring are the same as in winter, namely the *cirro-stratus;* but it more frequently gathers itself into the *cumulo-stratus*, which hovers about in the horizon, and either subsides entirely below it on the approach of the frost at night, or veils the zenith in the day-time, in the form of the *cirro-stratus*; but the *cumulo-stratus* of spring presents a very different aspect to what it does in summer, having generally a well defined though ragged margin, and a peculiar look of transparency or clearness, which is preserved even when the clouds become purple or nearly black. "With such skies," observes Mr Forster, "I have known cold S. winds; and on other occasions, with different kinds of clouds, hot N. winds in spring. The peculiar appearances which attend these exceptions to the usual coincidence of phenomena, ought to be particularly attended to."

2147. *Cirri* are not unfrequent in spring, and assume most remarkable relations with the lower classes of clouds. "I have seen the cirrus," says Mr Forster, "in tufts, moving along rapidly in the wind below cirro-cumulus, and over cumulus in a higher region. There were, however, other cirri more elevated in the sky at the same time."

2148. *Cirro-cumuli* often assume amusing and sportive features in spring; sometimes like long tapering columns, horizontal or inclined, and sometimes like freckles. "Mostly these little bunches of cloud are in a plane; but I have thought," observes Mr Forster, "though it might be an optical deception, that they have been sometimes in a roundish column, giving a faint resemblance to the tail of an armadillo. The cloud which gives what is called the mackerel-back sky, is composed of the long waving cirro-strative nubeculæ, but these sometimes acquire the apparent substance and solid look of cirro-cumulus." ‡

2149. *Rain.*—The character of the rain in spring is sudden, violent, and cold, not unfrequently attended with hail. The proportional quantity of rain that falls in

* Mudie's *Spring*, p. 266-71.
† *New Statistical Account of Scotland—Peeblesshire—Tweedsmuir*, vol. iii. p. 56.
‡ Forster's *Researches about Atmospherical Phenomena*, p. 75.

spring, taking the annual mean as 1, is, according to M. Flaugergues, in—

February,	0·0541
March,	0·0557
April,	0·0802
Mean of spring,	0·1900

It must not be supposed that these figures indicate the exact quantity of rain which falls in the three months of spring, as we have divided the seasons. The meaning of these figures is not to represent the actual amount of rain that falls in spring; but, taking whatever the amount of fall may be in the year as 1, the proportional amount of rain in the spring months mentioned, is represented by the figures given above. If, for example, we take 26 inches as the amount of rain which actually falls on the east coast of Britain, the quantity that falls in these spring months amounts to .19 of 26 inches, or 4·94 inches.

2150. The number of rainy days in the same months is as follows:—

February,	15·8 days.
March,	12·7 „
April,	14·0 „
	42·5

2151. Evaporation is quick in spring, especially with an E. wind, the surface of the ground being as easily dried as wetted. Hence two or three days of drought will raise the dust in March.

2152. *Sky.*—The sky is very clear in spring when the air is free of clouds, and of course the blue colour is very intense. It was a remark of Sir Isaac Newton, that the sky is of the most intense blue colour, just at the change from drought to deposition.

2153. *Prognostics.*—The weather in spring may be regarded as the key-stone to that of the ensuing seasons; its indications are analogous to those of *cirri*, which make the first movement in the upper regions of the sky, when a change is about to take place in the state of the atmosphere. The prognostics of spring are therefore worthy of attention, and the enumeration of a few of them may point to that class of phenomena which deserves the greatest attention at this season. Dr Dalton says, that the barometer is at the lowest of all during a thaw following a long frost, and is often brought down by a S. W. wind. When the barometer is near the high extreme for the season of the year, there is very little probability of immediate rain. When the barometer is low for the season, there is seldom a great weight of rain, though a fair day in such a case is rare: the general tenor of the weather at such times is short, heavy, and sudden showers, with squalls of wind from the S.W., W. or N.W. When the appearance of the sky is very promising for fair weather, and the barometer at the same time low, it may be depended upon that the appearances will not so long continue. The face of the sky changes very suddenly on such occasions. Very dark and dense clouds pass over without rain when the barometer is high; whereas, when the barometer is low, it sometimes rains almost without any appearance of clouds.

2154. A sudden and extreme change of temperature, either from heat to cold, or from cold to heat, is generally followed by rain within 24 hours.

2155. According to the observations of Dr Kirwan, in the course of 41 years there were 6 wet springs, 22 dry, and 13 variable. He considered a season *wet* when it continued to rain for two months; and a season *dry*, when the quantity of rain fell short of 5 inches. On these data, he said that a dry spring was followed by a dry summer 11 times, a wet 8 times, and a variable 3 times: a wet spring was followed by a dry summer 0 times, a wet 5 times, and a variable, once: a variable spring was followed by a dry summer 5 times, a wet 7 times, and a variable, once.

2156. During the forty-one years' observations, Dr Kirwan farther concluded that, in the beginning of any year, the probability of a *dry* spring is as 22 to 41; of a *wet*, as 6 to 41; of a variable as 13 to 41.

2157. After a *dry* spring, the probability of a *dry* summer is as 11 to 22; of a wet as 8 to 22; and of a variable as 3 to 22. After a *wet* spring, the probability of a dry summer is as 0 to 6; of a wet as

5 to 6; and of a variable as 1 to 6. After a *variable* spring, the probability of a dry summer is as 5 to 13; of a wet as 7 to 13; and of a variable as 1 to 13.

2158. After a *dry* spring and a *dry* summer, the probability of a dry autumn is as 3 to 11; of a wet as 4 to 11; and of a variable as 4 to 11. After a *dry* spring and *wet* summer, the probability of a dry autumn is as 2 to 8; of a wet, as 0 to 11; and of a variable as 6 to 8. After a *dry* spring and *variable* summer, the probability of a dry autumn is as 0 to 0; of a wet as 2 to 3; and of a variable as 1 to 2. After a *wet* spring and *dry* summer, the probability of a dry autumn is as 0 to 41; of a wet as 0 to 41; and of a variable as 0 to 41. After a *wet* spring and a *wet* summer, the probability of a dry autumn is as 2 to 5; of a wet as 1 to 5; and of a variable as 2 to 5. After a *wet* spring and *variable* summer, the probability of a dry autumn is as 1 to 41; of a wet as 0 to 41; and of a variable as 2 to 4. After a *variable* spring and *dry* summer, the probability of a dry autumn is as 1 to 7; of a wet as 1 to 7; and of a variable as 5 to 7. After a *variable* spring and *variable* summer, the probability of a dry autumn is as 0 to 41; of a wet as 0 to 41; and of a variable as 0 to 41.

2159. It is believed by many meteorologists, that when the bodies constituting our solar system are placed in particular positions or angles to one another, or *affect* one another, certain effects are produced in our atmosphere, which are indicated by consequent atmospherical phenomena. That increased and diminished attraction exist between the members of our solar system, as they may relatively be placed to one another, at any particular time, admits of easy belief, in a system so firmly balanced as the solar system must be; but what the amount of the mutual effects upon one another, at any time, must be, is a result which long, laborious, and continued observation alone can inform us. It is quite reasonable to suppose, however, that the sun, being so very much larger a body than any other in the system, must produce effects much greater than any of the planets; and his aspects must be far more important, both in power and duration, than the others. The others are supposed rarely to act beyond three days before and after their peculiar aspects.

2160. As regards the general character of the moon's aspects with the sun, it has been observed that the full moon and the quarters are less powerful to cause changes than the new moon and the semi-squares and sesque-squares. Changes sometimes take place at the trines, or distance of 120 degrees; and this aspect seems to act more powerfully to produce wind, (if there be any influences in operation at the time to cause wind,) than any other. Thus, if there be a high wind, and the moon be coming to the trine of the sun, the gale will be very furious about the time of the aspect: also, the full moon appears to be more frequently attended by windy weather than any other, though the trine exceeds it in the force of the wind. By what has been advanced, it will appear that the moon does not act, like the planets, by her own original power, but that, when she forms aspects with the sun and planets simultaneously, she appears to play the part of an electric conductor, and fires the train already laid, and ready to explode. There is reason to believe that electrical changes in the air occur when the moon aspects the sun, or passes the equator or tropics.

2161. Many prognostics of the weather have been received as proverbs by the country people; and as these have only become current after mature experience, we may rely on their accuracy. The following are a few relating to the months of spring in the order we have always placed them.

FEBRUARY.

February fill dyke, be it black or be it white:
But if it be white, it's the better to like.

The hind has as leif see his wife on the bier,
As that Candlemas day should be pleasant and clear.

MARCH.

March hack ham, comes in like a lion, goes out like a lamb.

A bushel of March dust is worth a king's ransom.

March grass never did good.

A windy March, and a showery April, make a beautiful May.

March wind and May sun
Make clothes white and maids dun.

So many frosts in March, so many in May.
March many weathers.
March birds are best.

APRIL.

April showers bring forth May flowers.

Chaucer writes in his Canterbury tales:—

When that Aprilis with her showery soote
The droughte of March had pierced to the roote.
When April blows his horn,
It's good both for hay and corn.
A cold April the barn will fill.

2162. The equinoctial flowers may be said to commence with the first breaking of the frost before February. These comprehend the snow-drop, the crocus, the colt's-foot, all the tribe of daffodils, narcissi, jonquils, hyacinths, primrose, cyclamen, heart's-ease, violet, cowslips, crown imperial, and many others; and every prognostic connected with these plants is of course indicative of the season of spring.

2163. Rain may be expected when the swallow flies low, and skims backward and forward over the surface of the earth and waters, frequently dipping the tips of its wings into the latter, because the insects have descended from the air to avoid the approaching rain. A superstitious respect is paid to the swallow in many parts of the country even at the present day. Their nests are protected, and it is considered unlucky to molest them even by accident. This is a very old opinion, mentioned by many writers; and the circumstance of their building so close to the habitation of man, indicates that they have long enjoyed freedom from molestation. This respect may have originated in the bird being the harbinger of spring, and from its inhabiting churches, temples, and other sacred places, and perhaps, in some measure, from its utility in clearing the air of insects. Swallows at one time, among the Greeks, appear to have been regarded as an evil omen, when a flock of them settled on a tent or ship—their low flight indicating rain, and their settling on buildings is an autumnal custom, previous to their departure, and to the commencement of wintry weather: hence it is, perhaps, they have been considered as portending evil.

2164. The modern husbandman smiles at the precision observed by the ancients in sowing, planting, reaping, and other rustic operations on particular days. This practice, however, till within a very late period, was common in Europe, and even to this day is observed in many parts of Britain. Ray, in his Proverbs, observes—"Sow or set beans in Candlemas waddle," that is, in the wane of the moon, which is nearest to the festival of the Purification. These old rustic rules correspond to the numerous observations in the *Opera et Dies* of Hesiod and other ancient writers.*

2165. The only observation applicable to spring that I can find of the Shepherd of Banbury is, that, "if the last eighteen days of February and ten days of March be for the most part rainy, then the spring and summer quarters are like to be so too; and I never knew a great drought but it entered in that season." †

2166. It is in spring that certain kinds of cutaneous eruptions usually appear; and, to prevent such maladies, it used to be the practice, if not so yet, to administer purgative medicine to young people every spring.

2167. A phenomenon sometimes occurs in spring, which, under peculiar circumstances, injures plants irremediably for the season, and even kills them. When hoar-frost occurs copiously in a calm clear evening, and should the clearness of the air continue until the sun rises cloudless in the east, the sudden melting of the hoar-frost by the heat of the sun has the effect of scorching, as if by fire, upon the tender twigs of plants; and should the sap, moreover, be in a state of activity, and the young leaves budding forth, the leaves will not only be scorched, but all the branches bearing them will die in the course of a few days. This effect may be seen along the east side of a thorn hedge, after the leaves have been partially developed; and such was the general effect of this scorching, in the spring of 1837, that every beech, plane, or oak, that was coming into leaf were destroyed; and even many evergreens, that had withstood forty winters, which

* Forster's *Researches about Atmospherical Phenomena*, p. 284.
† The Shepherd of Banbury's *Rules*, p. 44.

happened to be exposed to its influence, were also rendered lifeless masses. Such was the intensity of cold produced by the sudden evaporation of the hoar-frost by the sun's heat, that the sap was frozen, and the sapvessels ruptured, in consequence of the expansion of the ice.

2168. During a snow-storm in spring, wild birds, becoming almost famished, resort to the haunts of man. The robin is a constant visitor, and helps himself with confidence to the crumbs placed for his use. The male partridge calls in the evening within sight of the house, in hopes of obtaining some support before collecting his covey together for the night to rest upon the snow. In the severe snow-storm of 1823, several coveys used to approach my own door at sunset, and oftentimes, ere putting down the sheaf of barley for their nightly meal, at the root of an old beech-tree, the old cocks announced their arrival by the loud chirrup-like call. I believe that, had it not been for this timely supply of food, many coveys of partridges would have perished in the severity and length of that memorable storm. Hares came to the very door in the evening, and through the night in the moonlight, to receive the food set down for them; and so powerful a tamer is hunger of the most timorous creatures, that even the wood-pigeons, in large flocks, used daily to frequent an orchard immediately behind the house, to pick the tall curly greens which overtopped the snow, —their favourite food, the Swedish turnip, being then buried in the fields beneath the snow. The rooks now make desperate attacks upon the stacks, and, if allowed, will soon make their way through the thatch. Making their attacks upon the top, they seem to be aware of the exact place where the corn can be most easily reached. The sparrows burrow in the thatch; and even the lively tom-tit, with a strength and perseverance, one should suppose, beyond its ability, pulls out whole straws from the sides of the stacks, to procure the grain in the ear.

2169. Further on in the season, the insect world come into active life in myriads, to serve as food for the feathered tribes. Rooks, with sturdy walk and independent gait, diligently search the ground for them, in the wake of the plough, and feed their young therewith. Tom-tits clamber round every branch of the trees which indicate an opening of their floret buds. The swallows at length appear, giving animation to the air, and the stream of migration to the N. betokens the approach of genial weather.

2170. "By the time the season is fairly confirmed, the leisure-hours of the cottagers," and of the ploughmen, who are cottagers of the best kind, are spent, in the evening, "in the pleasing labour, not unaccompanied with amusement, of trimming their little gardens, and getting in their early crops. There is no sort of village occupation which men, women, and children set about with greater glee and animation than this; for, independently of the hope of the produce, there is a pleasure to the simple and unsophisticated heart in 'seeing things grow,' which, perhaps, they who feel the most are least able to explain. Certain it is, however, that it would be highly desirable, that not only every country labourer, but every artisan in towns, where these are not so large as to prevent the possibility of it, should have a little bit of garden, and should fulfil the duty which devolved on man in a state of innocence, 'to keep it and to dress it.' It is impossible for any one who has not carefully attended to the subject, to be at all aware how strong the tie is which binds man even to a little spot of his native earth, if so be that he can consider it as his own, and that he himself, and those on whom he loves to bestow it, are to enjoy the fruit. This is the very strongest natural hold which binds a poor man to his country, and to all those institutions established for the wellbeing of society. Show me the cottage, the roses and the honeysuckles on which are neatly trimmed and trained, and the garden behind is well stocked with culinary herbs and a few choice flowers, and I will speedily find you a cottager who never wastes his time or money, or debases his mind, and learns 'the broad road which leadeth to destruction,' in the contamination of an alehouse. If the garden is neat, one may rest assured that the cottage, however humble it is, is the abode of contentment and happiness; and that, however simple the fare may be, it is wealth and luxury in full store to the inmates, because they are satisfied with it, and grateful for the possession of it." * I believe that the contentment of the lot of the Scottish married ploughmen, and of the attachment to the farm upon which they serve, may be traced to the principles evolved in these remarks. No doubt, much yet remains to be done to inculcate on them and their families the advantages of practising habits of personal and domestic cleanliness. Hinds' houses, in this respect, might be much improved; and if they were, an air of tidiness and comfort would attend their dwellings, which at present is too generally awanting. A great deal depends on the example of the farmer himself; for while he keeps his garden and shrubbery and little avenue in a slovenly manner, it is not to be expected in servants to evince a desire to excel their master.

2171. A farmer's garden gets a trimming twice or thrice a-year, and in the mean season weeds riot on without molestation, and its produce is plucked as best suits the convenience or caprice of the kitchen-maid. Doubtless, considerable crops of vegetables are raised in these gardens; more by strength of manure than skill of culture. It is, I am aware, inconvenient to obtain the assistance of the professional gardener in the country when his services may be most wanted; but when a hedger is employed on a farm, he should learn as much of the art of gardening as to be able to keep the farmer's garden in decent order in the absence of the gardener, whose principal duty should be to crop the ground in the respective seasons. A field-worker now and then could keep the weeds in subjection, and allow both the sun and air free access to the growing plants.

2172. Towards the end of spring, the farmer thinks of disposing of his fat cattle; but, should he not be offered the price he considers them worth, he keeps them on, and even determines to put them to grass. The dealer and butcher affect shyness in purchasing at this season, knowing the abundance of fat stock in the country; but are, nevertheless, unwilling to allow a prime lot slip through their hands, and, therefore, keep a sharp look-out on all the best stock for disposal. The ready means of steam conveyance to London for fat stock and dead meat, gives the farmer a great advantage over the butcher, which the latter now avails himself of by closing a ready bargain on the best conditions he can make.

2173. Spring is the season for the letting of grass parks. These usually belong to landed proprietors, and form a portion of their park or lawn. The ready demand for such grass parks induces the retention of pleasure-grounds in permanent pasture, while it removes every temptation in their owners to speculate in the purchasing and grazing of cattle. It is not customary for farmers to let their grass-parks, except in the neighbourhood of large towns, where cowfeeders and butchers tempt them with high prices. Pasture grass is so convenient for the stock of those classes of people, that they will give any price for it rather than want it. In regard to the effect which letting of grass-parks by tenants has on the rights of the landlord, I may mention that his "hypothec extends over the crops and live-stock of the tenant, including horses, cows, sheep, cattle, and every description of stock *raised on the farm*, but it does *not extend to the cattle of others taken in to graze.* On this ground it has been held an irritancy of the lease, should the tenant, instead of stocking the farm, take in cattle to graze, and thereby give the landlord no security for his rent.—(MacKye, December 4, 1780, M. 6214.)" † Facility of obtaining grass-parks in the country is at times useful to the farmer who raises grazing stock, by putting it in his power to give them, perhaps, a better bite or warmer shelter than he can offer them himself, on the division of the farm which happens to be in grass.

2174. The landed proprietor has also to seek a market in spring for his timber, which he annually fells in thinning his plantations. Such sales afford convenient supplies to farmers in want of paling for fencing new hedges, wood for sheep-flakes or stobs, or timber for the erection of shedding for animals, or for implements. They are also serviceable to country joiners and implement-makers, in affording them necessary materials nigh at hand. The timber is felled by the owner, and

* Mudie's *Spring*, p. 274-5.

† *The Farmer's Lawyer*, p. 46.

assorted into the sizes and kinds of lots which he knows will best suit the local demand. Prunings and small thinnings are sold as firewood, and purchased by cottagers who cannot afford to buy coal, and by farmers who have to supply fuel to the farm servants that occupy bothies.

2175. Mean of the atmospherical phenomena occurring in spring is as follows:—

Mean of the barometer in England in

February, . .	29·81 inches.
March, . . .	29·83 „
April, . . .	29·86 „
Mean of spring,	29·83

Mean of the thermometer in England in

February, . .	36°·9 Fahr.
March, . . .	40°·8 „
April, . . .	45°·8 „
Mean of spring,	40°·9

Tension of vapour for 40°·9=8·36.

Mean fall of rain in England in

February, . .	1·64 inch.
March, . . .	1·75 „
April, . . .	1·59 „
Mean of spring,	1·66

Prevailing winds in England in February, March, and April, N.E. and S.W.

Number of storms in the west of Europe in spring is 17·7 in 100.

Number of hail-storms in England in spring is 29·5 in 100

Number of aurora borealis in

February, . .	307 times.
March, . . .	440 „
April . . .	312 „

Number of fire-balls seen in

February, ...	50
March, ...	50
April, ...	45

ON THE ADVANTAGES OF HAVING FIELD WORK ALWAYS IN A STATE OF FORWARDNESS.

2176. The season—*early spring*—having arrived, when the labouring and sowing of the land for the various crops cultivated on a farm of mixed husbandry are about to occupy all hands for several months to come, the injunction of old Tusser, to undertake them in time, so that each may be finished in its proper season, should be regarded as sound advice; for whenever field labour is advanced ever so little at every opportunity of weather and leisure, no premature approach of the ensuing season can come unawares; and no delay beyond its usual period will find you unprepared to proceed with the work. When work proceeds by degrees, there is time to do it effectually; and if it is not so done, you have yourself to blame for not looking after it. When work is advancing by degrees, it should not be done in a careless manner, to impress the work-people with the non-importance of what they are doing. The advantage of doing even a little effectually is not to have it to do over again afterwards; and a small piece of work may be done as *well*, and in as short a time, in proportion, as a greater operation. Even if only one man is kept constantly at the plough, he would turn over, in the course of a time considered short when looked back upon, an extent of ground almost incredible. He will turn over an imperial acre a day—that is, 6 acres a week, 24 acres in a month, and 72 acres in the course of the dark and short days of the winter quarter. All this he will accomplish on the supposition that he has been enabled to go at the plough every working day; but as that cannot probably happen in the winter quarter, suppose he turns over 50 acres in that time, these will still comprehend the whole extent of ground allotted to be worked by every pair of horses in the year. Thus is a large proportion of a whole year's work done in a single, and in the shortest, quarter of the year.

2177. Now, a week or two may quickly pass in winter, in doing things which, in fact, amount to time being thrown away—such as sending away all the teams to a stock corn-market, on a day when there is little prospect of disposing of the grain, and when of course they would have been better employed at home at the plough; or driving some material on the farm, which would have been easier done when the ploughs were laid idle at any rate by frost; or setting men to thrash or winnow corn, and allowing the horses to be idle for the time; or contriving some unimportant work to fill up the time for half a day. Such instances of misdirected labour are only regarded as trifles *in winter;* but they occupy as much *time* as more important work—and in a season, too, when every operation of the field is preparatory to others to be executed in a more busy season. The state of the work should be a topic for the farmer's frequent consideration, whether or not it is as far advanced as it should be; but rather than accuse himself of neglect, should the work be backward, he consoles his unsatisfied mind that when the season for active work really arrives, the people will be able to make up for the lost time. Mere delusion; for if work can be made up, so can *time*, the two being inseparable; and yet, how can lost time be made up, when every moment of the year has its work, and when that period, long as it seems, is usually found too short in which to do everything as it *ought to be done.* The result is, that the neglected work must be done in an unprecedentedly short time, and consequently in an inefficient manner.

2178. Convinced that *field*-labour should be perseveringly advanced in winter, whenever practicable, I am of opinion that plan is good which apportions ploughmen to different departments of labour—some to work constantly on the farm, others occasionally to go from home—some as constantly as possible at the plough, others frequently at the cart. Thus the benefits of the subdivision of labour are extended to farm operations. When a certain proportion of the draughts are appointed especially to plough, *that most* important of all operations will not only be well, but perseveringly executed. This proportion of the ploughmen will only be legitimately employed at any other work when there is no ploughing to be executed. Ploughing being a steady occupation, not subject to irregular action like the cart, may be performed by the older men and horses.

2179. It may be proper to give a familiar example of what I mean by having *field*-labour advanced at every opportunity. The work in spring is to sow the ensuing crops; it should therefore be the study of the farmer in winter to advance the spring sowing. When the weather is tempting to sow spring-wheat, then let a portion of the land, cleared of turnips by the sheep, be ploughed to answer wheat instead of barley. If beans are desiderated, then let the particular ploughing suited to their growth be executed; and in whatever mode the beans are to be cultivated, care should be taken in winter to have the land appointed for them particularly dry, by letting off the surface-water in winter by a few additional gaw-cuts where necessary, or by deepening those already existing. Where common oats are to be sown, they being sown earlier than the other sorts, the lea intended for them should be ploughed first, and the land kept dry in winter; so that the most unpropitious weather in spring may not find the land in an unprepared state. The land intended for potatoes, for turnips, or tares, or bare fallow, should be prepared in their respective order; and when every one of all these objects have been promoted, and there is little or nothing to do till the burst of spring-work arrives, horses and men may both enjoy a day's rest now and then, without incurring the risk of throwing the work back; but before any recreation be indulged in, it should be ascertained that all the implements required for the spring-work, great and small, have been repaired for work—the plough-irons new laid—the harrow-tines new laid, sharpened, and firmly fastened—the harness tight and strong—the sacks patched and darned, that no seed-corn be spilt upon the road—the seed-corn thrashed, measured up, and sacked, and what may be last wanted put into the granary—the horses new shod, that no casting or breaking of a single shoe may throw a pair of horses out of work for even one single hour—in short, to have everything ready to start for the work whenever the first notice of spring shall be heralded in the sky.

2180. But suppose the contrary of all this to happen—that the plough-irons and harrow-tines have to be laid and sharpened, when perhaps to-morrow they may be wanted in the field—a stack to be thrashed for seed-corn or for horse's-corn when the sowing of a field should be proceeding; suppose that only a week's work has been lost, in winter, of a single pair of horses, the consequence will be in spring that 6 acres of land have to be ploughed when they should have been sown: all which inconveniences happen in the busy season, by trifling offputs in winter. Compare the value of those trifles with the risk of finding the land unprepared for sowing beans or spring-wheat. Again, instead of having turnips in store for the cattle, when the oat-seed is begun, you are obliged to send away a part of the draughts to fetch turnips—the consequence will be, that turnips cannot be stored, and the cattle will have to be supplied with them from the field during all that busy season. In short, suppose that the season of incessant labour arrives and finds you unprepared to go along with it,—and what must be the consequences? Every creature about you, man, woman, and beast, will then be toiled beyond endurance every day, not to *keep up* work, which is a lightsome task, but to *make up* work, which is a toilsome burden. Time was lost when you were idling it in a season you consider of little value; and, after all, the toil will be bestowed in vain, as it will be impossible for you to sow your crop *in due season.* Those experienced in procrastination may fancy this to be a highly coloured picture; but it is drawn from the life. I have observed every incident I have mentioned, not, it is true, in any one year, but some in one, and some in other years; and what may occur in different years may all occur in one.

ON THE CALVING OF COWS.

2181. The first great event in spring, on a farm of mixed husbandry, is the *calving of the cows;* not that this event should not occur until spring—for most breeders of farm-stock are anxious to have calves early, particularly bull-calves, and for that purpose calves are born as early as December and January—but by far the largest proportion of cows are not desired to calve until February, and the season of calving continues in good time till the middle of April; after which, in May, the calves are accounted late, and then seldom retained as part of the *breeding*-stock, namely, that specially set aside to propagate its kind. Reluctance to late calves arises from no objection to their purity of breeding—for earliness or lateness of birth can have no effect in that respect; but chiefly because an early calf possesses the advantage of having passed through its period of milking in time to be supported on grass, as soon as that affords a sufficiency of food. From 8 to 10 weeks at this season is a period of great anxiety for the state of the cows; and, indeed, till her calving is safely over, the life of every cow is in jeopardy. Every care, therefore, that can conduce to her passing in safety over this critical period, ought to be cheerfully bestowed.

2182. The treatment of cows in winter, in respect to food and exercise, will be found in (1164, 1183, 1191, 1192, 1198.) When the cow first shows heavy in calf, which is usually after the 6th month, the litter in the court should not be allowed to become too deep, as over-exertion in walking over rather soft loose litter and dung, may cause such an excited action of the animal's system, and most probably of the womb, as to make her slip calf. The litter in a court constantly trampled by cattle at freedom, becomes firm, and affords a good footing; but the case is different in a cows'-court, which is usually filled with loose litter wheeled from the byre; and as this is walked upon only for a short time every day, and cows in calf are not disposed to roam much about, it never becomes firm. To render the litter as firm as can be under the circumstances, the cattle-man should spread every barrowful as he wheels it out, taking care to mix the straw with the dung in due proportions.

2183. Cows, as they calve, and after it is considered safe for them to go out in the air again, should not be allowed to go into the court at the same time with those yet to calve; as calved cows soon *come into season*, that is, become desirous of the bull; and when in this state a desire prevails on the part of the other cows to ride upon them, and, what is remarkable, it is strongest in those cows yet uncalved. As may be supposed, such violent exertion, made on soft litter, is likely to prove injurious to uncalved cows, by causing inversion of the calf in the womb, febrile action, or slipping of the calf. The time of the day at which cows in these different states may go out, should be left to the discretion of the cattle-man, who should consider that as cows, after having calved, become more tender in their habit than before, they should enjoy the best part of the day; that is, from 12 to 2 o'clock.

2184. *Cows may be ascertained to be in calf* between the 5th and 6th months of their gestation. The calf quickens at between 4 and 5 months. The calf may be felt by thrusting the points of the fingers against the right flank of the cow, when a hard lump will bound against the abdomen, and be communicated to the fingers. Or when a pailful of *cold* water is drunk by the cow, the calf kicks, when a convulsive sort of motion may be observed in the flank, by looking at it from behind, and, if the open hand is then laid upon the space between the flank and udder, this motion may be most distinctly felt. It is not in every case that the calf can be felt at so early a period of its existence; for lying then in its natural position in the interior of the womb, it cannot be felt at all; and when it lies near the left side of the cow, it is not so easily felt as on the opposite one. So that, although the calf cannot be *felt* at that early stage, it is no proof that the cow is not in calf. Some cow-dealers show great acuteness in ascertaining whether a cow is in calf. One whom I knew, that was bred a tailor, told me that when a resinous-looking substance can be drawn from the teats by stripping them firmly, the cow is sure to be pregnant. After 5 or 6 months, the flank in the right side fills up, and the general enlargement of the under part of the abdomen affords an unequivocal symptom of pregnancy. But there is no necessity of thus trying whether a cow is in calf, for if she has not sought the bull for some months, you may generally rely on her being pregnant.

2185. These are the vulgar modes of ascertaining the pregnant state of the cow; but the late Mr Youatt has afforded us more scientific means of ascertaining the fact. He says he would not give, nor suffer any one else to give, those terrible punches on the right flank, which he had no doubt were the cause of much unsuspected injury, and occasionally, at least, were connected with, or were the origin of, difficult or fatal parturition. At a very early stage of the gestation, he says, by introducing the hand gently and cautiously into the vagina, the state of the womb may be ascertained. If it is in its natural state, the mouth of the womb at the *os uteri* will be closed, though not tightly so; but if it is impregnated, the entrance of the uterus will be more firmly closed, and the protrusion will be toward the vagina. He adds a caution, however, in using this mode of exploration—"When half, or more than half, of the period of pregnancy is passed, it is not at all unlikely that so much irritation of the parts will ensue as to cause the expulsion of the fœtus." He would rather introduce his hand into the rectum, and as the fœtus of two months is still in the pelvic-cavity, he would feel the little substance under his hand. "I am certain that I am pressing upon the uterus and its contents. I cannot, perhaps, detect the pulsation of the embryo; but if I had delayed my examination until the fœtus was three months old, I should have assurance that it was there by its now increased bulk, while the pulsation of its heart would tell me that it was living." When still older, the pulsation of the heart may be distinctly heard on applying the ear closely to the flank, here and there, and upwards and downwards, while the cow was held quietly and steadily.

2186. The *womb* of the cow is a bag of irregular form, having a chamber or division attached to each side, called the *horns of the womb;* and so called, perhaps, because of the form they present, in an unimpregnated state, of the large curved horns of a Black-faced tup. The womb consists almost entirely of muscular fibres, with a large proportion of blood-vessels, and of vascular matter, which admits of contraction and extension. Its ordinary size in a large cow is about 2½ feet in length, but, when containing a full-grown fœtus, is 7 feet in length. This is an extraordinary adaptation to circumstances which the womb possesses, to bear an expansion of 7 feet, from about a third of that length, and yet be capable of performing all its functions. The use of the horns seems to be to form a lair for the calf, and each is occupied by the calf according to its sex. The quey-calf occupies the near, and the bull-calf the off-side horn,—so that a bull-calf is more easily felt in the womb than a quey-calf; and indeed the latter is frequently not felt at all until the 7th month, when other symptoms afford proofs of pregnancy. "The fœtus of the cow is huddled up in the right side of the belly," says Mr Youatt. "There its motions are best seen, and the beatings of its heart best heard. The enormous paunch lying principally in the left side, presses every other viscus, and the uterus among the rest, into the right flank. This also explains a circumstance familiar to every breeder. If the cow should happen to carry twins, they are crowded together in the right flank, and one seems absolutely to lie upon the other. Whenever the farmer notices the kicking of the fœtus high up in the flank, he at once calculates on twins."*

2187. The exact time of a cow's calving should be known by the cattle-man as well as by the farmer himself, for the time when she was served by the bull should have been marked down. Although this last circumstance is not a certain proof that the cow is in calf, yet if she has passed the period when she should have taken the bull again, without showing symptoms of season, it may safely be inferred that she became in calf at the last serving, from which date should be calculated the period of gestation, or of *reckoning*, as it is called. A cow is generally said to go 9 months, or 273 days, with calf, although the calving is not certain to a day. The experiments of the late Earl Spencer settle this point most satisfactorily. After keeping the record of the calving of 764 cows, he came to this conclusion:—"It will be seen that the shortest period of gestation, when a live calf was produced, was 220 days, and the longest 313 days; but I have not been able to rear any calf at an earlier period than 242 days. Any calf produced at an earlier period than 260 days must be considered decidedly premature; and any period of gestation exceeding 300 days, must also be considered irregular; but in this latter case the health of the produce is not affected. It will also be seen that 314 cows calved before the 284th day, and 310 calved after the 285th; so that the probable period of gestation ought to be considered 284 or 285 days, and not 270, as generally believed."

2188. It is also a popular belief that when a cow exceeds the calculated period of gestation, she will give birth to a bull-calf, and the belief accords with fact; as Lord Spencer observes, "In order fairly to try this, the cows who calved before the 260th day, and those who calved after the 300th, ought to be omitted as being anomalous cases, as well as the cases in which twins are produced; and it will then appear that from the cows whose period of gestation did not exceed 286 days, the number of cow-calves produced was 233, and the number of bull-calves 234; while those whose period exceeded 286 days, the number of cow-calves was only 90, while the number of bull-calves was 152." †

2189. Cows are most liable to the complaint of the *coming down of the calf-bed*, when near the period of calving, between the 8th and 9th months, and, from whatever cause it may originate, the position of the cow, as she lies in her stall, should be amended by raising her hind quarters as high as the fore, by means of the litter. The immediate cause of the protrusion of a part of the womb is the pressure of the calf's fore feet and head against that part of it which is opposite to the vaginal passage, and the protrusion mostly occurs when the calf is in its natural position; so that, although no great danger need be apprehended from the protrusion, it is better to use means to prevent its recurrence than be indifferent to bad consequences by over confidence.

2190. Much more care should be bestowed in administering food to cows near the time of their reckoning than is generally done; and the care should be proportioned to the state of the animal's condition. When in high condition, there is great risk of inflammatory action at the time of parturition. It is, therefore, the farmer's interest to check every tendency to obesity in time. This may partly be effected by giving fewer turnips and more fodder than the usual quantity; but some cows when in calf, and have been long dry, will fatten on a very small quantity of turnips; and there is a tendency in dry food to aggravate inflammatory action. Other

* *Journal of the Agricultural Society of England*, vol. i. p. 172.

† *Ibid.* p. 167-8.

means should therefore be used, alongst with a limited allowance of food; and, in as far as medical treatment can be applied to the case, there is perhaps nothing so safe as bleeding and laxatives. "Every domestic animal like the cow," observes a very sensible writer on this subject, "is to be considered as by no means living in a state of nature. Like man himself, she partakes of civilised life, and of course is subjected to similar infirmities with the human race. The time of gestation is with her a state of indisposition, and every manager of cattle should be aware of this, and treat her with every attention and care during this time. The actual diseases of gestation are not indeed numerous, but they are frequently very severe, and they occasion always a tendency to slinking, or the cow slipping her calf. As the weight of the calf begins to increase, it will then be necessary to take some precautions, — and these precautions will consist in an attention to her diet, air, and exercise." *

2191. It is the 8th and 9th months that constitute the critical period of a cow in calf. The bulk and weight of the fœtus cause disagreeable sensations in the cow, and frequently produce feverish symptoms, the consequence of which is costiveness. The treatment for this is bleeding once or twice, in proportion to the strength and condition of the cow, and the administering of laxative medicine and emollient drinks, such as a dose of 1 lb. of Epsom salts with some cordial admixture of ginger and carraway seed and treacle, in a quart each of warm gruel and sound ale. Turnips may be given, and they have a laxative tendency, especially the white varieties. Potatoes, too, are recommended; but I entirely object to giving potatoes to cows at any time, because of their great tendency to produce hoven; and if hoven were to overtake a cow far advanced in pregnancy, the calf would either be killed in the womb, or it would cause the cow to slip it.

2192. Having suffered the loss of two or three cows by costiveness, immediately after calving—the Swedish turnip in the maniplies being squeezed flat like the skins of apples from a cider press—I was induced to try *oil-cake* as a laxative along with the Swedish turnip. The cake was given to the cows for 2 months, one before and one after calving, and its valuable property of keeping them in a fine laxative state, and at the same time in good health, was highly satisfactory; and on continuing the practice every year afterwards, no similar mishap ever overtook my cows. The quantity given to each cow daily was 4 lbs., at an intermediate time between the feeds of turnips. The time of giving it was as regularly adhered to as that of the turnips; and when the hour arrived for its distribution, 10 o'clock forenoon, every cow expressed the greatest anxiety for the treat. It was broken to them in small pieces with the oil-cake breaker, fig. 53.

2193. But the state of over-leanness is also to be avoided in cows in calf. Instead of being bled, the cow should rather have nourishing food, such as mashes of boiled barley, turnips, and oil-cake, not given in large quantities at a time, but frequently, with a view to laying on flesh in a gradual manner, and at the same time of avoiding the fatal tendency to plethora. I believe when oil-cake is given to cows before and after their calving, as I have recommended, no apprehension need be entertained of their safety as far as regards their calving, in whatever condition they may happen to be, as it proves a laxative to the fat, and nourishing food to the lean cow.

2194. *Slinking*, or slipping of the calf, is a vexatious occurrence, and a great loss to the breeder of stock. It is not only a loss of perhaps a very valuable calf, but its want makes a blank in the number of the lot to be brought up in the season, and which can only be made up by purchase. And the vexation is, that the cow can never again be depended upon to bear a living calf, the probability being that she will slip it every season thereafter. Why this result should ensue has never been satisfactorily explained. The only remedy for the farmer is to take the milk from the cow as long as she gives it, and then fatten her for the butcher. I had a very fine shorthorn cow, bred by myself, that slipped her second calf; and not being disposed to trust her again, fed her off, when she be-

* Skellett *On the Parturition of the Cow*, p. 41.

came extraordinarily fat, and yielded very superior meat; and I was so far fortunate that this was the only cow I ever had which became a victim to the complaint we are speaking of.

2195. The *causes* of this troublesome complaint are various, arising chiefly, however, from violent exercise, the effect of frights, bruises, and knocks; "but," says Skellett, "a more common cause of slinking than any of them, and which is peculiar in its influence on this animal, is a disagreeable *nauseous smell*. The cow is remarked to possess a very nice and delicate sense of smelling, to that degree, that the slinking of one cow is apt, from this circumstance, to be communicated to a great number of the same herd; it has been often known to spread like an infectious disease, and great losses have been suffered by the cowfeeders from the same."* As there is much truth in these remarks, you will see the necessity of keeping every thing in a byre *occupied by breeding cows* in a clean and wholesome state; to have every particle of filth removed daily from the feeding troughs in front, and the urine-gutters behind them; and to have the byre thoroughly ventilated when the cows go out to the court. The same circumstance will show you the propriety of preventing pigs being slaughtered in the court in which cows walk, and any animal being bled near the byre; so much so, that when any of the cows require bleeding, the operation should be performed in another apartment than the byre.

2196. Whenever a cow shows symptoms of slinking, which may be observed in the byre, but not easily in the grass-field, she should be immediately removed from her companions. The *first symptoms are* a sudden filling of the udder before the time of reckoning would warrant, a looseness, flabbiness, and redness of, and a yellow glairy discharge from, the vagina, and a giving way of the ligaments on both sides of the rump. When these symptoms are observed, the cow should be narrowly watched, and means of preventing slinking instantly adopted, one of the chief of which is bloodletting. This should be followed by a laxative dose. But these means will prove ineffectual, if the symptoms make their appearance suddenly, and go through their course rapidly, and the calf will be slipped after all.

2197. The risk which the cow runs, after slinking, is *in not getting quit of the cleaning*, or *afterbirth*, or *placenta*, as it is not in a prepared state to separate from the womb. Should it be retained, corruption will soon take place in it, and produce a very nauseous smell, which will remain as long as the cleaning will be in passing away by degrees in putridity. When the cleaning does not come away in the course of a few hours, or at most a day, the assistance of the veterinary surgeon should be obtained. The following cordial drink will promote the cleansing—juniper berries 3 oz., bay berries 2 oz., nitre 1 oz., anise seed 1 oz., gentian $\frac{1}{2}$ oz., gum myrrh $\frac{1}{2}$ oz., assafœtida $\frac{1}{2}$ oz., well pounded together, for one dose, and given in 1 quart of mild ale made warm in 1 quart of penny-royal tea. This drink should be given fasting, and repeated every day till the cleansing be evacuated. The cow should have plenty of warm drinks, such as warm water, thin gruel, and mashes made of malt, with bran, so as to keep the body gently open—and this should be attended to at all times. Should the regimen not be sufficient to keep the body open, and feverish symptoms appear, recourse must be had to stronger remedies, such as Epsom salts 1 lb., nitre 2 oz., anise seed in powder 1 oz., cumin seed in powder 1 oz., ginger $\frac{1}{2}$ oz., mixed together for one dose, which is to be given in 2 quarts of water gruel with $\frac{1}{2}$ lb. of treacle. The dose may be repeated, if the first dose has not had the desired effect, in 10 or 12 hours.

2198. As to the *prevention* of the recurrence of this vexatious complaint, though, I believe, the best thing for the farmer is not to attempt any, but milk and fatten the cow, yet a natural desire is felt to retain a valuable and favourite cow, so that means may be used to enable her again to bear a living calf. Skellett mentions as preventive measures, that "when a cow has slipped her calf, in the next gestation she should be early bled, her body should be kept open by cooling physic; she should not be forced to take any more exercise than what is absolutely necessary

* Skellett *On the Parturition of the Cow*, p. 62.

for her health, and her interfering with other cattle guarded against by keeping her very much by herself. At the same time," he adds, "it must be observed, that though it is necessary to preserve a free state of the bowels, a laxity of them will often produce this accident; cows *fed very much upon potatoes*, and such other watery food, *are very apt to slink*, from their laxative effects. In the food of the cow, at this time, a proper medium should be observed, and it should consist of a due proportion of other vegetable matter mixed with the fodder, so as the bowels may be kept regularly open, and no more." Our author, however, does not see how these remedial measures can be effectual. If the cow is in high condition indeed, she should be reduced in condition; if in very low, she ought to get nourishing food and strengthening medicines; and if she is much annoyed by nauseous smells, these should either be counteracted, or the cow withdrawn from them. To counteract bad smells, Skellett recommends the following mixture to be formed, and rubbed a little every day on the parts the cows commonly smell each other:—Barbadoes tar 3 oz., balsam of sulphur 3 oz., rectified oil of amber 1 oz., fine oil of thyme 1 oz., and animal oil 1 oz. "Of what nature that odour is," continues Skellett, "which gives offence, we cannot altogether be certain; but the author has remarked that its effects occur at one season more than at another, and particularly when the weather has been wet, and the cows have long been kept at grass. From this fact," he concludes, "it would appear that the smell is of a vegetable nature, and connected with their feeding at that time."* It is understood that cows which are fed in the neighbourhood of and in woods, and that live on coarse rank pasture in autumn, are most liable to this complaint. In Switzerland, the complaint increases after the cows are put on rank pastures in autumn.

2199. Although slinking is spoken of as an infectious complaint, it has no property in common with any contagious disease; and sympathetic influence being a main cause of it, the result is as fatal as if direct contagion had occasioned it.

2174. About a *fortnight before the time of reckoning, symptoms of calving indicate themselves* in the cow. The loose skinny space between the vagina and udder becomes florid; the vagina becomes loose and flabby; the lower part of the abdomen rather contracts; the udder becomes larger, harder, more florid, hotter to the feel, and more tender-looking; the milk-veins along the lower part of the abdomen become larger, and the coupling on each side of the rump-bones looser; and when the couplings feel as if a separation had taken place of the parts there, the cow should be watched day and night, for at any hour afterwards the pains of calving may come upon her. From this period, the animal becomes easily excited, and, on that account, should not be allowed to go out, or be disturbed in the byre. In some cases, these entire premonitory symptoms succeed each other rapidly, in others they follow slowly; and the latter is particularly the case with heifers in first calf.

2200. These symptoms are called *springing* in England, and the heifers which exhibit them are named *springers*.

2201. In different parts of the country, different practices exist in regard to attending on cows at calving. In the southern counties of Scotland, the shepherd conceives it to be his duty to attend on the occasion, assisted by the cattle-man, and other men if required. In the northern counties, on the contrary, the calving is left to women to manage. I think this difference in practice must have arisen from the *degree of assistance* required at the operation. In the southern counties, the large and valuable breed of cows almost always require assistance in parturition, the neglect of which might cause the cow to sink from exhaustion, and the calf be strangled or drowned at its birth. Powerful assistance is sometimes required, and can only be afforded by men, the strength of women being unequal to the task. Indeed, I have witnessed the assistance of eight men, given one way and another, in the extraction of a calf coming in the natural position. The calf was the first of twins, very large, and this was the first labour of the heifer. I shall never forget the distressing cries of the poor creature when racked with pain, nor the

* Skellett *On the Parturition of the Cow*, p. 67-74.

patience and sympathy evinced by all the men who were summoned to assist. It was an interesting case, conducted by an experienced shepherd, and lasted altogether about five hours. The cow and calves were much exhausted; but all were well in the course of a few days. In the northern counties, cows are not only smaller, but the calves are small in proportion, so that most cows calve without assistance; and, therefore, women may manage the calving, and the cow and calf without difficulty. Of the two modes of conducting this delicate and oft-times tedious operation, I should say that it falls most legitimately under the guidance of the shepherd, who seems to be the natural guardian of all the young stock brought forth on a farm; and where there is no shepherd, the cattle-man should take the charge, the farmer himself, in all cases, giving his sanction to the means about to be employed—it being but fair that he himself should bear the heaviest part of the responsibility connected with this dangerous process.

2202. A few preparatory requisites should be at hand when a cow is about to calve. Two or three rein-ropes are useful, when *flat soft* ropes are not provided on purpose, to tie to the calf. A mat or sheeting, to receive the calf upon in dropping from the cow, should she be inclined to stand on her feet when she calves. The cattle-man should have the calf's crib in R, Plate II., well littered. The shepherd should pare the nails of his hands close, in case he should have occasion to introduce his arms into the cow to adjust the calf; and he should have goose-fat or hog's lard with which to smear his hands and arms. Goose-fat makes the skin smoothest and best withstands drying (1633.) It may be necessary to have a few sacks of straw to put under the cow to elevate her hind quarters, and even to have block and tackle to hoist her up by the hind legs, in order to adjust the calf in the womb. These last articles should be ready at hand if wanted. Some straw should be spread on the floor of the byre, to place the new-dropped calf upon.

2203. All being prepared, and the byre-door closed for quietness, the cow should be attended every moment. The proximate symptoms of calving are thus exactly described by Skellett, as they occur in an ordinary case. "When the operation of calving actually begins," he says, "then signs of uneasiness and pain appear: a little elevation of the tail is the first mark; the animal shifts about from place to place, frequently getting up and lying down, not knowing what to do with herself. She continues some time in this state, till the natural throes or pains come on; and as these succeed each other in regular progress, the neck of the womb, or *os uteri*, gives way to the action of its bottom and of its other parts. By this action, the contents of the womb are pushed forward at every throe; the water-bladder begins to show itself beyond the shape, and to extend itself till it becomes the size of a large bladder, containing several gallons; it then bursts, and its contents are discharged, consisting of the *liquor amni*, in which, during gestation, the calf floats, and which now serves to lubricate the parts, and render the passage of the calf easier. After the discharge of the water, the body of the womb contracts rapidly upon the calf; in a few succeeding throes or pains, the head and feet of it, the presenting parts, are protruded externally beyond the shape. The body next descends; and in a few pains the delivery of the calf is complete."* The easy calving now described is usually over in 2 hours, though sometimes it is protracted to 5 or 6, and even to 12 hours, particularly when the water-bladder has broken before being protruded beyond the shape.

2204. But although the calf may present itself in this natural position, with both its fore-feet projecting, its chin lying on both the fore-legs, and the point of the tongue appearing out of the side of the mouth, it may not be calved without assistance. To render this, the feet of the calf being too slippery to be held firmly by the bare hands, a rein-rope, with a folding loop at the double, is placed above each fetlock joint, and the double rope from each leg is held by the assistants. A pull of the ropes should only be given at each time the cow strains to get quit of

* Skellett *On the Parturition of the Cow*, p. 105.

the calf; and it should be a steady and firm pull, in a direction rather downwards from the back of the cow, and sufficiently strong to retain whatever advance the calf may have made; the assistance lent being given rather to ease the cow in her exertions in the throes, than to extract the calf from her by force. Mean time the shepherd endeavours to relax the skin of the shape around the calf's head, by manipulation, as well as by anointing with goose-fat, his object being to pass the skin over the crown of the calf's head, and when this has been accomplished, the whole body may be gently drawn out. In obstinate cases of this simple kind, a looped rope passed across the mouth and round the under jaw of the calf, and pulled steadily, will facilitate the passage of the head; but this expedient should not be resorted to until it is found that the shepherd cannot effect it, with his hands, as the strain upon the cord is apt to injure the tender mouth of the calf.

2205. On the extrusion of the calf, it should be laid on its side upon the clean straw in the floor, and the first symptom it exhibits of life is a few gasps which set the lungs in play, and then it opens its eyes, shakes its head, and sniffs with its nose. The breathing is assisted if the viscid fluid is removed by the hand from the mouth and nostrils; and the thin membrane which envelops the body in the womb should now be removed, much torn as it has been in the process of parturition. The calf is then carried by two men, suspended by the legs, with the back downwards, and the head held up between the fore-legs, to its comfortably littered crib, where we shall leave it for the present to attend still farther to its mother.

2206. The presentation is sometimes made with the *hind-feet foremost.* At first the hind-feet are not easily distinguished from the fore, but if a hind presentation is made in the natural position of the body, with the back uppermost, the hind-feet will be in an inverted position, with the soles uppermost. There is no difficulty in a hind presentation, only the tail should be placed in its natural position, and not folded up, before the legs are pulled out. The first obstructing point in this presentation is the rump, and then the thickest part of the shoulder. On drawing out the head, which comes last, it should be pulled away quickly, in case the calf should give a gasp for air at the moment of leaving the cow, when it would inhale water instead of air, and run the risk of drowning. The mouth and nose should be wiped immediately on the calf being laid down upon the straw on the floor.

2207. Some women have a custom of rubbing the skin of the new-dropped calf with a wisp of straw; but such a dressing should not be allowed, as it serves only to agglutinate the hair. If left to itself, the liquor evaporates in a short time and leaves the hair dry; but while the evaporation is proceeding, the calf trembles, no doubt from feeling cold; and on this account, its first litter should be soft, clean, and sufficient to bury its body out of sight. The trembling is considered a happy symptom of the strength of the calf.

2208. All as yet has been easily managed, and so will be as long as the cow lies still in her stall, with plenty of straw around and behind her hind-quarter; but some cows are of so restless a disposition that whenever the pains of labour seize them, they start to their feet, and will only lie down again when the pain ceases. Such cows are troublesome to deal with, and it is scarcely possible, by reason of those frequent risings up and lyings down, to ascertain the true position of the calf, especially when it is not presented in a natural position. In such a case, it is necessary to extract the calf energetically, and remove the uneasiness of the cow quickly; for until she gets quit of the calf, she will not settle in one position or another. When the calf is so near the external air as to enable the operator to get the ropes round its legs, whether fore or hind, they should be fastened on immediately after the discharge of the water, and, on gently pulling them, her attention will be occupied, and she will strain with great vigour, the standing position giving her additional power, so that the extraction of the calf, in such cases, is generally the most expeditious. As the calf will have to fall a considerable height to the ground, the mat or sheet should be held by two men, so as to receive the body of the calf upon it. I had a short-horn cow that was very troublesome at calving, always standing to calve, but whenever the process was actually begun, she strained with so much earnestness as to get quit of the calf in a few minutes. Upon one occasion, after the water had been discharged, while the shepherd was preparing the ropes to fasten round the legs of the calf, she gave so powerful a strain as to project the calf bodily from her, when it fell with violence upon the floor, but luckily upon the very straw that had been laid down to receive it. This instance shows that active means should be used after the symptoms of actual calving have begun; and, if such means are neglected, the calf may be found killed or injured for life.

2209. Some calves, though extracted with apparent ease, appear as if dead when laid upon the straw. In such a case, beside removing the viscid fluid from the mouth and nose, the hand should be placed against the side of the breast, to ascertain if the heart beats; and, if it does, all that is wanted is to inflate the lungs. To do this, the mouth should be opened, and still no breathing felt, some one should blow steadily into the open mouth, a device I have seen answer the purpose; and also a hearty slap of the open hand upon the buttock of the calf, will cause it to start, as it were, into being. Perhaps the bellows might be usefully employed in inflating the lungs. Should no beating of the heart be felt, and yet consciousness of life seems to exist, the calf should be carried without delay to its crib, and covered up with the litter, leaving the mouth free to breathe, and it may survive; but even after a few gasps, it may die. Most probably the cause of death arose from injury received in calving, such as too long detention in the vaginal passage, or a severe squeeze in the mouth of the womb, or by the rashness of the operator.

2210. The body of the calf when thus lost should be skinned while warm, cut in pieces, and buried in a compost for manure, and the skin either sold or made into wechts for the corn barn.

2211. The difficult cases of presentation which usually occur are with one foot and the head, and the other foot drawn back, either with the leg folded back altogether, or the knee doubled and projecting forward. In all these states the missing leg should be brought forward. To effect this, it is necessary to put round the presented foot a cord to retain it within the power of the operator, and the head is then pushed back into the womb to make room to get at the missing foot, to search for which the greased arm of the operator should be introduced, and the foot gently brought beside the other. The rope which was attached to the first foot now serves to pull the entire body into the passage, when the throes may again be expected to be renewed. A calf may be extracted with one leg folded entirely back alongside the body, and on feeling this to be really the case, it is perhaps better to extract the calf at once, than to delay the parturition in the attempt to bring forward the leg. The presentation may be of the head alone without the feet, which may be knuckled forward at the knees, or folded back along both sides. In the knuckled case both legs should be brought forward by first pushing the head back, but, in case of losing hold of the calf altogether, a loop should be put in the calf's mouth. In the folded case, one leg at least, and both if possible, should be brought forward. A worse case than either is, when one or both legs are presented and the head folded back upon the side. In this case the calf will most likely be dead. The legs should be pushed back, retaining hold of them by ropes, and the head brought forward, with both the legs if possible. It may be beyond the strength of the operator to bring forward the head; when he should put a loop into the calf's mouth, and his assistants will pull forward the head by it. Still worse cases may occur, such as a presentation of the shoulder, with the head lying into the side; a presentation of the buttock, with both the hind legs stretched inwards; or the calf may be on its back, with all the worst presentations now enumerated. In whichever of these positions the calf may present itself, no extraction can safely take place until the head, and one of the legs at least, are secured, and the other folded entirely back, or both the hind legs, with the back turned uppermost are presented. In no case should a fore or hind leg be so neglected as not only to obstruct the body on passing the mouth of the womb, but to tear the womb. The *safest* practice, therefore, is, to secure both legs as well as the head. This may cause the operator considerable trouble, but by retaining hold of what parts he can with the cords, and dexterously handling the part amissing, so as to bring it forward to the passage, whilst the assistants pull as he desires, his object will in most cases be attained; but it should be borne in mind that none of these objects will be attained but when seconded by the throes of the cow herself. If this circumstance is not attended to and watched for by the operator, the muscular grasp of the womb will render his arm powerless.

2212. Another circumstance should be considered by the operator, that when the hind-quarters of the cow have an inclination downwards, she has the power to strain the stronger, and of course to counteract his efforts the more easily. What he should therefore do, is, to raise the hind-quarters of the cow with bundles of straw higher than the fore-quarters, until he has got the calf in the position he desires, and then, on letting the cow down again, and watching her strainings, assist her at those times and only at those, and the extraction may be accomplished in a reasonable time.

2213. As to the block and tackle, they should never be resorted to but to save the life of the cow; and as they will be resorted to only to turn the calf in the womb, there is far more danger of injuring the womb than the value of the calf is worth; still, if the life of the cow may be saved while the calf is turned, this should, of course, be attempted in the best manner under the circumstances. But much rather destroy the calf by cutting it away in pieces than lose the cow.

2214. When the head only of the calf is presented, and cannot be protruded through the vagina, by reason of the unfavourable and obstructive position of the fore legs, an inspection should immediately be made of the position of the calf, by first thrusting the head back with a loop in the mouth, and bringing the legs forward. When this inspection has been too long delayed, and the head kept confined in the passage, the violent throes of the cow will certainly strangle the calf, and the head will swell to an inordinate degree. In such a case, as the swelling will prevent the calf's head being pushed back to get at the legs, it must be taken off, the legs brought forward, and the body then extracted. One of the most difficult cases is, when the fore feet are presented naturally, and the head is thrust down upon the brisket between the legs. The feet must first be pushed back, and the head brought up and forward, when the extraction will become natural.

2215. A skilful shepherd may be able to manage all these difficult cases within a reasonable time; but unless he is particularly dexterous at cases of parturition, it is much safer to obtain the advice of a veterinary surgeon, even although he should not be required to put a hand to the operation himself. In the case of extracting monstrosities, his assistance is indispensable.

2216. As regards the extraction of twin calves, before rendering the cow any assistance, it is necessary to ascertain that the calves have made a proper presentation; that they are free of each other; that one member of the one is not interlaced, or presented at the same time, with that of the other. When they are quite separated, then each calf may be treated according to its own case.

2217. Calving in a byre does not seem to produce any disagreeable sensations in the other cows, as they express no surprise or uneasiness in regard to what is going on beside them. When the cow gives vent to painful cries, which is rarely, the others no doubt express a sympathy; and when the calf is carried away, they may exhibit some restlessness; but any commotion arising from these circumstances soon subsides. But if a difficult labour is apprehended, it is better for the cows, and also for the cow herself, that she be delivered in another apartment, well littered, where the operator and his assistants can have freedom around her.

2218. A notion exists in some parts of England, that a cow, when seized with the pains of labour, should be made to move about, and not allowed to lie still, although inclined to be quiet. "This proceeds from an erroneous idea," Skellet well remarks, "that she will calve much easier, and with less danger; but so far from this being the case, the author has known a great many instances where the driving has proved the death of the animal by overheating her, and thus producing inflammation, and all its bad consequences. Every rational man will agree in opinion with the author, that the above practice is both cruel and inconsistent in the extreme; and this is confirmed by what he has noticed, that the animal herself, as soon as the pains of calving come on, immediately leaves the rest of the herd, and retires to some corner of the field, or under a hedge, in order to prevent the other cows, or anything else, coming near, that may disturb her in bringing forward her young."* In short, too much gentleness cannot be shown to cows when calving, and they cannot be too strictly guarded against every species of disturbance. The shepherd will not allow even his dog to enter the byre when calving is going on.

2219. The *afterbirth*, or placenta, does not come away with the calf, a portion of it being suspended from the cow. It is got quit of by the cow by straining, and, when the parturition has been natural and easy, it seldom remains with her longer than from 1 to 7 hours. In bad cases of labour it may remain longer, and may only come away in pieces; but when it remains too long and is sound, its separation will be assisted by attaching a small weight to it, say of 2 lb., which, with its continued force, and occasional straining of the cow, will cause it to drop.

2220. The usual custom is to throw the afterbirth upon the dung-hill, or to cover it up with the litter; but it should not be allowed to lie so accessible to every dog and pig that may choose to dig it up: nay, pigs have been known almost to choke themselves with it. Let the substance be buried in a compost heap, and if there be none such, in the earth.

2221. The umbilical cord or *navel string* of the calf breaks in the act of parturition.

2222. Should the cow seem *exhausted* in a protracted case of calving, she may be supported with a warm drink of gruel, containing a bottle of sound ale; and should she be too sick to drink it herself, it should be given her with the drinking-horn. After the byre has been cleansed of the impurities of calving, and fresh litter strewed, the cow, naturally feeling a strong thirst upon her from the exertion, should receive a warm drink. I don't know a better one than warm water, with a few handfuls of oatmeal stirred in it, and seasoned with a handful of salt, and this she will drink up greedily; but a pailful is enough at a time, and it may be renewed in a short time after, should she express a desire for it. This drink should be given her for two or three days after calving, in lieu of cold water, and mashes of boiled barley and gruel in lieu of cold turnips; but the oil-cake should never be forgotten, as it acts at this critical period as an excellent alterative and febrifuge.

2223. A very common practice in this country, is to give the cow barley in the sheaf to eat, and even raw barley, when there is no barley in the straw, and sometimes a few sheaves are kept for the purpose; and barley-chaff is given where people grudge to part with good barley in this way. Though common, the practice is objectionable, for nothing causes indigestion so readily as raw barley or barley-chaff at the time of calving, when the tone of the stomach is impaired by excitement or fever. *Boiled* barley, or any mucilaginous drink, is quite safe. Nothing should be given at this time of an astringent nature, but rather having a laxative quality.

2224. It is desirable to milk the new-calved cow as soon as convenient for her, as the withdrawal of milk affords relief. It frequently happens that an uneasiness is felt in the udder before calving; and should it increase while the symptoms of calving are yet delayed, the cow will experience much inconvenience, especially if the flush of milk has come suddenly. The cause

* Skellett *On the Parturition of the Cow*, p. 113.

of uneasiness is unequal hardness of the udder, accompanied with heat, floridness, and tenderness. Fomentation with warm water twice or thrice a-day, continued for half an hour at a time, followed by gentle rubbing with a soft hand, and anointing with goose-fat, will tend to allay irritation. In the case of heifers with the first calf, the uneasiness is sometimes so great during the protracted symptoms of calving, as to warrant the withdrawal of milk before calving. Should the above remedial measure fail to give relief, the great heat may cause direct inflammation, and consequent suppuration in the udder. To avert such an issue, the uneasiness should be attended to the first moment it is observed, as neglect may allow the complaint to proceed so far as to injure the structure of the whole udder.

2225. In ordinary cases of calving, little apprehension need be felt for the safety of the cow; but she must be carefully attended to for at least a fortnight after calving. No cold drinks, no cold turnips, should be given her; and no cold draughts of air be allowed to blow upon her. These things may check perspiration and cause the milk or puerperal fever. The hind-quarters, raised up by litter for a few days, will recover the tone of the relaxed parts.

2226. But in cases of severe and protracted labour the cow may be overtaken by several casualties, such as flooding or loss of blood, which is caused by the vessels of the womb being prevented from collapsing as they should do; but it is not often a fatal complaint, and may be removed by the application of a lotion, consisting of one gallon of spring water, mixed in a quart of strong vinegar, in which cloths should be dipped and applied frequently to the loins, rump, and shape. A drink of two quarts of cold water and a pint of ale will much relieve her, and assist the efforts of nature.

2227. The womb becomes inverted after the cleansing happens to remain too long after delivery, in consequence of long and severe pressing or straining of the cow. The womb must be made perfectly clean with soap and warm water, and replaced with care, taking hold of it only by the upper side. The hind-quarter of the cow should be well elevated with straw, and a saline dose of laxative medicine administered, with some opium, to allay pain and prevent straining.

2228. After severe calving, cold, and draughts of cold air, may cause inflammation in the womb; large drinks of cold water will produce the same effect, as well as the irritation arising from retention of the cleansing. A purge is the safest remedy, consisting of 1 lb. of Epsom salts, 2 oz. nitre, $\frac{1}{2}$ oz. of camphor, and 1 oz. each of coriander and cumin seeds, mixed in a powder, and given in 2 quarts of gruel and half a pound of treacle.

2229. But in all cases of severe calving, the veterinary surgeon should witness the process, and afterwards administer the proper medicines and prescribe the proper treatment and regimen.

2230. A cow will desire the bull in 4 or 5 weeks after calving. The symptoms of a cow being in season are thus well described by Skellett. "She will suddenly abate of her milk, and be very restless; when in the field with other cows, she will be frequently riding on them, and if in the cow-house, she will be constantly shifting about the stall; her tail will be in constant motion; she will be frequently dunging, staling, and blaring; will lose her appetite; her external parts will appear red and inflamed, and a transparent liquor will be discharged from the vagina. In old cows these symptoms are known to continue 4 or 5 days, but in general not more than 24 hours, and at other times not more than 5 or 6 hours. Therefore, if a cow is intended for procreation, the earliest opportunity should be taken to let her have the bull; for if it be neglected then, it will often be 2 or 3 weeks before the above symptoms will return. These instructions," adds Skellett, "are necessary to be given only to the proprietor of a small number of cows, where a bull is not always kept with them. . . . If a cow, after calving, shows symptoms of season sooner than 4 or 5 weeks, which is sometimes the case, she should *not be permitted to have the bull sooner than 4 or 5 weeks from that period*—for the womb before that time is, in general, in so relaxed a state, as not to be capable of retaining the seed, consequently she seldom proves with calf, if she is suffered to take him sooner."* This last remark I consider of great value, for I am persuaded that most cases of cows not holding in calf the first serving after calving, arises from the want of consideration on the part of breeders, whether the cow is in that recovered state from the effects of calving, as to afford a reasonable hope that she will conceive; and this is a point more to be considered than the mere lapse of time after calving; for a cow, after a severe labour, may be in a much worse state for conception, even at double that length of time, than another which has calved with ease, though the former may have come as regularly into season as the latter. The state of the body, therefore, as well as the length of time, should both be taken into consideration in determining whether or not the cow should receive the bull.

2231. There are still other considerations connected with the serving of cows which deserve your attention. The usual practice, in places where there is no bull, is to take the cow to the bull at a convenient time for the cattle-man to go with her; and, should she have passed the bloom of the season before her arrival at the bull, the issue will of course be doubtful. The cow may have travelled a long distance and become weary, and yet no rest is allowed her, and she must undergo the still farther fatigue of being served. Some people cannot be satisfied with the service which their cows receive, until both cow and bull are wearied out. Others will force either the cow or bull, or both, to go together against their inclination, she being held by the nose, and he goaded on with threats and thumps. In all such cases the chances are much against conception. There is, to be sure, the inconvenience of not having the bull on the spot, but, when he is reached, he may have been worn out for the day by previous service. No inconvenience is experienced when there is a bull at home; but even then, when the cow has to be taken to him out of the byre, a discretion is requisite of the proper time she should be taken out; and this can only be known by studying the idiosyncracy of each cow.

2232. It appears to me as essential to keep a record of the characteristics of each cow, in regard to her state of season, as of her reckoning to calve; and the conviction is strengthened by the great differences, in this respect, evinced by different cows under the same treatment. For example, one arrives soon at mature season after the symptoms are exhibited: a second requires a few hours to arrive at the same point, and the season continues for some time longer in a languid state: a third runs through the course of season in a few hours; while a fourth is only prepared to receive the bull at the last period of her season: a fifth may exhibit great fire in her desire, which induces her keeper to have her served at once, when too soon; whilst a sixth shows comparative indifference, and, in waiting for an exhibition of increased desire, the season is allowed to pass away; and in such a case, some cattlemen, conscious of neglect, and afraid of detection, will persist in the bull serving her, though she may be very much disinclined for the embrace, and does everything in her power to avoid it.

2233. There is no way so natural for a bull to serve a cow, as when both are in the field together, and understand one another. The most proper time is chosen by both, and failure of conception then rarely happens. But it is possible that the bull cannot serve the cow in the field, by disparity of height, or by corporeal conformation, when the cow will require to be taken to a part of the ground which will favour his purpose. Two or three *thorough* skips are quite sufficient for securing conception.

2234. The cow should be kept quiet in the byre after being served until the desire leave her, and she should get no food or water for some hours after, as any encouragement of discharges from the body, by food and drink, is inimical to the retention of the semen.

2235. "When nature is satisfied," says Mr Skellett, "or the symptoms of season

* Skellett *On the Parturition of the Cow*, p. 11-13.

disappear in the animal, conception has taken place. The neck of the womb becomes then completely closed by a glutinous substance which nature has provided for that purpose, being perfectly transparent, and with difficulty separated from the parts. This matter is for the purpose of excluding all external air from the mouth of the womb during gestation, which, if admitted to the fœtus, would corrupt the membranes and the pellucid liquor in which the fœtus floats, and would undoubtedly cause the cow to slink. This glutinous substance also prevents the lips of the mouth of the womb from growing together; and when the cow comes into season it becomes fluid,—the act of copulation serving to lubricate the parts, and prevent inflammation."*

2236. The heifers that are to be transferred to the cow-stock should be taken from the hammels N, Plate II, in which they have been confined all winter, into the byre, at once into the stalls they are to occupy, about three weeks or a fortnight before their reckoning. If they had been accustomed to be tied by the neck when calves, they will not feel much reluctance in going into a stall; but if not, they will require some coaxing to do it. When taking them to the byre at first, it should be remembered that a fright received at this juncture may not be forgotten by them for a long time to come. To avoid every chance of that, let them go in quietly of their own accord; let them snuff and look at every thing they wish; and having plenty of assistants to prevent their breaking away, let the cattle-man, with the shepherd, allow them to move step by step, until they arrive at the stall. Here may be some difficulty—some favourite food should have been put in the manger to entice them to go up. Another difficulty will be putting the seal, fig. 76, round the neck. It should be hung, when not in use, upon a nail in the stake, from which it should be quietly taken down, without clanking the chain; and, while the heifer is eating, let the cattle-man slip one hand below the neck with the chain, while the other is passed over it, to bring the loose end of the seal round the neck, and hook it into whatever link he first finds. The moment the heifer feels she is bound, she will hang back, or attempt to turn round in the stall to get away, which she should be prevented doing by gentle means; and after remaining in that state for some time, and feeling herself well used and kindly spoken to, she will yield; but although she may appear to submit for the time, she must not be left alone for some time—till the assurance she will not attempt to turn in the stall is received. No dogs should be allowed to be present on such occasions. I have detailed thus minutely the first treatment of heifers in a byre, that you may avoid an accident that happened to a fine short-horn heifer of my own, which, on being *rather rudely* prevented running away, by being very quickly turned on a causeway, was lamed in the shoulder joint, upon which grew a large callous lump, which ever after remained unsubdued.

2237. The following table, containing the dates at which cows should calve from those at which they were bulled, is founded upon the data afforded by Lord Spencer, namely, 285 days as the average period of gestation. It is unnecessary to fill up the table with marking down every day of the year, as in the short period between each fortnight you can easily calculate the particular reckoning of each cow:—

A RECKONING TABLE FOR THE CALVING OF COWS.

When Bulled.		When will Calve.		When Bulled.		When will Calve.	
Jan.	1.	Oct.	13.	July	16.	April	27.
—	15.	—	27.	—	30.	—	11.
—	29.	—	10.	Aug.	13.	May	25.
Feb.	12.	Nov.	24.	—	27.	—	8.
—	26.	—	8.	Sept.	10.	June	22.
March	12.	Dec.	22.	—	24.	—	6.
—	26.	—	5.	Oct.	8.	July	20.
April	9.	Jan.	19.	—	22.	—	3.
—	23.	—	2.	Nov.	5.	Aug.	17.
May	7.	Feb.	16.	—	19.	—	31.
—	21.	—	2.	Dec.	3.	Sept.	14.
June	4.	—	16.	—	17.	—	28.
—	18.	March	30.	—	31.	Oct.	12.
July	2.	April	13.				

2238. A few years since, Mr A. Burnett of Newcastle-upon-Tyne constructed a table, which he denominated The Farmer's Cycle, intended to indicate at a glance the exact day of reckoning when every kind of animal should bring forth its young, from the day in which it was served by the male. Mr Burnett confined his table to calculating the time of cows, ewes, and sows; but it might as easily be extended to that of mares, and even to that of the hatching of all kinds of poultry. The table consists of a zodiac circle, divided into as many large divisions as there are months in

* Skellett *On the Parturition of the Cow*, p. 17.

the year, which are so named, and these again into as many days as are in every month, February having the ordinary number of 28, one more being added by the mind in leap years. Within this circle, which may be projected upon a stout piece of card or wood, is another circle, which is made to revolve upon their common centre. Upon the movable circle is drawn a radius with a pointer at its extremity, and there is marked along it the words "when served" or "set." On bringing the pointer to the day in which any female of the stock was served by the male, other radii set their pointers at the day when the female should bring forth its young, be it a cow, a mare, a ewe, or a sow; allowing the proper period of gestation to every kind of animal. The cow is allowed 285 days, the mare 334, the ewe 152, the sow 112; and on setting their eggs, the goose is allowed 30, the turkey 30, and the hen 21 days. Such a table would be highly useful in the possession of every shepherd, cattle-man, and dairy-maid.

2239. The usual mode of determining whether a cow is in calf is deceptive. She may not have held when bulled; she may have taken the bull again in a few days, and she may not show evident symptoms of calving until only a few days before she actually calves. The application of the ear to the flank of the cow is a simpler and more certain mode of ascertaining the point: and the curious and valuable discoveries brought to light by the *stethescope*, renders that mode truly philosophical. The existence of pregnancy may be detected by it at as early a stage as six or eight weeks, by which time the beating of the heart of the calf may be distinctly heard, and its singular double beating cannot be mistaken.

2240. *Milk or Puerperal Fever.*—"Although parturition is a natural process," as is well observed by Mr Youatt, "it is accompanied by a great deal of febrile excitement. The sudden transferring of powerful and accumulated action from one organ to another—from the womb to the udder—must cause a great deal of constitutional disturbance, as well as liability to local inflammation."* One consequence of this constitutional disturbance of the system is *milk-fever*. "The cause of this disease," says Skellett, "is whatever obstructs perspiration, and accumulates the blood internally; hence it may be produced by the application of cold air, by lying on the cold ground, or by giving cold water after calving; and these causes will naturally produce this effect from the open state of the pores at this time, and from the external parts being so wide and relaxed after the operation. Cows in high condition are more subject than others to this complaint, and especially if they have been kept up for some weeks before calving."† The complaint may seize the cow only a few hours after calving, or it may be days. Its first attack is probably not observed by those who have the charge of the cows, or even by the farmer himself, who is rather chary in looking after the condition of cows, in case he should offend his female friends, to whose special care that portion of his stock is consigned. The symptoms are first known by the cow shifting about in the stall, or from place to place if loose, lifting one leg and then another, being easily startled, and looking wildly about her as if she had lost her calf, and blaring for it. Then the flanks begin to heave, the mouth to open and issue clear water, she staggers in her walk, and at length loses the use of her limbs, lies down and places her head upon her side. The body then swells, the extremities feel cold and clammy. Shivering and cold sweats follow, the pulse becomes irregular, and death ensues. The promptest remedy to be used, after the first symptom has been observed, is to bleed to the extent of 3 or 4 quarts; and the next is to open the bowels, which will be found to have a tendency to constipation. From 1 lb. to 1½ lb. of Epsom salts, according to the strength of the cow, with a little ginger and carraway, should be given as a purge; and if the dose does not operate in due time, ½ lb. of Epsom salts should be given every 6 hours until the bowels are opened. This result will be much expedited by a glyster of warm thin gruel and soap or oil. After the opening medicine has operated, a cordial drink will be necessary, by which time the cow may show symptoms of recovery by expressing an inclination to eat, in which she should be gratified, but with precaution.

2241. I may here mention an unaccountable fatality which overtook a short-horn cow of mine, in Forfarshire, immediately after calving. She was an extraordinary milker, giving not less than 30 quarts a-day in summer on grass; but what was more extraordinary, for two calvings the milk never dried up, but continued to flow to the very day of calving, and after that event returned in increased quantity. In the third year she went naturally dry for about one month prior to the day of reckoning; every precaution, however, was taken that the milk should dry up without giving her any uneasiness. She calved in high health, the milk returned as usual in a great flush after calving, but it was impossible to draw it from the udder; not a teat would pass milk, *all the four being entirely corded.* Quills were first introduced into the teats; and then tubes of larger size were pushed up into the body of the udder. A little milk ran out of only one of them—hope revived; but it soon stopped running, and all the art that could be devised by a skilful shepherd proved unavailing to draw milk from the udder; rubbing and softening the udder with goose-fat, making it warmer with warm water—all to no purpose. To render the case more distressing, there was not a veterinary surgeon in the district. At length the udder inflamed, mortified, and the cow died in the most excruciating agony on the third day, from being in the highest state of health, though not in high condition, as her milking propensity usually kept her lean. No loss of the kind ever affected my mind so much—that nothing *could* be done to relieve the distress of an animal which could not help itself.

* Youatt *On Cattle*, p. 546.

† Skellett *On the Parturition of the Cow*, p. 195.

I was told afterwards by a shepherd, to whom I related the case, that I should have cut off all the teats, and although the horrid operation would, of course, have destroyed her for a milk cow, she might have been saved for feeding. He had never seen a *cow* so operated on ; but it suggested itself to him in consequence of having been obliged at times to cut off the teats of ewes to save their lives. The suggestion I think is good. The cow was bred by Mr Currie, when at Brandon in Northumberland.

2242. *Red-water.*—The ninth day after a cow has calved, an uterine discharge should take place and continue for a day or two, after which the cow will exhibit all the symptoms of good health. I have observed that when this discharge does not take place, the cow will soon after show symptoms of red-water. She will evacuate urine with difficulty, which will come away in small streams, and be highly tinged with blood, and at length appear like dark grounds of coffee. "The nature and cause of the disease are here evident enough," as Mr Youatt well observes. "During the period of pregnancy there had been considerable determination of blood to the womb. A degree of susceptibility, a tendency to inflammatory action had been set up, and this had been increased as the period of parturition approached, and was aggravated by the state and general fulness of blood to which she had incautiously been raised. The neighbouring organs necessarily participated in this, and the kidneys, to which so much blood is sent for the proper discharge of their function, either quickly shared in the inflammation of the womb, or first took an inflammation, and suffered most by means of it."* The prevention of this disease is recommended in using purgative medicine after calving ; but as purging never fails to lessen the quantity of milk given by the cow for some time after, a better plan is to give such food as will also operate as a laxative, for some time before as well as after calving—and the substance which possesses these properties is *oil-cake.* I have proved this from experience. I lost two cows in Forfarshire by red-water, one a short-horn and the other an Angus, and one of the hinds lost one also ; all in different but successive years. By examination of the stomach and bowels after death, I became satisfied that the determination of the blood to the womb, during pregnancy, had caused a tendency to inflammation in the bowels and stomach, and that indigestion and constipation were the consequences, and these were aggravated by the state of the food, which consisted entirely of Swedish turnips, and which, at that season, in April, were fibrous, dry, and sweet. The remedy was obvious—give a laxative diet ; and as that cannot readily be effected by turnips, particularly in cows which do not receive as many as they can eat, nor by raw potatoes, which incur the risk of hoven, the only alternative was oil-cake ; and, fortunately, from the period I employed it medicinally, for a month before and one after calving, to the extent only of 4 lbs. a-day to each cow, the complaint never recurred.

2243. I never saw the disease in Berwickshire ; and the opinion in Forfarshire, where the disease is prevalent, that it arises from cows eating some noxious plant, and is called the *muir-ill*, cannot be well founded—as cows living on the *same kinds of sown* grasses have been differently affected in different parts of the country. Besides, a two years' pasture has not time to become stocked with natural plants, whether noxious or innoxious ; nor could the noxious effects of even natural pasture plants be felt in spring, after cattle had lived upon turnips for a number of months ; nor can simple laxatives, for a few days in spring, counteract the effects of plants grazed on for half a year in the previous summer. Indigestion and constipation, at the time of calving, must therefore arise from some other cause than the consumption of plants in summer. One cause may be sought in the prevailing practice in Forfarshire, of keeping cows constantly in the byre during the winter half-year. Remove the tendency to constipation by a gentle laxative, and allow the cows air and exercise in winter in a court, and the complaint will never more be heard of after calving. Whatever may be the cause of the disease in summer, when it is said to be most prevalent in dry weather, where cows have liberty to roam over marshes, muirs, or woods, and eat what plants hunger may impel them, it is clear that the disease in spring cannot arise from the same cause.†

2244. *Tail-ill or Tail-slip.*—A very prevalent notion exists in Scotland amongst cattle-men, that when the tail of an ox or of a cow feels soft and supple immediately above the tuft of hair, there is disease in it ; and it is called the tail-ill, or tail-slip. The almost invariable remedy is to make a large incision with the knife along the under side of the soft part, stuff the wound full of salt and butter, and sometimes tar, and roll it up with a bandage for a few days, and when the application is removed, the animal is declared quite recovered. Now, this notion is an absurdity. There is no such disease as imputed ; and as the poor animal subjected to its cure is thus tormented, the sooner the absurd notion is exposed the better. The notion will not soon be abandoned by the cattle-men ; but the farmer ought to forbid the performance of such an operation on any of his cattle without his special permission, and the absurd practice will fall into desuetude. "The disease, in ordinary cases," as Professor Dick describes it, "is *said* to consist in a softening of the bones about the extremity of the tail *(mollities ossium)* ; and is to be distinguished by the point of the tail being easily doubled back upon itself, and having, at this doubling, a soft and rather crepitating kind of feel. But let us inquire," as the Professor very properly suggests, "what is the *healthy* state of this organ, and what is its use,

* Youatt *On Cattle*, p. 504.

† See *Prize Essays of the Highland and Agricultural Society*, vol. ix. p. 8-34, for a number of essays on this subject, all of which, it will be observed, unconditionally ascribe the origin of the disease to cattle eating some noxious plants.

before we proceed to pronounce upon this supposed disease. Almost all the lower animals are furnished with this organ; in some adding much to their grace and symmetry, and in all being an organ of greater or less utility." Now, the natural structure of the tail is this: "The tail of the ox is lengthened out to the extent of 3 feet, and is formed like a common whip. Towards the extremity, the bones terminate gradually, becoming insensibly smaller as they approach the termination. At this part is found a soft space, which is said to be the *seat* of this *disease*, the *tail-slip*. Beyond this, again, a firm, swelling, cartilaginous portion is found, covered with hair, to brush off the flies within its reach. Now, why have we the long column of bones, the termination with a soft space of a few inches, and this thickened hard cartilaginous part at the very extremity, and that extremity covered with hair? Why, but with a view to form a whip to drive off, with the greatest possible effect, the insects which wound and do torment the animal. Here, the column of bones forms the elastic shaft or handle of the whip; the soft part, the connexion between the handle and thong, the couple; while the thickened extremity may be easily recognised to represent the thong, and the hair to form the lash or point. They have thus a whip to drive and a brush to wipe off their foes as they make their attack." The tail being thus shown to be admirably suited for its purpose, it could not be so well suited for it if it wanted that soft part which is said to be in a state of disease. On the conclusion to be drawn from this statement of facts, the Professor anticipates it thus—"But it will perhaps be asked, after what I have stated of the facts previously ascertained, do I deny the existence of the *tail-slip?* I answer, Yes. But if I am again asked, Is the *tail not liable to disease?* I answer, it is; but these diseases, or rather injuries, are only those common to other parts. The *softness* at the extremity is *no disease*; it is the natural structure, intended to allow a free and extensive motion; and although, in some cases, mortification may have attacked the extremity of the tail, ought we not to ascribe this to some common cause—some external injury? or might it not, perhaps, have become frost-bit by exposure to cold?" * A real disease of the tail, whatever it is, is, at all events, *not* the tail-ill.

ON THE MILKING OF COWS.

2245. *The structure of a cow's udder* is remarkable. It consists of 4 glands, disconnected with each other, but all contained within one bag or cellular membrane; and the glands are uniform in structure. Each gland consists of 3 parts, the *glandular* or secreting, the *tubular* or conducting, and the *teat* or receptacle or receiving part. The glandular forms by far the largest portion of the udder. It appears to the naked eye composed of a mass of yellowish grains, but under the microscope these are found to consist entirely of minute blood-vessels forming a compact plexus, which secrete the milk from the blood.

2246. The udder should be capacious, though not too large, for the size of the cow. It should be nearly spherical in form, though rather fuller in front, and dependant behind. The skin should be thin, loose, and free from lumps, filled up in the fore-part of the udder, but hanging in folds in the hind part. Each quarter should contain about equal quantities of milk, though I have always believed that the hind ones yield the most.

2247. The teats should be at equal distances every way, not too long or too short, but of moderate size, and of equal thickness from the udder to the point, which should be smaller. They should not be too large at the udder, to permit the milk to flow down too freely from the bag and lodge in them; nor too small at that place, to allow the coagulation of the milk to *cord up* or fill the orifice; nor too broad at the point, to have the orifice as large as that the cow cannot retain her milk after the bag becomes full and heavy. They should be smooth, and feel like velvet, firm and soft to handle, not hard and leathery. They should yield the milk freely, and not require to be forcibly pulled.

2248. When the milk is first to be taken from the cow after calving, the points of the teats will be found plugged up with a resinous substance, which, in some instances, requires some force to be exerted on them before it will yield. The milk that is obtained for the first four days has a thick consistence, and is of a yellow colour, and has obtained the name of *beistyn* in Scotland. It possesses the coagulable properties of the white of an egg, and will boil into a thick substance called beistyn cheese; but it is never used for such a purpose, and is given to the calf, because the country people have a notion that it is not wholesome to use the beistyns.

* *Quarterly Journal of Agriculture*, vol. iii. p. 310-13.

2249. "Thus, then," says a writer, "we perceive that the milk is abstracted from the blood in the glandular part of the udder; the tubes receive and deposit it in the reservoir or receptacle; and the sphincter at the end of the teat retains it there till it is wanted for use." This is not quite correct, for the teat does not terminate in a sphincter—the milk being upheld in the teat simply by a valvular structure, like as the blood is supported in the veins. A sphincter acts by the power of four muscles, which contract or expand at will across a common orifice. "But we must not be understood to mean, that all the milk drawn from the udder at one milking, or *meal*, as it is termed, is contained in the receptacle. The milk, as it is secreted, is conveyed to the receptacle, and when this is full, the larger tubes begin to be filled, and next the smaller ones, until the whole become gorged. When this takes place, the secretion of the milk ceases, and absorption of the thinner or more watery part commences. Now, as this absorption takes place more readily in the smaller or more distant tubes, we invariably find that the milk from these, which comes the last into the receptacle, is much thicker and richer than than what was first drawn off. This milk has been significantly styled *afterings;* and should this gorged state of the tubes be permitted to continue beyond a certain time, serious mischief will sometimes occur: the milk becomes too thick to flow through the tubes, and soon produces, first irritation, then inflammation, and lastly suppuration, and the function of the gland is materially impaired or altogether destroyed. Hence the great importance of emptying these smaller tubes regularly and thoroughly, not merely to prevent the occurrence of disease, but actually to increase the quantity of milk; for so long as the smaller tubes are kept free, milk is constantly forming; but whenever, as we have already mentioned, they become gorged, the secretion of milk ceases until they are emptied. The cow herself has no power over the sphincter (?) at the end of the teat, so as to open it and relieve the overcharged udder; neither has she any power of retaining the milk collected in the reservoirs when the spasm of the sphincter is overcome." *

2250. You thus see the necessity of drawing away the last drop of milk at every milking, and the greater milker the cow is, this is the more necessary. You also see the impropriety of *hefting* or holding the milk in cows until the udder is distended much beyond its ordinary size, for the sake of showing its utmost capacity for holding milk, a device which all cow-dealers, and indeed every one who has a cow for sale in a market, scrupulously adopts. It is remarkable that so hackneyed a practice should deceive any one into its being a measure of the milking power of the cow—for every farmer is surely aware, or ought to be, that the person who purchases a hefted cow, on account of the magnitude of its udder as exhibited in the market, gains nothing by the device; for, afrer the cow comes into his possession, she will not be hefted, and, of course, not show the greatest magnitude of udder, and cannot yield the advantage for which she was bought erroneously in preference to others with udders in a more natural state. If, then, purchasers derive no benefit from hefting, because they do not allow it after the cow becomes their own, why do they encourage so cruel and injurious a practice in dealers? Is it not better to select cows by the udder in the state in which it will be in their own possession? Were purchasers to set their face against the barbarous practice, by insisting on a reduction in the price of the cow, for the injury done her by the hefting, the dealers would soon be obliged to relinquish it.

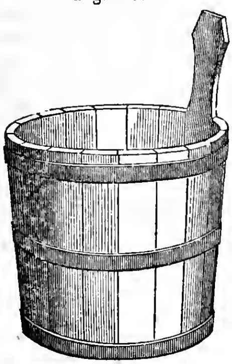
2251. There is also another fallacy in regard to the milking properties of a cow, which should be exposed—I mean the notion of a large milk-vein below the belly indicating the milking powers of the cow. The vein, commonly called the milk-vein, is the sub-cutaneous vein, and has nothing to do with the udder; it belongs to the respiratory system, and is the means of keeping up an equilibrium in the blood between the fore and hind quarters. This vein certainly indicates a strongly developed vascular system, which is favourable to secretion generally, and no doubt is so to that of the milk among the rest.

2252. The vessel used for receiving the

* Blurton's *Practical Essay on Milking*, p. 6.7.

milk from the cow is simple, and is shown in fig. 197, which represents one of the most convenient form, and the size may be made to suit the dairy-maid's taste. It is made of thin oak staves bound together with three thin iron hoops, which should always be kept bright. Pitchers of tin are mostly used to milk in in the dairies of towns. In Holland the milking pails are made of brass, and of course must be kept quite bright, otherwise they would injure the milk. The Dutch dairy-maids have a great deal of trouble in keeping these vessels in proper order. A pail, as fig. 197, is of a convenient size when 9 inches in diameter at the bottom, 11 inches at the top, and 10 inches deep, with a handle 5 inches high, and having a capacious enough mouth to receive the milk as it descends, and of a sufficient height to rest on the edge of its bottom when held firmly between the knees of the dairy-maid, as she sits upon the three-legged stool. Of course the pail should not be milked full, and should be large enough to contain all the milk that a cow will give at a milking, as it is undesirable to disturb the cow by rising from her before the milking is finished, or exchanging one pail for another.

Fig. 197.



THE MILK PAIL.

2253. The byre-stool is seen in fig. 198, made of ash, to stand 9 inches in height, or any other height to suit the convenience of the dairy-maid, with the top 9 inches in diameter, and the legs a little spread out below to give the stool stability. Some milkers do not care to have the assistance of a stool, and prefer sitting on their haunches; but a stool keeps the body so steady and secure, that the arms have greater freedom of action, and are more ready to prevent accidents to the milk in case of any commotion with the cow.

Fig. 198.

THE MILKING STOOL.

2254. The cow being a sensitive and capricious creature, is so easily offended, that, if the dairy-maid rise from her before the milk is all withdrawn, the chances are she will not again stand quietly at that milking; or if the vessel used in milking is taken away before the milking is finished, and another substituted in its place, the probability is that she will *hold* back her milk—that is, not allow it to flow. This is a curious property which cows possess, and how it is effected has, I believe, never been ascertained; but there is no doubt of the fact occurring when a cow becomes irritated, or frightened by any cause. Of course, all cows are not affected to the same degree; but, as a proof of their extreme sensitiveness in this respect, very few can be milked so freely by a stranger the first time as by one to whom they have been accustomed.

2255. There is one side of a cow which is usually called the *milking side*—that is, the left side—because, somehow, custom has established the practice of milking her from that side. It may have been adopted for two reasons: one, because we are accustomed to approach all the larger domesticated animals by what we call the *near side*—that is, the animal's left side—as being the most convenient one for ourselves; and the other reason may have been, that, as most people are right-handed, and the common use of the right hand has made it the stronger, it is most conveniently employed in milking the hinder teats of the cow, which are often most difficult to reach, because of the position of the hind legs, and the breadth of the hinder part of the udder. The near side is most commonly used in Scotland, but in many parts of England the other side is preferred. Whichever side is selected, that should always be used, as cows are very sensitive of changes.

2256. It is a rare sight to see a cow milked in Scotland by any other person than a woman, though men are very commonly employed in England. For my part, I never see a man milking a cow without being impressed with the idea that he is engaged in an office which does not befit him; and this sense seems to be expressed in the terms usually applied to the persons connected with cows—a dairy-*maid* implying one who milks cows, as well as performs the other functions of the dairy,—a dairy-*man*, one who owns a dairy.

2257. *Milking* is performed in two ways, stripping and nievling. *Stripping* consists of seizing the teat firmly near the root between the face of the thumb and the side of the fore-finger, the length of the teat lying along the other fingers, and by pressing the finger and thumb while passing them down the entire length of the teat, and causing the milk to flow out of its point in a forcible stream. The action is renewed by again quickly elevating the hand to the root of the teat. Both hands are employed at the operation, each having hold of a different teat, and are moved alternately. The two nearest teats, the fore and hind, are first milked, and then the two farthest.

2258. *Nievling* is done by grasping the teat with the whole hand, or *fist*, making the sides of the fore-finger and thumb press upon the teat more strongly than the other fingers, when the milk flows by the pressure. Both hands are employed, and are made to press alternately, but so quickly in succession, that the alternate streams of milk sound on the ear like one forcibly-continued stream; and although stripping also causes a continued flow, the nievling, not requiring the hands to change their position, as stripping does, draws away the larger quantity of milk in the same time. Stripping is thus performed by pressing and passing certain fingers along the teat; nievling by the doubled *fist*, pressing the teat steadily at one place.

2259. Of the two modes, I prefer the *nievling*, because it appears to me to be the more natural one of imitating the sucking of a calf. When a calf takes a teat into its mouth, it seizes it with the tongue and palate, causing them to play upon the teat by alternate pressures or pulsations, while retaining it in the same position. This is what nievling does; but stripping is not like this at all,—it is rather like the action which a thief would make when stealing milk from the cow. It is said that stripping is good for agitating the udder, and agitation is conducive to the withdrawal of a large quantity of milk; but there is nothing to prevent the dairy-maid agitating the udder as much as she pleases, while holding the teats in nievling—indeed, a more constant agitation could be kept up in that way, by the vibrations of the arms, than by stripping, and is more like the poking of the udder with the nose when the calf sucks. Stripping, by using a constrained pressure upon two sides of the teat, is much more apt to press it unequally than grasping the whole teat in the palm of the hand; while the *friction* occasioned by passing the finger and thumb firmly over the skin of the teat, is more likely to excite heat and irritation in it than a mere grasp of the hand. To show that this friction causes an unpleasant feeling even to the dairy-maid, she is obliged to lubricate the teat frequently with milk, and to wet it at first with water; whereas nievling requires no such expedients. And as a further proof that stripping is a mode of milking which may give pain to the cow, it cannot be employed when the teats are chapped, or when these and the udder are affected with the cow-pox, with so much ease to the cow as nievling. This difference I saw strikingly exemplified one summer, when all my cows were affected with the cow-pox, and when the assistant, who could only milk by stripping, was obliged to relinquish her duty till the cows were so far recovered as to be again able to endure her mode of milking.

2260. Milking should be done *fast*, to draw away the milk as quickly as possible; and it should be continued as long as there is a drop of milk to bring away. This is an issue which the dairy-maid cannot too particularly attend to herself, and see it attended to by her assistants. Old milk left in the receptacle of the teat soon changes into a curdy state; and the caseous matter, not being at once broken and removed by the next milking, is apt to irritate the lining membrane of the teat during the operation, especially when the teat is forcibly rubbed down between the finger and thumb in stripping. The consequence of this irritation being repeated is the thickening in a part of the lining membrane, which at length becomes so hardened as to constitute a stricture which at length closes up the orifice of the teat. The stricture may easily be felt from the outside of the teat, and the teat is then said to be *corded*. After this the teat becomes *deaf*, and no more milk can afterwards be drawn from the quarter of the udder with which the corded teat communicates.

2261. Cows are easily rendered troublesome on being milked; and the kicks and knocks which they usually receive for their restlessness only render them the more fretful. If they cannot be overcome by kindness, thumps will never make them better. But the fact is, restless habits were engendered in them by the treatment they received when first taken into the byre, when, most probably, they were dragooned into submission. Udders and teats are very tender immediately after calving, and especially after the first calving; and when unfeeling horny hands tug the teats in *stripping*, as if they had been accustomed to the operation for years, no wonder that the young and inexperienced cow should wince under the infliction, and attempt to get quit of her tormentor by kicking. Can the creature be otherwise than uneasy? and how can she escape the pain but by striking out her heels? The hobbles are then placed on the hind fetlocks, to keep the heels down. The tail is then employed by her as an instrument of annoyance, and it then is held by some one while the milking is going on; or it is tied to the creature's leg by the hair of the tuft. Add to these the many threats and scolds uttered by the dairy-maid, and you will have a faint idea of how a young heifer is broke into milking. Some cows, no doubt, are very unaccommodating and provoking; but, nevertheless, nothing but a gentle course of conduct towards them will ever render them less so. Some cows are only troublesome to milk for a few times after calving, and become soon quiet; others kick pertinaciously at the first milking. In this last case, the surest plan, instead of hobbling, which only irritates, is for the dairy-maid, while standing on her feet, to place her head against the flank of the cow, stretch her hands forward, and get a hold of the teats the best way she can, and let the milk fall to the ground; and while in this position, it is out of the power of the cow to hurt her. Such ebullitions of feeling, at the first milking after calving, arise either from feeling pain in a tender state of the teat—most probably from inflammation in the lining membrane of the receptacle; or simply from titillation of the skin of the udder and teat, which become the more sensitive as the heat wears off; or the udder, being still hard, gives pain when first touched—and should the udder be difficult to soften, the advice of Mr Youatt may be tried, by allowing the calf to suck at least three times a-day until the udder becomes soft. This will doubtless cure the udder, but it will cause another species of restlessness in the cow when the calf is taken entirely from her. Still, rather let the dairy-maid suffer this inconvenience than the udder of the cow be injured. Be the cause of irritation what it may, one thing is certain, that gentle discipline will overcome the most turbulent temper in a cow.

2262. The milking of cows affords different degrees of pleasure to the milker. Some yield their milk with a copious flow, with the gentlest handling that can be given; others require great exertion to draw the milk from them in streams no larger than threads. The udder of the former will have a soft skin, and the teats will be short; that of the latter a thick skin, and the teats long and tough. The former feels like velvet, the latter not pleasanter than tanned leather.

2263. A few years ago, a plan of drawing milk from the cow was recommended by Mr Blurton, Field Hall, Staffordshire, by introducing tubes into two teats, and milking the other teats at the same time. He was once of opinion that a tube in each teat would draw away all the available milk at the time from the udder; but, finding his mistake in this, he has adopted the following method of milking. I may mention that he names his tubes *siphons*, but they have not the form, and therefore cannot have the property, of the siphon, which first elevates the fluid in a vessel to draw it over its rim, whereas his tubes just allow the milk to run out of the bottom of the udder through the open teat. His improved plan of milking is this:—"The milker sits down as in the common method, fixing the siphon can (pail) firmly between his knees: he then takes hold of the near-hand teat with a slight pressure of his right hand, and with his left introduces the *small* tube of the siphon an inch or more into the teat, putting the thumb on the large tube, to prevent the milk from running out till completely introduced—and so on with the near fore teat, reserving the two farthest teats to be milked by hand. By this method I find that I can milk three teats with my right hand, assisted by the siphons, in the time I can milk one with my left, and this with ease and comfort to myself. I must here also observe, that the action of milking one or two teats by hand, is quite sufficient to induce the cow to give her milk down freely from those milked by the siphons; as I have before observed, the cow does not possess the power of retaining her milk in any one quarter of the udder, while it flows freely from the others."

2264. These tubes, containing a small and larger end, beyond which they cannot pass into the teat, may be made of ivory, bone, or metal. They should be thrown into the pail and milked on before being used, and when taken out of the teat, let fall into the can. On being used, they should be dipped in boiling water and blown through. They do not seem to possess any advantage over the hand; on the contrary, the hand must be employed to complete what they cannot accomplish, and must be in use when they are employed.

2265. Mr Blurton very properly advocates clean milking, and describes a very good plan by which will be drawn away all the milk from an udder much better than by any tube. "In aftering," he says, "I have adopted the plan of using the *left hand to press down the thick milk* into the receptacle and teat, at the same time *milking with the right hand*; then, in a similar manner, discharging the whole from the remaining quarters of the udder." He adds what is very true, that "it must not be supposed that this method is distressing to the animal; on the contrary, her quietness during the process is a satisfactory indication that it occasions no pain, but rather an agreeable sensation." *

2266. I have said that the udder, in some cases of heifers, becomes uneasy even before calving, (2224,) and they are very subject to inflammation soon after calving. "The new or increased function which is now set up," says Mr Youatt, "and the sudden distention of the bag with milk, produce tenderness and irritability of the udder, and particularly of the teats. This in some cases shows itself in the form of excoriations or sores, or small cracks or chaps on the teats; and very troublesome they are. The discharge, likewise, from these cracks mingles with the milk. The cow suffers much pain in the act of milking, and is often unmanageable. Many a cow has been ruined, both as a quiet and a plentiful milker, by bad management when her teats have been sore. . . . . She will also form a habit of retaining her milk, and which very speedily and very materially reduces its quantity. The teats should be fomented with warm water in order to clean them, and get rid of a portion of the hardened scabbiness about them, the continuance of which is the greatest pain in the act of milking; and, after the milking, the teats should be dressed with the following ointment: Take 1 oz. of yellow wax, and 3 oz. of lard, and melt them together, and when they begin to get cool, rub well in ¼ oz. of sugar of lead, and one drachm of alum finely powdered."†

2267. Cows differ very much in the time they continue to give milk, some not continuing to yield it more than 9 months, whilst others afford it for years. The usual time for cows that bear calves to give milk is 10 months. The cow that died in consequence of the corded teats, mentioned above (2136,) gave milk for 3 years, and bore a calf every year. A cow of mine that slipped her calf, and was not again served by the bull, gave milk for 19 months; but many remarkable instances of cows giving milk for a long time are on record. "The immense length of time for which some cows will continue to give milk," says a veterinary writer, "if favourably treated, is truly astonishing; so much so as to appear absolutely incredible. My own observation on this subject extends to four most remarkable cases: 1. A cow purchased by Mr Ball, who resided near Hampstead, that continued to give milk for 7 years, subsequently to having her first and only calf. 2. A large dun Suffolk cow, shown to me as a curiosity by a Yorkshire farmer. This animal, when I saw her, had been giving milk for the preceding 5 years, during which period she had not any calf. The five years' milking was the result of her second calving. During that period attempts had been made to breed from her, but ineffectually. 3. A small aged cow, belonging to a *fermier* near Paris, that gave milk for 3 years subsequent to her last calf. 4. A cow in the possession of Mr Nichols, postmaster, Lower Merrion Street, Dublin. This animal was in Mr Nichols' possession 4 years, during the entire of which time she continued to give an uninterrupted supply of milk, which did not diminish in quantity more than 3 pints per diem, and that only in the winter months. . . . . He disposed of her for butchers' meat, she being in excellent condition. The morning of the day on which she was killed, she gave her usual quantity of milk."

2268. The same writer enters fully into a subject with which I was not previously acquainted—namely, the possibility of securing permanency of milk in the cow. This is effected, it seems, by simply *spaying* the cow at a proper time after calving. The operation consists in cutting into the flank of the cow, and in destroying the ovaries of the womb by the introduction of the hand. The cow must have acquired her full stature, so that it may be performed at any age after 4 years. She should be at the flush of her milk, as the future quantity yielded depends on that which is afforded by her at the time of the operation. The operation may be performed in ten days

* Blurton, *Practical Essay on Milking*, p. 10-12.

† Youatt *On Cattle*, p. 552.

after calving, but the most proper time appears to be 3 or 4 weeks after. The cow should be in high health, otherwise the operation may kill her or dry up the milk. The only preparation required for safety in the operation is, that the cow should fast 12 or 14 hours, and the milk taken away immediately before the operation. The wound heals in a fortnight or three weeks. For two or three days after the operation the milk may diminish in quantity; but it regains its measure in about a week, and continues at that mark for the remainder of the animal's life, or as long as the age of the animal permits the secretion of the fluid ; unless, from some accidental circumstance —such as the attack of a severe disease—it is stopped; but, even then, the animal may be easily fattened.

2269. The advantages of spaying milk cows are thus summed up:—"1. Rendering permanent the secretion of milk, and having a much greater quantity within the given time of every year. 2. The quality of the milk being improved. 3. The uncertainty of, and the dangers incidental to breeding, being to a great extent avoided. 4. The increased disposition to fatten, even when giving milk, or when, from excess of age, or from accidental circumstances, the secretion of milk is checked ; also, the very short time required for the attainment of marketable condition. 5. The meat of spayed cattle being of a quality superior to that of ordinary cattle." * With these advantages, of course, breeders of stock can have nothing to do; but, since the operation is said to be quite safe in its results, it may be presented to the notice of cowfeeders in town.

ON THE REARING OF CALVES.

2270. We left the new-dropped calf comfortably housed in its crib amongst plenty of clean straw, until we should have time to attend to it. Let us now consider how it should be reared until it shall go to grass to provide for itself.

2271. For convenience, the *calves' house* should be placed immediately adjoining the cow-byre. This apartment is seen at R, Plate II., fitted up with cribs. It is 35 feet in length, and 18 feet in width, and the roof ascends to the slates. Calves are either suckled by their mothers, or brought up on milk by the hand. When they are suckled, if the byre be roomy enough—that is, 18 feet in width—stalls are erected for them against the wall behind the cows, in which they are usually tied up immediately behind their mothers; or, what is a less restrictive plan, put in numbers together in large loose boxes at the ends of the byre, and let loose from both places at stated times to be suckled. When brought up by the hand, they are put into a separate apartment from their mothers, and each confined in a crib, where the milk is given them. The superiority of separate calves to having a number together is, that it prevents them sucking one another, after having had their allowance of milk, by the ears, teats, scrotum, or navel, by which malpractice certain diseases may be engendered.

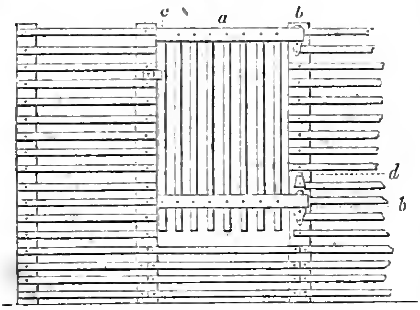
2272. The crib is large enough for one calf at 4 feet square and 4 feet in height, sparred with slips of tile-lath, and having a small wooden wicket to afford access to the calf. The floor of the cribs may be of earth, but the passage between them should be flagged, or of asphalt. Abundance of light should be admitted, either by windows in the walls, or sky-lights in the roof; and fresh air is essential to the health of calves, the supply of which would be best secured by a ventilator in the roof, such as fig. 81. A door should communicate with the cow-house, and another, having upper and lower divisions, into a court furnished with a shed, as *k* Plate II., which the calves may occupy until turned out to pasture. The crib should be fitted up with a manger to contain cut turnips or carrots, and a high rack for hay, the top of which should be as much elevated above the litter as to preclude the possibility of the calf getting its feet over it. The general fault in the construction of calves' houses is the want of both light and air, light being cheerful to animals in confinement, and air essential to the good health of all young animals. When desired, both may be excluded. The walls of the calves' house should be plastered, to be neat and clean. Some people are of opinion that the calves' house should not only have no door of communication with the cow-house, but should be placed at a distance from it, that the cows may be beyond the reach of hearing the calves. Such an objection could only have originated from an imperfect acquaintance with the character of these animals. A cow that is prevented smelling and suckling her calf, does not know its voice, and will express

* Ferguson *On Distempers among Cattle*, p. 29-36.

no uneasiness about it a few minutes after they are separated, and after the first portion of milk has been drawn from her by the hand.

2273. The front and door of a calf's *crib*, is represented by fig. 199, in which *a* is the wicket door which gives access to

Fig. 199.



A CALF'S-CRIB DOOR.

it, *b b* are the hinges, and *c* is a thumb-catch to keep it shut. This sort of hinge is very simple and economical. It consists of those rails of the wicket intended for the hinges, being elongated towards *b*, where they are rounded off; and their lower face is shaped into a round pin, which fills and rotates in a round hole made in a billet of wood, seen at the lower hinge at *b*, securely screwed to the upright door-post of the crib. Another billet *d* is screwed immediately above the lower rail, *b*, to prevent the door being thrown off the hinges by any accident. Cross-tailed iron hinges, of the lightness suited to such doors, would soon break, by rusting in the dampness usually occasioned by the breath of a number of calves confined within the same apartment.

2274. A court should be attached to the calves' house. It is 30 feet in length by 25 feet in width, and there should be erected in it, for shelter to the calves in cold weather, or at night before they are turned out to pasture, or for the night for a few weeks before they are put into the larger court when at pasture, a *shed k*, Plate II., 30 feet in length by 12 feet in width, fitted up with mangers for turnips, and racks for hay. A trough of water *w* is also requisite in this court, as well as a gateway for carts, by which the dung may be removed, and a liquid-manure grating, *x*, to keep the court dry.

2275. The state of the navel-string is the first thing that should be examined in a new-dropped calf, that no blood be dropping from it, and that it is not in too raw a state. Inattention to this particular may overlook the cause of the navel-ill, the treatment of which is given below; and, insignificant as this complaint is usually regarded, it carries off more calves than most breeders are aware of.

2276. The first food which the calf receives consists of the beistyn. Being of the consistence of the yolk of the egg, it seems an appropriate food for the young calf. On giving it its first feed by the hand, in a crib, it may have risen to its feet, or been content to lie still. In whichever position it is found, let it remain so, and let the dairymaid take a little beistyn in a small dish—a *handy* formed like a miniature milk-pail, fig. 197, and of similar materials, is a convenient one—and let her put her left arm round the neck of the calf, and support its lower jaw with the palm of the hand, keeping its mouth a little elevated, and open, by introducing the thumb of the same hand into the side of its mouth. Then let her fill the hollow of her right hand with beistyn, and pour it into the calf's mouth, introducing a finger or two with it for the calf to suck, when it will swallow the liquid. Let it get, in handful after handful, as much as it is inclined to take. When it refuses to take more, its mouth should be cleaned of the beistyn that may have run over. Sometimes, when a calf lying is begun to be fed, it attempts to get upon its feet, and, if able, let it do so, and rather assist than prevent it. Some people are afraid to give a calf as much beistyn at first as it can take, because it is said to produce the navel-ill. This is nonsense: let it take as much as it pleases; and as to the navel-ill, it proceeds from neglect of the proper inspection after the calf is born. I have thus minutely described the simple process of first feeding a new-dropped calf by hand, because very absurd modes are adopted of doing this. Nothing is more common than to plunge the calf's head into a large quantity of beistyn, and because the liquid bubbles around its mouth with the breath from the nose, and it will not drink, its head is the more forcibly thrust and kept down into the tub. How can it drink with its nose immersed amongst the fluid? and why should a calf be expected at first to *drink with its head down*, when its natural instinct would lead it to *suck with its head up?* It should always be borne in mind, that feeding calves by the hand is an *unnatural* process; nevertheless, it is a convenient, practicable, and easy one, provided it be conducted in a proper manner. The young calf must be *taught to drink*, and a good mode of teaching it is as I have described above. In this way it is fed as often as the cow is milked, which is at first three times a-day at least. After the first two or three days, however, another plan should be adopted, for it should not be *accustomed* to suck the fingers, as it will not drink without their assistance. The succeeding plan is to put a finger or two of the right hand into its mouth, and holding the small pail of milk with the left under its head, bring the head gradually down into the pail, where the fingers induce it to take a few gluts of the milk; and while it is doing this, the fingers should be gently withdrawn, while the head should be held down in its position with the hand, taking care not to dip the nostrils into the milk. In a few days more the fingers will not be required, and in a few more still the calf will *drink* of its own accord.

2277. For the first month the calf should have as much sweet milk warm from the cow as it can drink. It will be able to drink nearly 3 quarts at each meal—that is, in three meals a-day, in the morning, noon, and evening, it will drink 8 quarts. After the first month, to the end of the third, it gets its quantity of milk at only 2 meals, morning and evening. It is supported 3 months in all on milk, during which time it should have as much sweet milk as it can drink. Such feeding may be considered expensive, and doubtless it is, but a *good* calf cannot be *well* brought up in any other way, for no substitute will answer the purpose of new milk. Some people grudge giving sweet-milk to calves after a few days, and take the cream off it, and give the skimmed milk. This is considered thrifty management; but although it may insure immediate gain in the cream, it insures ultimate loss in the calf. It is impossible to derive a double advantage from a given quantity of sweet-milk. If butter is preferred to calves or good beasts at an after period, the immediate wish is attained, and the farmer has had his preference; but he ought to know that he cannot have butter and good beasts from the same identical milk. Others, seemingly more generous, give half-sweet and half-skimmed milk to the calves; whilst some provide a substitute for the milk, by making gelatine of boiled linseed or sago, and give no milk at all. When milk is really scarce, expedients are permissible; but when plentiful, and used merely in the farm-house, or sold, the recourse to expedients is a practical avowal that the farmer does not wish to bring up his stock as he might.

2278. The jelly from linseed, or *lythax*, as it is called, is easily made by boiling good linseed in water, and while it is in a hot state to pour it into a vessel to cool, where it becomes a firm jelly, a proportion of which is taken every meal, and bruised down in a tubfül of warm milk, and distributed to the calves. They are very fond of it, and in the third month of the calf's age, when it can drink a large quantity of liquid at a time, and during a day, it is excellent food for them.

2279. Sago may be prepared in the same way; but without milk it is a very improper food for calves, as it contains no ingredients to afford the substance of muscle or bone to the young animal.

2280. But a better substance for calves than either, in my opinion, is pea meal. It should not be boiled, but made into *brose*, by pouring hot water upon it, and stirring the mixture till it is *fine*. It becomes gelatinous on cooling; and when cold, a portion of it is put into as much new warm milk, and mixed so intimately with the hand, as not a lump of the meal shall be felt in the mixture, which should be of a consistence which a calf can easily drink.

2281. When the calves suck their mothers, and are in large cribs at convenient parts of the cow's byre, in a loose state, they are let out of the cribs to the cows, as the hours arrive for feeding them, each going directly to the cow which suckles it.

2282. When they are tied by the neck in stalls, erected for the purpose against the wall of the byre, immediately behind the cows, they are loosened from their bindings, and pass across the byre to the cows.

2283. Generally, in both cases, one cow suckles two calves; and a cow that has calved early may suckle two sets, or four calves, or at least three, in the season.

2284. As regards the merit of these plans, I must say that I am averse to tying calves by the neck. It cramps their motions, and deprives them of that freedom of action which is so conducive to health and growth. By preventing motion, they will no doubt sooner acquire condition; but for stock calves, this is of less importance than strength acquired by moderate exercise within a limited space, such as in a crib. As to having a number of calves within the same crib, though they certainly have liberty to move, they have also liberty to suck one another. The ears, navel, scrotum, and teats, suffer by this dirty habit; and there is no preventing it after it has been acquired, as long as two calves remain together. Upon the whole, I prefer the separate crib to each calf, so formed of spars as to allow every calf to see its neighbours, and they are then as much in company as to remove the idea of loneliness. The separation, at all events, prevents the abominable habit of sucking being acquired; and such cribs are as useful when the calves are suckled by the cows as when brought up by hand.

2285. In regard to bringing up calves by suckling, there is no question it is the best way, provided the calf has free access to the cow which is supporting it; but I am doubtful of the superiority of suckling over feeding by hand, when the calf is only allowed to go to the cow at stated times. It saves the trouble of milking the cows and giving the milk to the calves; but a saving of trouble is of no importance compared to rearing young stock well. An objection to suckling exists, when one cow brings up two calves at a time, that the quantity of milk received by each calf is unknown, and the fastest sucker will have the larger share. True, they are both brought up; but are they brought up as well as when the quantity of milk consumed by them is known to be sufficient for their support? The milk becomes scarcer, too, as the calves get older, instead of becoming more plentiful. The objection to partial suckling is, that a cow suckling a calf does not allow milking afterwards with the hand in a kindly manner, as every cow prefers being sucked to being milked by the hand. Unless, therefore, cows are kept for the purpose of suckling entirely, they become troublesome to milk with the hand after the calves are weaned.

2286. At a month old, the male calves that are not intended to be kept for bulls are *castrated*. Though the operation is simple and safe, it should not be performed at a time when any inflammation affects the navel-string, or symptoms of costiveness or dysentery are present. Supposing the calf to be in good health, the castration is performed in this manner. An assistant places the calf upon its rump on the litter, and, sitting down himself, takes it between his outstretched limbs on the ground, with its back at the shoulder against his breast. Then seizing a hind hock of the calf in each hand, he draws up a hind leg to each side of its body, and holds both in that position as firmly as he can. The operator causes the testicles keep the scrotum smooth and full with his left hand, and cuts with a sharp knife through all the integuments till the testical is laid bare, which he seizes with the right hand, and pulls out as much of the spermatic cord as he can, and divides it with the knife. The same operation he performs on the other testicle, and the entire castration is accomplished in a minute or two. The calf is laid down on the litter, and he will feel stiff in the hind quarters for a few days, and the scrotum may even swell. Should the swelling become serious, fomentations of warm water should be frequently applied; and should suppuration ensue, the incisions in the scrotum should be opened out to give the matter vent; but the probability is, that the cuts will heal by the first intention, and give no further uneasiness to the calf than a stiffness in the hind quarters for a few days.

2287. The practice some time ago was to *spay* the heifer calves—that is, to make an opening in the flank, through which the ovaries of the womb were extracted, in order to extinguish all desire for the bull; but the operation is falling into desuetude, most probably from the circumstance of every breed of cattle being now so much improved, that the heifers are generally considered fit for breeding, and are therefore kept *open*, as the phrase is, and disposed of at a better price than when fattened for the butcher.

2288. When the air becomes mild as the season advances, and as the older calves attain the age of two months, they should be put into the court *k*, Plate II. during the day; and, after some days' endurance to the air, should be sheltered under the shed at night, instead of being again put into the cribs. Sweet hay should be offered them in the racks; as well as a few slices of Swedish turnips in the mangers in the shed. The change of food may cause costiveness in some calves, and looseness in others; but no harm will arise from either, if remedial measures are employed in time. Large lumps of chalk to lick at will be serviceable in looseness. Should the weather prove wet, snowy, stormy, or cold, they should be brought back to their cribs till the storm pass away.

2289. At 3 or 4 months old, according to the supply of milk and the ready state of the grass to receive them, the calves should be *weaned* in the order of seniority, due regard being had to their individual strength. If a calf has been always strong and healthy, it may be the sooner weaned from milk when the grass is in a state to support it; but should it have ailed, or be naturally puny, it should still have good sweet milk as the best means to recruit its debility. When determined on weaning, calves should not be deprived of milk all at once; the quantity should be lessened daily, and given at longer intervals, so that it may be withdrawn insensibly. Calves, on being stinted of milk preparatory to weaning, are supplied with a sufficient quantity of other food than milk, and it is given so as to entice them to take it. Fresh bundles of the most clovery portions of the hay, turnips fresh sliced, fresh carrots, pure water at will, a little pounded oil-cake, presented in turns when they used to get their milk, will be eaten for the sake of novelty; but if these, or any of them, are given anyhow to save trouble, and are left to be picked up in a court, or bare lea, the calves cannot but suffer from hunger, nor is it surprising they should make their hunger be loudly known. Thus treated, they will inevitably fall off in condition; and if they do this at the critical period of weaning, the greater part of the ensuing summer will elapse ere they regain the condition, strength, and sleekness of coat, they had when on the milk. A small sheltered paddock, in good heart, near the steading, is an excellent place for weaning calves, before turning them out to a pasture field; but unless it afford a full bite of grass, to support them as the milk is taken from them, they will be as much injured in it as in a poor grass field.

2290. When *bull* calves are brought up, they should be early calved, and receive as much new milk as they can drink, and should not be weaned till the grass is fully ready to support them. The object of this high keeping is not to fatten them, though it may do that too, but to give strength to their *bones*, and vigour to their *constitution*, these being much enhanced by the quality and quantity of food at the earliest period of existence. The impulse thus given in calfhood, is evinced by bulls in the vigour of succeeding life, and it is sure to lay the foundation of a long and useful service. Even with ordinary calves, if they are pushed forward in the first month of their existence, the probability is they will evade every disease incident to that age.

2291. I should mention that, when they receive milk in the court, some will be apt to plague those which are getting theirs, by poking their heads into the same pail, by boxing, or by sucking the ears, &c. To prevent these annoyances, the dairymaid should be provided with a supple cane or switch, and tap the ears of every one disposed to be troublesome. Discipline, while it does no harm to those subjected to it, impresses on others the necessity of obedience. We err if we consider animals, because they are dumb and young, incapable of instruction of any kind. On the contrary, they are very susceptible of it, and its influence is evinced by habitual forbearance from wrong.

2292. On *carse farms* no calves are brought up, those produced by the cows which supply the people with milk being sold to rearers of stock, or fattened for the butcher. On *pastoral farms*, devoted to sheep, the same plan is usually pursued ; but on those which rear cattle only, as on the west coast of Scotland, in Wales, and in Ireland, the calves are suckled by the mothers, and entirely brought up by them—which, as I have already said, is an excellent plan, provided the mothers are well fed, and make their calves follow them over the pastures, and then they will become strong, and be free of disease. On *dairy farms* calves are not brought up, excepting as many of the quey calves as shall be required to renovate the stock of cows, the milk being appropriated to quite other purposes ; nevertheless, it is in the dairy districts that the calves are best fattened for the butcher.

2293. Strathaven in Scotland has long been famed for rearing good *veal* for the Glasgow and Edinburgh markets. The dairy farmers there retain the quey calves for maintaining the number of the cows, while they feed the male calves for veal. Their plan is simple, and may be followed anywhere. Milk only is given to the calves, and very seldom with any admixture, and they are not allowed to suck the cows. Some give milk, but sparingly at first, to whet the appetite, and prevent surfeit. The youngest calves get the first drawn milk, or *fore-broads*, as it is termed, and the older the *afterings*, even of two or three cows, being the richest portion of the milk. After being three or four weeks old, they get abundance of milk twice a-day. They get plenty of dry litter, fresh air, moderate warmth, and are kept nearly in the dark to check sportiveness. They are not bled during the time they are fed, and a lump of chalk is placed within their reach. They are fed from 4 to 6 weeks, when they fetch from £3 to £4 a-piece ; and it is found more profitable to fatten the larger number of calves for that time, to succeed each other, of from 25 lb. to 30 lb. per quarter, than to force a fewer number beyond the state of marketable veal.*

2294. The plan followed of fattening calves, for thirty miles round London, is very different. There, the cows are made to suckle the calves three times a-day for the first three or four days, and afterwards twice a-day. If the cow is full of milk, two calves are put to her ; and, at any rate, one calf is put on after another is fattened off. In this way, the veal-farmers keep from 6 to 12 cows each, and convert their whole milk into veal. The calves are placed in boarded boxes, 4 feet high, and just large enough inside for a calf to turn. The floor is also boarded ; the boards having holes, are raised from the ground, and littered with clean wheat-straw. A lump of chalk is placed within reach of each calf. The calf is fed for 10 weeks, when it will attain about 35 lb. per quarter or more, and is then warranted *prime* veal. A calf, however, of 9 or 10 stones, will fetch a shilling or two a-stone more than one of 17 or 18 stones. Notwithstanding this, the English veal-farmers believe, contrary to those of Strathaven, that a calf grows and fattens faster after it is 10 weeks old than before, and requires less milk to carry it on ; and the profit is greater, inasmuch as one large calf incurs only one prime cost, one risk of life, and one commission ; whereas, two small calves incur twice the cost and risk of life. The butchers bleed the calves repeatedly before slaughtering them ; and they judge of the colour of the flesh by looking at the inside of the mouth and white of the eyes. "The profit of fattening calves," observes Mr Main, "may be judged of by an example in figures, which I have oft experienced. A calf is suckled for 10 weeks, and weighs from 10 to 11 stones imperial, *sinking the offal*, as it is called in London. The calf fetches £5 at market, from which deducting 30s. which it might have been sold for when a week old, and 5s. salesman's commission, leaves a profit of £3, 5s, or 6s. 6d. per week for the cow's milk. Now, deducting 2s. 6d. per week for the keep of the cow, the bare profit left is only 4s. per week. But it must be remembered, that a good cow will fatten off two calves while she is in milk—some I have had, two and a half : but this can be but rarely accounted on. Still, taking one cow with another, kept for the purpose of suckling, her annual returns will be nearly what it is commonly estimated at, namely, £12. To *insure* this, or any other sum, as clear profit, depends entirely on the attention bestowed on the cows and calves. Some cows are odd-tempered, letting down their milk only to their own calves, and withholding it from those they are made to foster. This, if not corrected, will injure both cow and calf ; the one will be starved, and the other will soon become dry."†

2295. Veal is generally considered a delicate species of meat, is held in high repute as a dish, and always fetches a higher price in the market than beef or mutton, being 9d. per lb. when beef is 6d. or 7d ; and, being thus accounted delicate, it is a remarkable fact, that fresh fried veal takes so long as 4½ hours to digest.‡

2296. *Navel-ill.*—On examination after the first drink is given to the calf, the navel-string may perhaps continue slowly to bleed. "In this case," advises Mr Youatt, "a ligature should be passed round it close, but, if it can be avoided, not quite close to the belly. Possibly the spot at which the division of the cord took place may be more than usually sore. A pledget of tow, well wetted with Friar's balsam, should be placed over it, confined with a bandage, and changed every morning and night ; but the caustic applications that are so frequently resorted to should be avoided. Sometimes, when there has been previous bleeding, and especially if the caustic has been used to arrest the hemorrhage, and at other times

* *Quarterly Journal of Agriculture*, vol. v. p. 249. † *Ibid.* p. 611.
‡ Combe *On Digestion and Dietetics*, p. 136.

when all other things seemed to have been going on well, inflammation suddenly appears about the navel between the third and eighth or tenth day. There is a little swelling of the part, but with more redness and tenderness than such a degree of enlargement could indicate. Although there may be nothing in the first appearance of this to excite alarm, the navel-ill is a far more serious business than some imagine. Mr Sitwell, an intelligent breeder at Barmoor Castle in Northumberland, says, 'that in his part of the country, as soon as the calf takes on this disease, they consider it as dead; and butchers and graziers will not purchase any calves until the usual time for having the disorder is passed.' Fomentation in the part, in order to disperse the tumour, the opening of it with a lancet if it evidently *points*, and the administration of 2 or 3 oz. doses of castor oil, made into an emulsion by means of an egg, will constitute the first treatment; but if, when the inflammation abates, extreme weakness should come on, as is too often the case, gentian and laudanum, with perhaps a small quantity of port wine, should be administered."* In my own calves a single instance of this disease was never experienced, but a careful examination of the navel-string was made both before and after the calf was first fed.

2297. *Costiveness.*—The black and glutinous fæces that had been accumulating in the intestines of the calf, during the period of its fœtal existence, should be got rid of; and there is no aperient better suited for the purpose than beistyn. The dairymaid who throws it away, does not know the jeopardy in which she places the lives of calves. Should the beistyn not have the effect soon of removing the fæces, 2 or 3 oz. of castor oil, beat up with the yolk of an egg, or in thick gruel, should be administered, and a scruple of powdered ginger, to act as a carminative. In cases of actual costiveness, which young calves are very liable to contract, and inattention to which, at first, is the cause of the loss of many of the best young stock, arising partly from repletion of milk at times, when calves are permitted to suck the cows, or when they eat too much hay at one time after the milk has been too suddenly removed from them at weaning, active measures should be adopted to prevent its confirmation, as the case will soon become hopeless, fever inevitably ensue, and the food harden into a mass in the maniplies. Doses of warm water, containing a solution of 2 or 3 oz. of Epsom salts, should be frequently administered, both to soften the matter in the stomach and move the bowels.

2298. *Scouring.*—Calves are liable to a disease of an opposite nature from this, namely, *looseness*, *scouring*, or *diarrhœa*. They are most subject to it when put out to grass, though still on milk, at too early an age. I should say that, if so treated before attaining 2 months, they are certain of being affected with it. One means of prevention is, to retain the calves in the house or shed till they are at least 2 months old, and if a little older so much the better. Of course, it is only the latest calves that are likely to be too soon put on grass, the earlier having attained the mature age for weaning before the grass is ready. In the house, scouring may be brought on by starvation and excess, and on grass by a sudden change of food. As long as the calf is lively, and takes its milk, there need be no apprehension from a thin discharge of fæces; but dulness and loathing of food, accompanied by discharge, should create alarm. The first application of a remedy should be a mild purgative, to remove, if possible, the irritation of the bowels; and then should follow anodynes, astringents, and alkalies, with carminatives, the withdrawal of every sort of green food, and the administration of flour or pea-meal gruel. The following mixture the farmer is called to "*rely* on, and it is recommended that he should have it always by him, as it will do for all sucking animals—namely, 4 oz. of prepared chalk, 1 oz. of Winter's bark, powdered, 1 oz. of laudanum, and 1 pint of water. Give 2 or 3 table-spoonfuls, according to the size of the animal, 2 or 3 times a-day."† Another prescription is,—"Take ½ oz. to ¾ oz. of tincture of rhubarb, with an equal quantity of water, according to the age and strength of the calf. To be given every alternate day, in case one dose is not sufficient. I have used the remedy for several years," says a writer, "and have not lost a calf."‡ Mr E. E. Dawson, Ingethorpe, Grantham, recommends this,—"For young calves boil ½ oz. of ground black pepper in half a pint of ale; add a tea-spoonful of ginger; mix together; to be given lukewarm every morning until the calf recovers of its weakness: to have its milk as usual. Older calves will require ⅓ more for a complete cure. Great care should be used in making use of the above recipe, that the animal does not receive the mixture too fast; for want of this attention mischief may be done."§ I have given all these remedies for the scour in calves, as it appears that it may be removed by various means, and one may be more efficacious in one locality than in another. I never saw among my calves but one instance of serious scouring, and it occurred before the calf was put to grass. It was a short-horn quey-calf, and the medicine which effected a cure, after trying many, was taken from White's *Farriery.* "The *immediate* cause of the disorder," observes White, "appears most frequently to be an unhealthy action of the liver, which seems to form bile of an acrid or hurtful quality, by which the bowels are constantly irritated. I would advise, therefore, in the early stages of the complaint, to give the following drink for three successive mornings, which will rather increase the scouring at first; and when the effect of this medicine has ceased, let the astringent drink be given every morning and evening." The laxative drink consists of quicksilver pill, from 1 to 2 drachms, India rhubarb 1½ drachm, castor oil 2 oz. in half a pint of gruel. These should all be well mixed before being given, as the quicksilver pill is heavy, and will fall down. While taking this medicine, the animal should not be exposed to either cold or wet, and all its drinks should be warm fluids, of which thin gruel is

* Yonatt *On Cattle*, p. 558.
† Johnson's *Farmer's Encyclopædia*, art. *Diarrhœa.*
‡ *Bell's Weekly Messenger* for March 1842.
§ *Mark Lane Express* for November 1842.

the best. The astringent drink is made of starch, 2 oz., which is made as if for stiffening clothes, with 1 quart of warm water ; to this add laudanum 1 drachm, ginger 1½ drachm, and Japan earth ¼ oz. I ought to mention that these prescriptions are recommended by White for cows, that for calves being milder ; but having tried the one for calves without success, I adopted those for cows, and succeeded—by only taking half the quantities of the ingredients prescribed, which was just the quantities given above. "An observation we have made, when treating of some other diseases," remarks White, "is equally applicable to this—that is, at an early period of the disorder, a cure may generally be effected by the treatment above described; but if neglected, and suffered to go on until the *structure* of the affected part is injured, medicine is but a useless expense." *

2299. *Calf-louse.*—It is not a little singular, in a physiological point of view, that there should be a *peculiar pedicular parasite appropriated to the calf;* yet such appears to be the case, although the creature is by no means common. It is very like the ox-louse, *Hæmatopinus eurysternus,* fig. 100, but comparatively narrower, and having two rows of dusky spots on the abdomen. It is termed *Hæmatopinus vituli*, or louse of the calf.†

2300. Mr Youatt gives a description of castrating bull-calves in France by means of *torsion,* termed *bistournage.* The effect of the torsion seems to be, that the testicles remain fixed against the abdomen, and gradually wither away. The animal is usually bled after the operation, and half of the allowance of food is only given ; and it may be sent to pasture on the second or third day, if the weather is favourable. Although this mode of castration does not seem very painful to the animal, and is rarely attended by any dangerous results ; yet we are informed of the state in which it leaves the ox, that "the animals that are thus emasculated are said to preserve more of the form of the bull than others from whom the testicles are excised : they also retain more of the natural desires of the bull, and are occasionally very troublesome among the cows."‡

2301. It is improbable that the breeders of this country will follow a practice which will let loose such a horde of *riglins* amongst their herds; as they are already too well aware of the trouble which even a single *riglin* and *chaser* gives on a farm.

ON THE SOWING OF SPRING WHEAT.

2302. When wheat is sown in spring, it is usually after turnips, whether these have been entirely stripped from the land, or partly consumed on the ground by sheep. Whichever of these states of the turnip crop may be chosen to be followed by wheat, it is not merely sufficient to raise a good crop of turnips with a plentiful supply of manure for once upon an exhausted soil, to insure a good crop of spring wheat; the land should be, and should have been for some time, in good heart, otherwise the attempt will inevitably end in disappointment.

2303. Wheat cannot be sown in spring in every sort of weather, and upon every variety of soil. Unless the soil possesses a certain degree of firmness, arising from clay, it is not well adapted for the growth of wheat—at least it is more profitable to sow barley upon it; and unless the weather is, besides, as dry as to allow strong soil to be ploughed in early spring, it is also more profitable to defer the wheat, and sow barley in the proper season. The general climate of a place affects the question of sowing wheat there in spring; and it seems a curious problem in climate why wheat sown in autumn should come to maturity at a place where spring wheat will not. Elevation of position, even in a favourable latitude, produces similar effects. Experience in these well-known effects renders the farmers of Scotland chary of sowing wheat in spring, unless the soil is in excellent condition, and the weather very favourable for the purpose. But, under the most favourable circumstances, it has not been sown after the first week in March, until these few years, when a variety of wheat has been introduced into Scotland, named April wheat, because it may be sown as late as that month.

2304. On farms possessing the advantages of favourable soil and climate, and on which it is the custom to sow spring wheat every year, the turnip-land is ploughed with that view up to a certain period of the season, usually the beginning of March ; and even on those on which spring wheat can only be sown occasionally, when a favourable field comes in the course of rotation, or the weather proves tempting, the land should still be so ploughed as advantage may be taken to sow the wheat. Should the weather take an unfavourable turn for this purpose, the soil may afterwards be easily worked for barley.

* White's *Farriery*, vol. iv. p. 57-9. † Denny's *Monographia Anoplurorum Britanniæ.*
‡ Youatt *On Cattle*, p. 561.

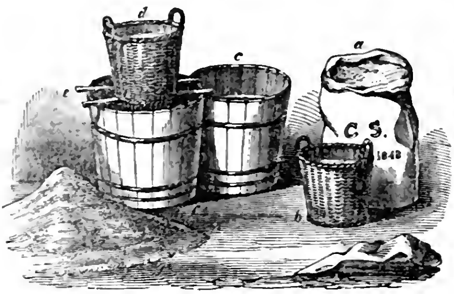
2305. The land should only receive one furrow—the seed-furrow, for spring wheat; and if it were ploughed oftener after a manured green crop, and in spring, when it had become tender by the winter frost, it would want that firmness so essential to the growth of wheat. The mode of ploughing this seed-furrow depends upon circumstances. If the land presents a visible form of ridge, and soon becomes wet, it should be gathered up, fig. 20, and then it will have the appearance of being twice gathered up, as in fig. 26. If it is flat, and the subsoil somewhat moist, gathering up from the flat will answer best, as in fig. 20. If the soil has a dry subsoil, though of itself a pretty strong clay, it may be cast fig. 22 with gore-furrows, (756.) And should it be fine loam, resting on an open bottom, the ridges may be cast together without gore-furrows, as in fig. 22. It is probable that a whole field may not be obtained at once to plough up in either of these ways, and such a case rarely happens in regard to preparing land for spring wheat; but when it is determined to sow it, a few ridges should be ploughed up as convenience offers, and then a number of acres sown at one time. In this way a whole field may be sown by degrees; whereas to wait until a whole field can be sown at once, may prevent the sowing of spring wheat altogether in the proper season. Bad weather may set in, prevent the sowing, and consolidate the land too much after it had been ploughed; still a favourable week may occur, and, even at the latter end of the season, the land may be ribbed with the small plough, in the manner to be afterwards described, which will move as much of the tender part of the soil on the surface as sufficiently to bury the seed.

2306. The land, having been ploughed, should be *sown* as quickly as possible; for which purpose the seed-wheat should have been measured up in the sacks, or ready to be measured up in the corn-barn or granary, and the means of pickling it provided for. Wheat should be sown thick in spring, as there is no time for the plant to *stool* or *tiller*—that is, to throw up young shoots from the roots, as in the case of autumnal sown wheat. About 3 bushels per imperial acre will suffice for seed for spring wheat, which does not tiller, but less would suffice for winter wheat. A controversy about thick and thin sowing is carrying on at present, to which we shall direct our attention at a convenient time.

2307. Seed-wheat should be *pickled*—that is, subjected to preparation in a certain kind of liquor—before it is sown, in order to insure it against the attack of a fungal disease in the ensuing summer, called *smut*, which renders the crop comparatively worthless. Some farmers affect to despise this precaution, as originating in an unfounded reliance on an imaginary specific; but the existence of smut, and its baneful effect upon the wheat-crop, are no imaginary evils; and when experience has proved, in numberless instances, that steeped grain prevents the appearance of this serious disease, the small trouble which pickling imposes may surely be undertaken, rather than place the entire crop in jeopardy. *Why* pickling the seed should have the effect of preventing the smut in the crop, is a question more easily asked than answered; and it is, perhaps, because it has never received a satisfactory answer, that pickling is disregarded by some farmers. No valid objection can be stated against the practice, for the palpable fact stands obvious to conviction, that one field sown with pickled wheat, and otherwise managed in the usual way, will escape the smut; while the adjoining one, managed in exactly a similar manner, but sown with wheat in its ordinary state, will be almost destroyed with the disease. I have seen such a case tested by two neighbouring farmers, the Messrs Fenton, late tenants of Nevay and Eassie, in Forfarshire. It is true that, on some farms, wheat sown in its usual state escapes the disease, which I have heard the late Mr Oliver, Lochend, near Edinburgh, state was the case on his farm; and it is also true that pickling does not *entirely* prevent the occurrence of the disease on other farms; but such cases do not prove that every farm must also be free of the smut: indeed no one, beforehand, can aver that any farm *shall* be so; and while so much uncertainty exists, the *safer* practice is to pickle the seed, the expense being a mere trifle. It is now an ascertained fact, that vaccination will not insure immunity from small-pox, yet it certainly very much modifies its attack when it does occur, and precisely so is the case with pickling wheat.

2308. Wheat is pickled in this way. For some time, 2 or 3 weeks, let a tub, as *c*, fig. 200, be placed to receive a quantity of chamber ley, and whenever the ammonia

Fig. 200.



THE PICKLING OF WHEAT.

is felt disengaging itself from the ley, it is ready for use. It is better that the ammonia be as strong as to smart the eyes, and water be added to dilute it, than that the ley be used fresh. This tub should be removed to the straw-barn, as also the wheat in sacks to be pickled, and part of the floor swept *clean*, to be ready for the reception of the wheat. Let two baskets, *b* and *d*, be provided, capable of holding easily about half a bushel of wheat each, having handles standing upright above the rims. Pour the wheat into the basket *b* from the sack *a*, and dip the basketful of wheat into the tub of ley *c* as far down as completely to cover the wheat, the upright handles of the baskets preventing the hands of the operator being immersed in the ley. After remaining in the liquid for a few seconds, lift up the basket, let the surplus liquid run out of it, and then place it upon the drainer *e*, on the empty tub *f*, to drip still more liquid, till the empty basket is filled with wheat and dipped in the tub. Now empty the dripped basket *d* of its wheat on the floor; and as every basketful is emptied, let a person spread, by riddling through a wire wheat-riddle, fig. 157, a little slaked caustic lime upon the wheat. Thus all the wheat wanted at the time is pickled and emptied on the floor, when the pickled and limed heap is turned over and over again, till the whole mass appears uniform.

2309. The mixing by turning is most surely managed in this way.—Let two men be each provided with a square-mouthed shovel, fig. 83, and let them turn over the heap, one bearing the helve of his shovel in the right hand, and the other with his left—both making their shovels meet in their edges upon the floor, under one end of the heap of wheat, and, on lifting each shovel-full of wheat, turn them over behind them, proceeding by shovelfuls, to the other end of the heap. Let them return in a similar manner in the opposite direction, and as often, until the heap of wheat is completely mixed and dried with the lime. The pickled wheat is then sacked up, and carried to the field in carts.

2310. Other substances beside chamber ley are used for pickling wheat, such as brine of salt, sufficiently strong to float an egg; solution of blue vitriol—all good enough, I dare say; but when so simple, efficient, and easily obtained an article as ley can be had, it appears to me unnecessary to employ anything else. It is powerful, and can destroy vegetable life in the course of a few hours, and, on this account, the wheat should be sown immediately after being pickled; and as this danger exists, no more should be pickled at one time than can immediately be sown. The use of the quick-lime seems merely to dry the ley quickly, so that the grains may be easily separated from one another in the act of sowing; though it may effect some chemical change serviceable to the purpose for which it is employed.

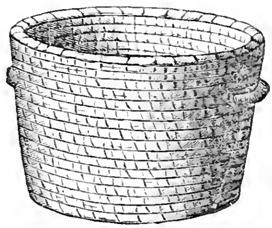
2311. *Sowing by hand.*—There is some art in setting down sacks of seed-corn on the field. It should be ascertained how many ridges of the field to be sown are contained in an acre—a fact which I have recommended to the attention of the student in (571,) so that the sacks may be set down between so many ridges, as each sack or row of sacks shall contain seed to sow the ground between them at the specified quantity of seed to the acre. This instruction should be given to the ploughman before he proceeds to the field with the sacks, otherwise he may set them down either too close or too wide. One row of sacks is sufficient, when the ridges are just long enough for the sower to carry as much seed as will bring him back again to the sack, and the sacks should be set down in the middle of the ridge ; when the ridges are short, the sacks may be set down on a headridge ; and when of such a length as the sower cannot return to the sack by a considerable distance, two sacks should be set down on the same ridge, dividing the length of the ridge equally between them. The setting down of the sacks should be begun from the side at which the sowing commences, and this again depends on the form of the surface of the field.

2312. If the surface is level, it matters not which side of the field is chosen for commencing operations ; but if inclined, then that side which lies to the left while looking down, or to the right on looking up the inclination, should begin the sowing. The reason for this preference is, that the first stroke of the harrows along the ridge is most difficult for the horses to draw; and it is easiest for them to execute the first stroke *downhill*. This first action of the harrows is called *breaking-in* the land. The sacks are always placed on the furrow-brow of a ridge, (738,) that the hollowness of the open-furrow beside it may give advantage to the person who carries the seed, to take it out more quickly and easily as it sinks in the sack.

2313. The *carrier of the seed* is a field-worker, and the instant the first sack of seed is set down, she proceeds to untie and roll down its mouth, and fill the *rusky* fig. 201, with seed, and carries the first quantity to the sower, who should be ready sheeted awaiting her arrival on the head-ridge at the side of the field. Her endeavour should be to supply him with such a quantity at a time as will bring him in a line with the sack when he wants more ; and as the sacks are placed about half-way down the ridges when only one sack is wanted, this may easily be arranged; but when there are two rows of sacks, she must go from sack to sack on the same ridge, and endeavour to make the most convenient arrangement for the sower, it being her special duty to attend to his wants, and not his to attend to her convenience. This regular plan will give her the least trouble, and supply the sower always with the requisite quantities of seed—for, otherwise, nothing can be more annoying to a sower than to have his sheet served too full at one time, and with a stinted quantity at another ; and it loses much time to him to be obliged to wait the arrival of the seed-carrier, whereas she should be awaiting his arrival. If the sacks of seed are conveniently placed, with one on a ridge, one active seed-carrier will serve two sowers ; but when two sacks are required for a ridge, and more than one sower, two carriers will be required. Better that the carriers have little to do than that the sowers should lose time, which they assuredly will incur when the carriers have too much to do.

2314. The *rusky*, or seed-basket, fig. 201, is usually made of twisted straw in rows above each other, fastened together by means of withes of willow. It is provided with a couple of handles sufficient to admit the points of the fingers, and also a rim round the bottom, of the same material, upon which to stand. In the Border counties it is carried on the head of the seed-carrier when full; in other parts in the arms, with the bottom rim supported by the haunch. It should be filled each time with just the quantity of seed, and no more, which the sower requires at one time.

Fig. 201.



THE SEED-CORN RUSKY.

The mouth of the sack should always be kept rolled round upon itself, that the seed may be easily and quickly taken out, for little time is usually at the disposal of the carrier. The carrier should be careful not to spill the seed upon the ground on taking it out of the sack, otherwise a thick tuft of corn will unprofitably grow upon the spot.

2315. As one sack becomes empty, it should be taken by the carrier to the nearest sack, and as they accumulate, should be put into one, and thus carried forward out of the way of the harrows. It is too common to see the sacks allowed to lie upon the ground where they are emptied, and flung aside as the harrows come to them, and thus are not unfrequently torn.

2316. The *sower* is habited in a peculiar manner—he puts on a *sowing-sheet*, fig. 202. The most convenient form of

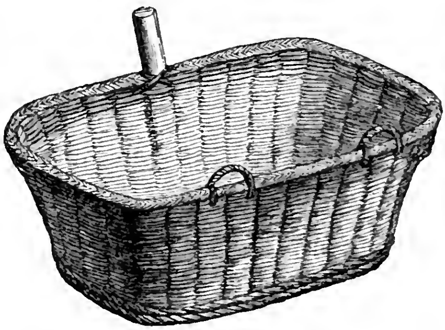
Fig. 202.

THE METHOD OF PUTTING ON THE SOWING-SHEET, AND OF HAND-SOWING.

one is that of the semi-spheroid, made o. linen sheeting, having an opening large enough along one side of its mouth to allow the head and right arm of a man to pass through, and the portion passed under rests upon his left shoulder. On distending its mouth with both hands, and on receiving the seed into it, the superfluous portion of the sheet is wound tight over the left arm, and gathered under it into the left hand; by which it is firmly held, while the load of corn is thus securely supported by that part of the sheet which passes over the left shoulder across the back, and under the right arm. The right arm, which throws the seed, finds easy access to the corn from the open side of the mouth of the sheet, between the left hand and the breast of the sower. A square sheet, knotted together in three of its corners, and put on in a similar manner, is sometimes used as a sowing-sheet; but one formed and sewed of the proper shape, and kept for the purpose, is a much more convenient article. Linen sheeting makes an excellent material for a sowing-sheet, and, when washed at the end of the season, will last many years. The difficult point is to make the sowing-sheet fit the sower on the top of the left shoulder, where the greater part of the weight of the corn rests; and, in attempting this, the principal thing to be considered is, to make the strap, which goes over the shoulder, broad enough, and take the slope of the top of the shoulder from the neck downwards. The gatherings of the cloth on each side of the shoulder-top should be as neatly executed as in a shirt, and a couple of tapes should be drawn through a slot-hem, to be tied tight in front of the sheet across the breast. Fig. 202 shows very correctly the manner in which a well-made sheet should be put on and held.

2317. A *basket* of wicker-work, such as in fig. 203, is very commonly used in England for the sowing of seed. It is sus-

Fig. 203.



THE ENGLISH SOWING BASKET.

pended by girths, fastened to the two loops shown on the rim of the basket, by passing the girth from the left-hand loop over the left shoulder, behind the back to the other loop—or from one loop to the other, round the back of the neck; and the left hand holds the basket steady, by the wooden stud on the other side of the rim. Such an instrument, no doubt, answers the purpose of the sower, or it would not have been so long in use; but, for my part, I much prefer the comfortable feel of the linen sheet to the hard friction of the wicker basket.

2318. Both these utensils for sowing seed are intended for the use of one hand only, but some sowers throw the seed with both hands, and then the instrument must be made to suit the practice. Such a one is a basket, or box made of thin deal, the nearest side curved to suit the front of the body. It is suspended by girths fastened to loops on the side next the sower, and passed round the back of the neck. A strap and buckle fastens it round the body; and the further side is suspended by straps slanting to the shoulders of the sower, and fastened to the strap buckled round behind his body. A more simple form of sowing-sheet for both hands is a linen semi-spheroidal bag, attached to a hoop of wood or of iron-rod, formed to fit the body, buckled round it, and suspended in front in the manner just described. Both hands are thus at liberty to cast the seed.

2319. In sowing with one hand, the sower walks on the third and fourth furrow-slices from the open-furrow, which he keeps on his right hand. Taking as much seed as he can grasp in his right hand, he stretches his arm out and a little back, with the clenched fingers looking forward, and the left foot making an advance of a moderate step. When the arm has attained its most backward position the seed is begun to be cast, with a quick and forcible thrust of the hand forward. At the first instant of the forward motion, the fore-finger and thumb are a little relaxed, by which some of the seeds drop upon the furrow-brow and in the open-furrow; and while still further relaxing the fingers gradually, the back of the hand is so also turned upwards, until the arm becomes stretched before the sower, by which time the fingers are all thrown open, with the back of the spread hand uppermost. The motion of the arm being always in full swing, the grain, as it leaves the hand, and partaking of its momentum, receives such an impetus as to be projected forward in the form of a figure corresponding to the sweep made by the hand. The forward motion of the hand is accompanied by a coresponding forward advance of the right foot, which is planted on the ground the moment the hand casts forward the bulk of the seed. The action is attempted to be represented by fig. 202. The figure which the seed describes, on falling upon the ground, is like the area of one end of the longer axis of a very eccentric ellipse, having one angle resting on the open-furrow, and the other stretching 2 or 3 feet beyond the crown of the ridge, the broadest part of the area being on the left hand of the sower where he walks. The moment the seed leaves it, the hand is brought back to the sowing-sheet, while the left foot is advanced simultaneously, and the hand, thence replenished, is stretched back for a fresh cast. Thus the right hand and right foot move regularly and *simultaneously*, while the left hand and left foot move also simultaneously, but *alternately* with the right.

2320. The seed ought to be cast *equally over the ground.* If the hand and feet do not move regularly, the ground will not be equally covered, but a strip left almost bare between the casts. When the braird—that is, the young plants—come up, they will show themselves in stripes like the steps of a ladder; and hence this species of bad sowing is named in the country *laddering*, or *happergawin.* This error is most apt to be committed by a sower with a stiff elbow, who always casts the grain too high above the ground. The arm should always be thrown well back and stretched out, though, in continuing the action, it will become painful in the inner part of the elbow joint. If the hand is opened too soon, too much of the seed falls upon the furrow-brow, and the crown will receive less than its proportion. This fault young sowers are very apt to commit, from the apprehension that they may retain the seed too long in the hand. If the hand is brought too high in front, the seed is apt to be acted upon by the wind, and tossed in a different direction from that intended. High casting is a very common error with sowers, and is unsafe in practice in windy weather. When the wind becomes strong, the sower is sometimes obliged to walk on the adjoining ridge to the windward, to sow the one he wishes; and a sower who casts high will never make good work in such a case. In casting high, the hand is elevated above the ordinary level of the elbow, whereas it should always sweep below that line. The hand should be kept low, the arm stretched out, and the seed made to fly off in a curve in front, by a sharp turn up of the back of the hand, and a free opening of the fingers near the end of that action, the nearest parts of the seed falling within two paces of the sower. Seed, when so cast, will be little affected by even a strong wind. Some sowers take long steps and fill their hand with the seed as if in a shovel, and make long casts, causing some of the seed to reach across the ridge from open-furrow to open-furrow. Such a sower will spill the seed behind the hand, and make bad work in wind. The step should be short, the casts frequent, and the seed held firmly in the hand, when the whole work is under complete command. The sower should never bustle, and try to hurry through his work: he should commence with such a steady pace as he will be able to maintain during the day's work. Some conceited sowers always sow a whole ridge with one cast, and if they do it well, it must be by mere chance; for, while they are obliged to walk on the side of the crown of the ridge, they must cast high before the grain can reach from one open-furrow to the other; and, with the least wind moving, there is no chance of making good work. And even in a decided calm, the side of the ridge on the left hand must receive the cast in the opposite way from the other side—that is, from the crown to the open-furrow; while the correct way is, to receive it from the open-furrow to the crown—because, when any stray grains fly away from the cast farther than they should do, they will fall near the crown, where the thickest part of the soil is to be found on the ridge; whereas, in the other case, the stray grains will fall into the open-furrow, where they are not wanted, and where they will most probably perish.

2321. A sower with one hand only attempts to sow half a ridge with one cast. When the ridge is single, fig. 20, he keeps the open-furrow on his right hand; when it is double, that is, cast together, fig. 22, he goes first up and down the ridge, round the crown, and then up and down on the furrow-brows, keeping the open-furrows on his right hand. When the land is ploughed two-out-and-two-in, fig. 25, a mark of some sort, such as a feering-pole, fig. 18, at both ends of the ridges, will be required to keep him in the proper line between the crown and open-furrows; but when two sowers work together, they guide one another in the position to be kept on such ploughed land.

2322. A sower with both hands makes the casts alternate, the hand and foot of the same side moving simultaneously, and, moving along the crown of the ridge, casts the seed from the crown towards the open-furrow on both sides—thereby violating the rule of good sowing in throwing the stray grains into the open-furrow. A man who sows in this manner must cast high, to avoid striking his hands upon the seed-basket, and in a windy day has no command over his work. I can see no advantage attending this mode of sowing over the other; but, on the contrary, a considerable risk of scattering the seed unequally—for, however dexterous an ambidexter sower may become, his left arm will not make so perfect a cast as his right, if he is a right-handed person. In calm weather, he may get on tolerably well—as also with the wind direct in his face or in his back; but a side-wind must puzzle him, for, while adjusting himself to it for one of the hands, he places the other in the most disadvantageous position. In short, he ought not to sow with both hands in wind.

2323. The mode I have seen in Ireland of sowing is to make a step, then stand still, and cast the seed with two short and one long swing of the arm. This is slow work. The process seemed very similar to what I have witnessed in nursery grounds, in the sowing of the seeds of forest trees and shrubs.

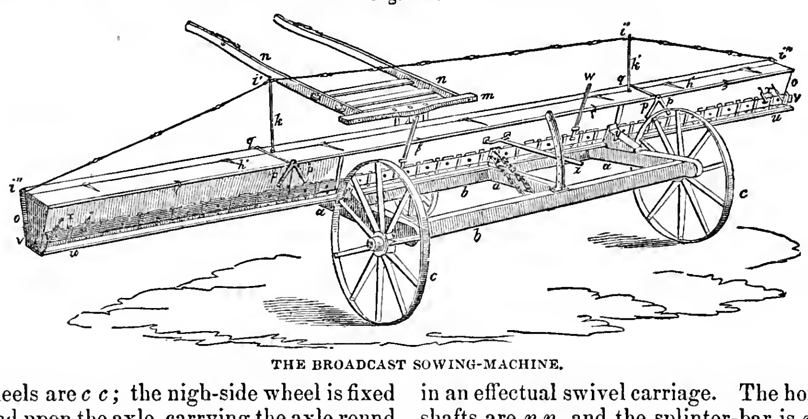
2324. Pickled wheat annoys the sower, the caustic lime acting upon the skin of the sowing hand, and shrivelling it. It also rises in impalpable dust, and adheres to the eyelids and lips, and even sticks upon the face when in a state of perspiration. It is scarcely possible to avoid this annoyance, especially when a gentle wind blows upon the back—the face is then almost smothered in the eddy. To prevent future bad consequences of the lime, the hands and face should first be washed with milk, and the milk then washed clean off with warm water and soap; and, lastly, the eyelids, lips, and back of the hand, anointed with cream or butter.

2325. It is obvious that, in sowing with the hand, the corn is scattered promiscuously; and, in whatever arrangement the plants may come up, depends on the form of the ground—whether in lines along the common furrows, or in drills. In the latter case, the drills are formed by the corn falling into the hollows of ribs made by the small plough; and in the former, the seed falls into the hollow of the common plough furrows, and the plants would come up in narrow irregular drills, but that their arrangement is made broadcast by the action of the harrows after the sowing.

2326. *Sowing with machines.*—Seed is sown with machines as well as by the hand, and the machines sow it either broadcast or in drills, according to the fancy of the farmer. A material difference exists in the utility of these two classes of machines: the broadcast one sows grass seeds as well as grain, while the drill machine cannot sow grass-seeds, and the adoption of the one or the other by the farmer is partly a question of expense. Another material difference between them is, that the broadcast machine deposits the seed upon the surface of the ground, and is in fact a direct substitute for hand-sowing; and as it deposits the seed very regularly—more so than is done by the majority of sowers by the hand—this machine is now much used, and will probably ultimately supersede hand-sowing altogether. The drill machine deposits the seed at once at a specific depth under ground in rows, and at such distances between the rows, and with such thickness in the rows, as the will of the farmer may decide. The seed being left by the broadcast machine on the ground like hand-sowing, is buried in the soil, more or less deep as the harrows may chance to take it, whereas the drill machine deposits the seed in the soil, at any depth the farmer chooses, and all the seed at the same depth, thereby giving the farmer such a command over the position of the seed in the soil, as no broadcast machine or hand-sowing can possibly do. I shall describe in general terms both classes of sowing-machines, and then we shall be the better able to judge which is the most useful and perfect.

2327. *The Broadcast sowing-machine.*—There are various forms of this machine; but the one I have chosen for an illustration is one manufactured by Mr James Slight, Edinburgh, because I think it exhibits the machine in the most perfect form, not only doing the work easily and well, but is so constructed that its long sowing-chest is divided into sections, the two end ones of which can be folded upon the central division, whereby the machine may pass through any field-gate without having to remove the sowing-chest, which is necessary to be done in all other similar machines. Fig. 204, is a view in perspective of the entire machine, as it appears at work. The carriage is marked *a b a*; the hind

Fig. 204.



THE BROADCAST SOWING-MACHINE.

wheels are *c c*; the nigh-side wheel is fixed dead upon the axle, carrying the axle round with it to give motion to the pitch-chain, at *a* in the centre, where it is seen as if entering the chest; the off-side wheel runs loose. The front wheel, seen partially at *b*, is usually of cast-iron, and is supported on cast-iron shears, and turns on a pivot in an effectual swivel carriage. The horse-shafts are *n n*, and the splinter-bar is *m*.

2328. The seed-chest *o o* is 18 feet in length; a part of the cover of the chest forming a hinged flap. The two extreme segments of the chest are supported by the light tension chain *i″ i′ i′ i″*, which passes over the two upright iron stanchions k k', the tops of which i' i' form the suspending fulcra for the chain, while its extremities are secured at the points i'' i'' with adjusting nuts. These chains support the two ends of the chest, which is divided in three pieces.

2329. The *sowing-geer* of the machine is connected with the main axle of the carriage by the pitch-chain *a*. Shafts extend the entire length of the chest, coupled at the junction of the segments of the chest by means of small clutch couplings attached to the ends of the shaft, and these engage or disengage of themselves when the segments of the chest are let down or folded up. The shafts are armed with the seed-wheels, 32 being required for an 18 feet chest. The wheels are of cast-iron, of very light fabric; their points being slightly rounded, to adapt them to the concave groove or cup that is formed in the back of the chest around each discharging orifice.

2330. Corresponding to each seed-wheel, a discharging orifice is formed in the back of the chest. The position of the seed-wheels, in relation to the bottom *u* of the chest, is such as to make the teeth turn at about one quarter of an inch clear of the bottom. The seed orifices are defended by iron plates, the fixing of which requires some attention, in order that the orifices may exactly coincide with those of the slides; without perfect coincidence in these two parts, the sowing will be unequal. To effect the precise adjustment of the orifices, the slide is made in two halves, and, at each end of the chest, an adjusting screw *v* acts in a nut attached to the end of the chest, the point of each screw being brought to bear against the end of the slide; and their shutting is effected by moving the slide still further to the right hand, by means of the levers *w*, until the orifices are entirely closed. Both ends of the chest having undergone this operation, which is done in an instant, but in reverse directions, the machine may go to any distance without discharging a grain; but whenever it has been turned into the next ridge, the levers *w* are thrown in the opposite direction, moving the slide towards the adjusting screw *v*; and this being done at both ends, the orifices will have attained precisely the same area as before; and thus the shutting and opening again to the same area, and of course the same discharge, is effected for any number of turns, without the smallest variation, so long as the screw *v* remains unaltered. The sowing-geer of this machine has undergone a variety of changes. In the example before us, the pitch-chain is employed to communicate motion from the first mover—the carriage axle—to the seed-wheels. It is simple, but it keeps the seed-wheels constantly in motion, whether sowing or not, which is supposed to have a tendency to injure the grain that lies in contact with the wheels; but to avoid any apprehension on this score, a gearing may be employed, which disengages the seed-wheels from the first mover by means of a lever.

2331. For the purpose of equalising the distribution of the seed over the surface of the ground after it has left the discharging orifice, the bottom-board of the seed-chest is made to project beyond the back of the chest, forming an *apron* on which the seed is first received from the orifice, and, being thus checked in its descent, is thereby more uniformly scattered over the surface. Another precaution is taken, the better to secure a uniform discharge, in the case of sowing on ground that has a high inclination. In sowing up hill, in such situations the weight of the seed is thrown more upon that side of the chest from which it is discharged, tending thereby to increase the discharge. On sowing down hill, on the other hand, the effect of pressure is reversed, and the discharge will be less. To obviate these inconveniences, a tilting motion has been introduced to the seed-chest, but which of course renders the machine a little more costly.

2332. As the seed-chest is 18 feet in length, and it may sometimes be desirable to reduce its breadth of sowing to 16 or to 15 feet, to suit ridges of these breadths, the reduction is effected by stopping two, three, or more of the seed-orifices at each end, by means of a flat swing-clasp turning upon a pin.

2333. In using this machine, it is frequently drawn by one horse; but it forms a rather heavy draught, and is, therefore, more frequently the work of two horses. The chest is filled from end to end with the seed-corn, and, the horses walking in the furrow, the machine sows the half ridge on either side. When the chest has been filled, and the machine brought to that position which places the horses in the furrow,—the sower having previously determined the degree of opening in the orifices that will deliver the desired quantity per acre, he throws each slide outward against its graduating screw, which will produce the proper opening; and, this done, the horses are driven forward. On arriving at the farther end of the ridge, and before entering upon the head-ridge, the slides are withdrawn towards the centre, closing up the vents; the machine is then turned round on the head-ridge, and takes up a position on the next furrow, when the process is repeated, and so on till the field is sown all over, the head-ridges being the last portion of the work; and here the blinding of the extreme orifices come frequently into play, if the head-ridges are of less breadth than the single ridges of the field, which they should never be.

2334. The eye of an experienced sower will, on passing over a few yards with the machine, by simple ocular inspection, be able to judge of the quantity of seed he is bestowing upon the soil. If experimental accuracy is required, the sower may then put into the chest as much grain as will just cover the seed-wheels, and then *measure* in one or two bushels, and proceed to sow this until as much remains as will just cover the wheels again, so that the measured quantity is found to have been discharged. By now measuring the number of yards in length that have been sown with two bushels, he will ascertain by calculation the proportional quantity required for an acre. Thus, let the intended quantity to be sown upon an acre be 3 bushels, or any other number, and that 1 bushel has been sown in the experiment, which has covered 276 yards of a 15 feet ridge, or two half-ridges equal to 15 feet, or 5 yards. The imperial acre contains 4840 square yards, and this divided by 5, the yards in the breadth of the ridge, we have 968 as the number of lineal yards in length of a 15 feet ridge to make up an acre; and one-third of this, or 322·66 lineal yards, is the extent that should have been covered by 1 bushel of seed-corn. The machine having, as supposed, covered only 276 yards, it follows that the sowing is about one-seventh part of the bushel too thick—the graduating screws, therefore, must be turned forward a little, and the experiment repeated, if thought necessary. It is seldom, however, that such experiments will be required in the hands of a practical sower.

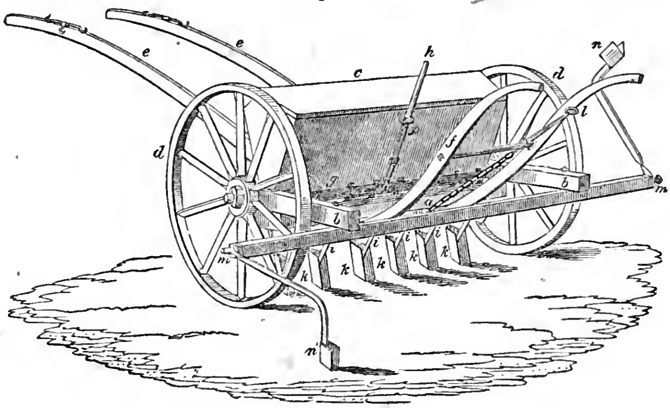
2335. In reference to the inconvenience attending the great length of the seed-chest, when it is in one length, it may be observed, that the method by which it is shifted is this:—In its working state, the chest is kept in its bolsters by means of two quadrants attached to the lower part of the chest, one being on each side of the carriage: these are formed concentric with the curvature of the bolster, and a bolt, over which the quadrant slides, is screwed into the side of the carriage, and this retains the chest in its place. When it is found necessary to move the chest, the two bolts are unscrewed, which sets the chest at liberty; it is then lifted from its bolsters and laid longitudinally on the carriage. In this operation, however, the pitch-chain, when that medium of power is employed, has to be disengaged by withdrawing a coupling-link from the chain; but when the lever is employed, there is nothing required but the unscrewing of the quadrant-bolts, to set the chest at liberty. It is then lifted and laid longitudinally on the carriage as before.

2336. The price of these machines ranges from £10 to £12. Being a machine necessarily composed of many parts, it cannot be constructed at a small cost; but it cannot be regarded as a costly machine, when it sows all the species of the cereal grains equally well, as well as the grass seeds.

2337. The *Common* or *East Lothian Drill-sowing machine*, is here taken to illustrate the principles of the drill machine. Though it may be deficient in some points as compared with those of Berwickshire and Roxburghshire, yet its extreme simplicity and cheapness has brought it into very extensive adoption, not only in East Lothian, but in other districts where the drill system is followed. Fig. 205 is a view in perspective of this machine, having drills to sow six rows, which is the size most generally used, chiefly because it can be drawn by one horse; but also, in the event of its being employed along swelling ridges, its covering but a small breadth secures a nearly equal depth for the deposition of the seed, which cannot be easily done under the same circumstances if the machine is mounted with a greater number of coulters. But it follows from the peculiarity of structure, the coulters being permanently fixed in position for the depth to which they penetrate the soil, that the machine is best adapted for sowing across the ridges; and hence it is almost invariably worked in that direction, though, when worked in the direction of the ridge, the breadth covered by the machine is equal to nearly one-third of a 15 feet ridge.

2338. In the construction, *a* is a bed-plank, across the ends of which are bolted

Fig. 205.



THE EAST LOTHIAN GRAIN DRILL-MACHINE.

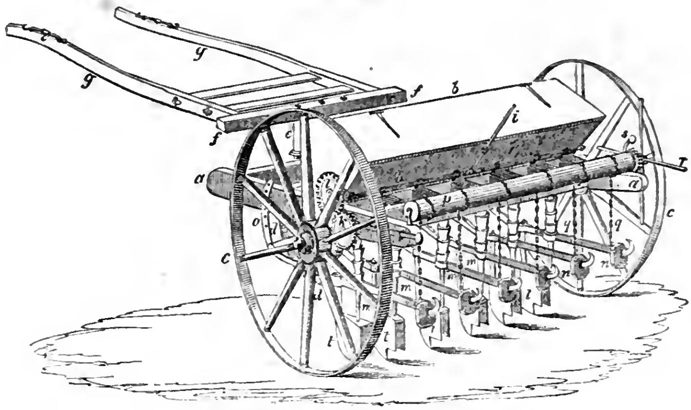
the two side-bars *b b*, which are crossed by the bar *m m*, bolted to the side-bars, serving a special purpose, to be afterwards noticed; and these four parts form the simple frame-work of the machine. The seed-chest *c* is placed between the side-bars *b*, and attached to these and the bed-plank. The chest is mounted similar to the broadcast machine, (2328,) except that, in place of the *apron* on which the seed falls in the broadcast, the orifices deliver the seed directly into a small hopper-shaped aperture formed in the bed-plank. The axle of one of the carriage-wheels is *d*, coupled to the small shaft of the seed-wheels, thereby giving them the requisite motion, their revolution coinciding with that of the wheels, and the opposite wheel *d* turns upon an axle fixed permanently upon the bed-frame. The horse-shafts *e* are jointed to the bed-plank. The coulters *k k* are furnished at the lower end with a pointed sheath of sheet-iron. The seed, on leaving the orifices, falls into the funnel-shaped receptacle in the upper side of the bed-plank, from which it passes down the tubes *i i* into the sheaths of the coulters, by which it is deposited into the rut formed by the sheaths.

2339. From the construction and action of this machine, and the resistance of the soil to the passage of the coulters through it, there is a constant tendency, produced by the traction of the horse when the machine is in action, to elevate the extremity of the handles; and by thus swinging upon the axle of the wheels, the coulters are withdrawn from their action on the soil, and from forming the rut for the reception of the seed. The tendency thus produced being greater than a man is capable of continuing to contend with, is counteracted by the application of a balance-chain, producing a change of direction in the line of draught, and of the point of attachment of the draught. When the chain is brought under tension, and the shafts borne up by the horse, the resistance to the coulters is transferred to the back of the horse. The marker *n n* is another appendage to the machine, which, although not so necessary as the balance-chain, is yet generally applied to this drill-machine, especially when sowing across the ridges. It consists of the bar *m m*, and the marking-rod *m n*. The use of the marker is to trace a line on the surface of the ground parallel to the direction in which the machine travels, and at a distance from the middle point of the surface covered by the machine, equal to the entire breadth, so covered; hence, on returning to sow the next breadth, the horse should walk exactly upon the line drawn by the marker. In sowing with the machine here described, the distance from line to line will be 4 feet 6 inches; the distance between the rows being 9 inches. The wheels are usually set 54 inches apart, measuring at the point where they rest on the ground; or their distance in any machine may be found by multiplying the number of coulters by the number of inches given to the interval between the rows or coulters; thus six coulters at 9 inches of interval, give $6 \times 9 = 54$ inches. From the construction of the machine it is found, that when the balance-chain is under tension, the coulters are drawn to the ground, and the handles also drawn downward; but on releasing the chain, which is done at the land-ends and turnings, the conductor must support the handles, to keep the coulter from the ground, and in this state, if the handles are let go when the machine is standing, the coulter will pass forward, and the handles will fall to the ground. To prevent this last inconvenience, a crutch is usually appended to the marker-bar, which, on stopping, is allowed to drop to a perpendicular position, resting on the ground, and thus keeps the machine upon a level. This appendage, not being of much importance, is left out of the figure. The price of this machine varies from £6 to £10.

2340. *New Lever-drill sowing-machine.*—This drill sowing-machine was introduced to public notice, a few years ago, by Mr James Slight of Edinburgh. Mr Slight having been impressed with the superiority of the improved English lever-drills, but seeing at the same time the difficulty, or impossibility, of introducing such an expensive machine into Scottish practice, was induced to make the attempt of ingrafting what appeared the better parts of the English machine upon the more simple machinery of the Scottish one—the one just described—thus producing a machine little, if anything, inferior to the original, at one-third of the price. The results appear to justify the expectations, for the new lever-drill has now been tested in the hands of a number of practical judges, and found to give entire satisfaction, either sowing grain alone, or depositing granulated manures along with the seed in any required proportion. The figure here given of the machine represents it without the manure-chest, which, when adopted, is placed immediately before the seed-chest, making very little change in the appearance, and adding little to the apparatus, except the chest itself.

2341. Fig. 206 represents this machine in perspective. In the construction of this drill, the bed-frame *a a* consists of two side rails with three principal cross rails, besides a minor rail, forming the bearing or platform of the seed-funnels. The entire width of the bed-frame for a 6-row drill is 4 feet 7 inches over all, and the length over the rails is 4 feet 3 inches. The seed-chest *b* is constructed and mounted in every respect similar to that of the broadcast machine, fig. 204, excepting again the projecting apron, which in the drill-machine is not required, and in the mode of communicating motion to the seed-wheels. The carriage-wheels are *c c*. The fore-wheel is mounted on sheers, and *e* is one of the two pillars of the swivel-plate, to which the splinter-bar *j* is attached. The shafts are *g g*. The remaining parts of the fore-carriage are precisely the same as in fig. 204 for the broadcast sowing-machine. The sowing geer in the lever-drill consists of a wheel fixed upon the inward end of the nave of the carriage-wheel, on the nigh side; of a second wheel *k*, placed intermediate between it and the third wheel *l*, which last is mounted on a continuation of the seed-wheel shaft. The intermediate wheel *k* is supported upon a stud in the end of a bent lever, the handle of which is seen below the roller *p*; by means of which the wheel *k* is withdrawn from the wheel *l*, to stop the motion of the seed-wheels. The discharging apparatus of the seed-chest is precisely the same as in fig. 204, with the slide *h*, lever *i*, and adjusting screw. From the orifice in the slide, the seed falls into telescope funnels *k*, *m m*, the uppermost being fixed to the bed-frame, and the lowermost to the lever *n n*. To the quadrant *o* the levers *n n* are jointed upon a rod of iron, which extends from side to side of the bed-frame. The levers are

Fig. 206.



SLIGHT'S NEW LEVER-DRILL SOWING-MACHINE.

forked at the end, and diminish gradually to the extremity *n*, which is turned up to prevent the weight from being dropt off. The weight is a block of cast-iron of from 3 to 7 lbs. weight, of which there may be several sizes, to be applied according to the state of the land, its purpose being to press the coulter into the ground. The point of the coulter, sinking 1 inch deeper than the sheath, gives the seed a more pulverised bed than can be produced with a coulter that is level below. A wooden roller *p*, furnished with a ratchet, is supported in a light iron standard at each end, upon the side-bar of the bed-frame. A light chain *q* from each lever is attached to the roller, and a cross *r* being fixed upon the right hand side, the roller can thus be turned round by means of the cross-arms, the chains wound up to any desired extent, and the coulters lifted from the ground. This operation is found convenient at the turnings, or at any time when the machine is not sowing, and the roller, chains, and levers, are held in the desired position by the pall *s* falling into the ratchet wheel. The coulters are represented nearly out of the ground, and when let down to the working level, they penetrate to the depth of 2 or 3 inches. The distance between the wheels, where they rest on the ground, is equal to 54 inches, as in the common drill; one of the wheels, therefore, will always fall into the track of the former round, which may serve as a marker to the conductor of the machine; but, though not shown in the figure, a marking bar, similar to that of the common drill, is usually fitted to it as a movable appendage.

2342. From the construction of this machine, with its fore-wheel and with its lever-coulters independently movable, its motions are more steady and its management more easy, while the freedom of vertical motion in the coulters gives it the advantage of sowing on any kind of surface, on ridges however round, at equal depths for every coulter, and either across or along the ridges with equal facility. The price of these machines ranges from £10 to £18.

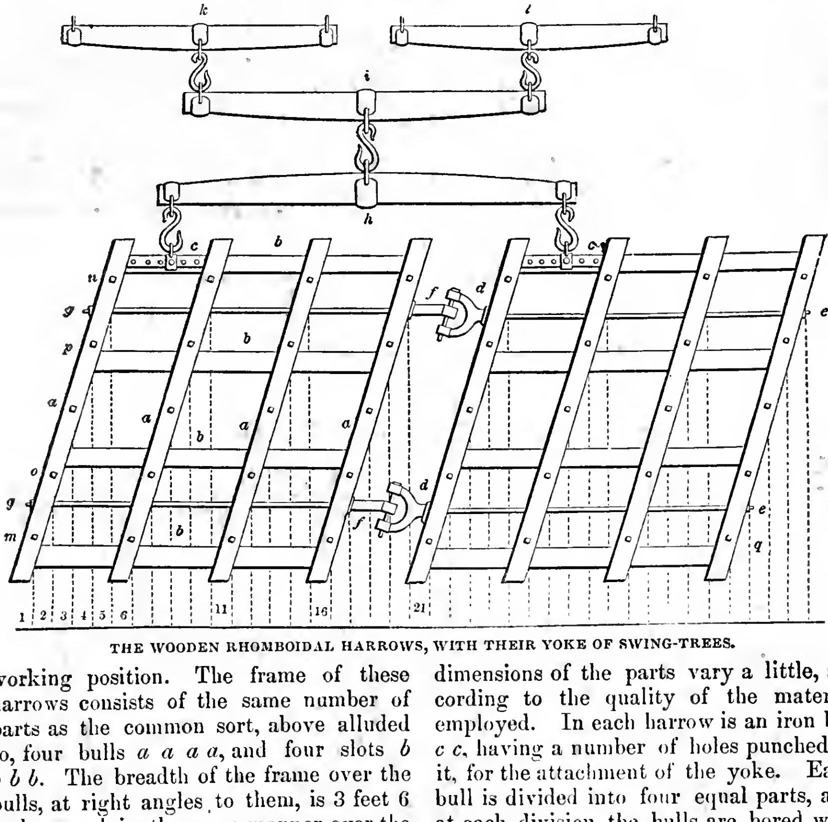
2343. To render the expensive English drill-machines more generally useful, it is not an uncommon practice in England for the owner of one to travel the country with it at seed-time, and undertake to sow the fields of any farm, where the farmer may choose to employ him. The charge is usually 2s. 6d. per imperial acre, the farmer supplying the requisite number of horses to work the drill, and undertaking to deliver it at the farm on which it is to be next employed.

2344. The land, whether sown by hand or with either sort of machine, must be harrowed; but the time of using the harrows differs on the sort of machine used for sowing the grain. When the grain is sown by hand or with the broadcast machine, the harrow is used after the grain has been sown; but in sowing with either of the drill machines, the harrow is first used to put the land into the proper state for the machine, and it is used to the extent required to give the land such a proper degree of harrowing as the nature of the crop to be sown requires. I shall first describe the harrow before directing the manner in which the land should be harrowed.

2345. "*The Harrow*—considering the operation it has to perform," observes Mr Slight, "in covering the seeds that have been cast upon the surface of the soil—is an implement of no small importance; and yet its effects are apparently rude and uncertain, while its construction is of the simplest order. So simple, indeed, is this construction, that at a very remote period it appears to have taken that form which, in so far as the simple principles of its action are concerned, is almost incapable of further improvement." The dimensions of the rectangular harrows are, on an average, 3 feet 9 inches in breadth, measuring over the bulls, and 3 feet 10 inches in length over the slots.

2346. The *improved* form given to the harrow, as above alluded to, changes the rectangle into a rhomboid, and this, when duly proportioned, gives to the implement, as has been supposed, as high a degree of perfection, in point of form, as it appears capable of attaining. Fig. 207 represents a pair of the rhomboidal harrows in the working position. The frame of these harrows consists of the same number of parts as the common sort, above alluded to, four bulls *a a a a*, and four slots *b b b b*. The breadth of the frame over the bulls, at right angles to them, is 3 feet 6 inches, and in the same manner over the slots the length is the same; but the bulls extend at each end 4 inches beyond the slots, making their entire length, including the obliquity, about 4 feet 6 inches. The dimensions of the parts vary a little, according to the quality of the material employed. In each harrow is an iron bar *c c*, having a number of holes punched in it, for the attachment of the yoke. Each bull is divided into four equal parts, and at each division the bulls are bored with an auger for the reception of the tines. The length of the tine is about 10 inches, of which 6 or 7 inches project below the bulls.

Fig. 207.



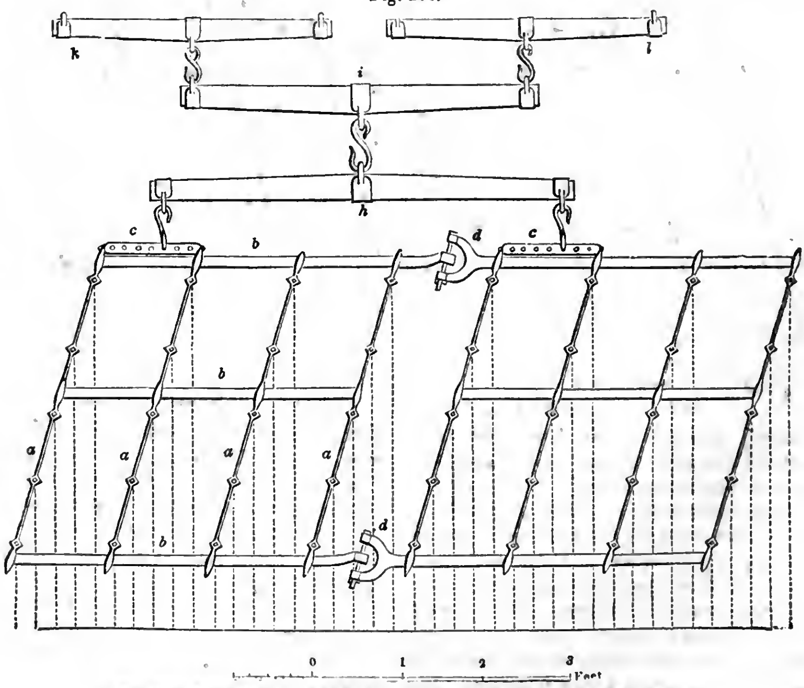
THE WOODEN RHOMBOIDAL HARROWS, WITH THEIR YOKE OF SWING-TREES.

2347. There is one point in the improvement of this harrow that appears of even more importance than the rhomboidal shape—it is the joints or hinges *d d*. In the one harrow, the tail of the double joints of the hinge is prolonged into a bolt *d e*, *d e* passing through all the bulls, and secured with screw-nuts at *e e*. The single joints are in like manner prolonged into the bolts *f g*, *f g* thus serving to add greatly to the strength as well as to the efficiency of the harrows. The loose joints *d f*, *d f* have been found to answer their purpose much better than the well-fitted joints originally given to them, by their allowing a great freedom of action, and the double joints *d d* are therefore now usually made as in the figure. The eye of the single joint *f* has great freedom to play upon the joint-bolt.

2348. From the figure of the rhomboidal harrow, when duly constructed, it can only perform its maximum of effect when drawn forward with its slots at right angles to the direction of its motion, and this is effected by the master swing-tree *h*. This tree, for harrows of the dimensions here described, requires to be 4 feet 8 inches in length between the points of attachment, and it is connected to the harrows by means of the S hooks and shackles at *c c*. The balance of draught of the harrows is adjusted by shifting the shackles into the different holes of the bars *c c*, until the harrows are found to lie at right angles to the draught when in motion; and this, be it observed, is not attained by having an equal number of tines on each side of the centre of the swing-tree *h*, for there is found to be a greater resistance to the forward motion of the implement on the left than there is upon the right side, arising, it is supposed, from the tines presenting a broader surface to resistance on that side than on the other. The other parts of the yoke, *i k l*, are the common plough swing-trees, fig. 6. Wooden harrows cost £2, 15s. per pair.

2349. The extensive application of iron has of late years brought the use of that material to the formation of the harrow as well as of the plough, and iron harrows are now coming very generally into use, both in the rectangular and the rhomboidal form. Fig. 208 represents the malleable-iron rhomboidal harrow, as commonly

Fig. 208.



THE IRON RHOMBOIDAL HARROWS, WITH THEIR YOKE OF SWING-TREES.

constructed, and its dimensions are the same as already given for those of wood. The arrangement of the parts are somewhat different, and, from the nature of the materials, the dimensions of the parts differ also more materially. Thus, the bulls *a a a a* are swelled out where the mortises for the slots are formed, and also for the tines, their ends projecting only 2 inches beyond the slot. The slots are *b b b*, and there being only three of them, the middle one is so placed as to be free of the middle row of tines; while the end slots are elongated towards the meeting sides of the pair, and are there formed into the hinge-joints *d d*, as formerly described for the wooden harrows. The bars *c c* are inserted in the projecting ends of the first and second bulls, and the master swing-tree *h* is attached to them by twisted S hooks. The swing-trees *i k l* are the same as described for the wooden harrows. The construction of the iron harrow is so similar to the others, that it is unnecessary to enter into further details regarding it; but it may be remarked, that, from the almost imperishable nature of the materials, as compared with wood, there seems every reason to expect the iron implement will entirely supersede the wooden; and though the price of the iron harrows is considerably above that of wood, the additional first cost is more than repaid by the greater durability of the iron. There is good reason also to believe, that, by a construction more adapted than the present to the nature of the material, the price may yet be considerably reduced.

2350. The *form of the tines* is that which has its cross section forming an exact square, and inserted in the bull with its diagonal pointing in the direction of the progressive motion. This form and position of the tine, however well adapted to the soil, cannot, with propriety for safety to the implement, be used in the wooden harrow from the powerful tendency it has to split the wood. In the iron implement this difficulty does not exist; and as this form of tine is in every respect best adapted to the intended purpose, it should never be omitted in the iron harrow. Whatever be the cross section of the tine, in that part which passes through the bull, the projecting part is tapered towards the point, not uniformly but a little barrelled, and terminates in an obtuse point. In all wooden harrows the tines are simply driven firmly into the wood after it has been bored. In most iron harrows they are fixed in the same manner; but as the tines are sometimes liable to become loose, when simply inserted and driven down by the hammer, they are, when a more perfect construction is followed, fixed by being driven from below, and secured by a screw-nut above.

2351. The dotted parallel lines in figs. 207 and 208 represent the lines which the tines make in the ground in the act of harrowing it; and as they are at equal distances, it follows that the harrows, as in the figures, are set in the proper manner for working. They are wrong set when these lines are not at equal distances.

2352. The *harrows* follow the sowers, each sower keeping 2 pair of harrows employed when the land receives a *double tine*—that is, backwards and forwards on the same ground, that is, on the same ridge, which the *breaking-in of the seed* should always receive. I have said that, on inclined ground, for the sake of the horses, that end of the field should be first sown which gives the horses the advantage of *breaking-in the ground down hill* (2312.) If the sowing commences at the top of the declination, the harrows start at once for the breaking-in down the hill; but if it commences at the foot of the inclination, the harrows will have to go an extra landing to the upper side of the field and begin there. Two pairs of harrows work best together, their united breadth covering the entire ridge, and lapping over the crown where the soil is thickest. One pair takes the lead, by going on the near side of the ridge, while the other pair follows on the off side, but the leader usually takes that side of the ridge which is nearest the open field. Each pair of harrows should be provided with double reins, one rein from each horse; and every ploughman should be made to walk and drive their horses with the reins from behind the harrows. If a strict injunction is not laid upon them in this respect, the two men will be found walking together, the leading one behind the harrows, the other at the head of his horses, with their attention more engrossed in talk than the work in hand. Indeed, in some parts of the country, the ploughman who drives the hindmost pair of harrows does not think it requisite to employ reins at all, so sure is he of leading his horses by the head; and the leader, to give himself less trouble than using his voice, only guides the near horse with a single rein. It is the constant use of the single rein which renders horses, in those parts of the country, more easily *hied* than *hupped*, (692, 693.) The double rein, on the other hand, enables the ploughman to *hup* his horses with ease; though, doubtless, the horses will turn more naturally towards their driver than away from him.

2353. To draw the harrows as they should be drawn, is in reality not so light work for horses as it seems to be; and, when the tines are new sharpened and long, and take a deep hold of the ground, the labour is considerable. To harrow the ground well—that is, to stir the soil so as to allow the seed to descend into it, and bring to the surface and pulverise all the larger clods—requires the horses to go at a smart pace; and not only for this, but on all occasions, harrows should be driven with a quick motion.

2354. If the men owe the steward a grudge for his sharp discipline, spring-wheat sowing is a favourable time to take advantage of him, when the land is naturally friable and the horses are quite fresh, and also when the lime of the pickle is sure to annoy the sower's face, and he is unable to walk quickly on the rather soft land. If they keep the harrows close at his heels, for very shame he must sow hard to keep before them; and should he be a slow sower and a heavy walker, he will get a good heating. It is always prudent in a sower to start the sowing as soon as the first sackful of seed is set down, to get in advance before the sacks are all set down and the harrows yoked. Indeed, he must have one ridge sown before the harrows can commence their work. I never saw a man sowing with his coat on but a wish arose to see the harrows kept close at his heels to punish him for the lazy trick.

2355. In conducting the harrowing after the seed, the mode must be guided by the circumstances of the case. If the harrowing commences at the foot of the inclination, the ridge next the fence should be ascended by both the pairs of harrows; and on gaining the top of the inclination, the second ridge is descended, to break-in the seed; and *hieing* both the horses at the foot, the first ridge is again ascended, which finishes its double tine; and though both tines have been given on it in the same direction, the anomaly should be submitted to, in order to gain a favourable point for the horses to break-in the seed. *Hieing* the horses again on the upper head-ridge, the third ridge is broke-in; and *hieing* again on the lower head-ridge, the second ridge is ascended, and is thus finished of its double tine. Thus by *hieing* both pairs of harrows at both ends, one ridge is broke-in on going down, and another receives the double tine on coming up, and this is a simple and easy mode of working the horses. Suppose the harrowing had been begun at the top of the declivity, the breaking-in will then commence at once on going down hill, and to preserve the advantage, the harrows come up the same ridge and finish it with a double tine; and so on with every succeeding ridge. As there is little room for 2 pairs of harrows to turn at the end of one and the same ridge, the leading harrows are driven straight forward upon the head-ridge, and the horses are *hied* so as to make them move round upon the far side of the head-ridge, and still *hied* round, they take up their place on the same side of the ridge they had come down; while the hind harrows are *hupped* so far at the end of the ridge as to give them room to turn by the far side of the head-ridge, and then *hieing*, take up their position on the same side of the ridge they had come down, in rear of the leading harrows, which by this time have gone on to their side of the ridge, and are moving onwards. The entire movement is easily and quickly managed with double reins; but with a single rein, or with the voice alone, this mode of turning at the end of a ridge is apt to create confusion. If the inclined field is begun to be sown at the opposite side, the same arrangements as I have just described for easy breaking-in of the seed for the horses, and according as the harrowing is begun at the foot or top of the inclination, should be followed; but in following them here the horses will have to be *hupped* instead of *hied*, because now the open side of the field is on a different hand. I have recommended the *kieing* because it is more easy for the horses, they being more accustomed to it; but instead of always *hupping*, which this last mode imposes, there is a plan of avoiding the inconvenience—and it is this: Take in a division of 6 ridges, and the harrowing of them is begun on the last-sown ridge, and continued over the six in the same manner as if the first of them had begun the proper side of the field; the effect is, that the harrowing proceeds in the opposite direction from that in which the sowers are walking, instead of proceeding in the same direction. When one division of six ridges has received a double tine of harrowing, another is taken in, until the entire field is finished being broken-in.

2356. After the appointed piece of ground, whether a whole field, or part of one, has been sown and broken-in, the land is *cross-harrowed* a double tine, that is, at right angles to the former harrowing, and to the ridges; but as, in this operation, the ground is not confined within the breadth of ridges, the harrows cover as much of the ground as they can, and get over it in less time than in breaking-in; besides, any second harrowing is easier for the horses, and they can of course walk faster.

2357. The harrowing is finished by another double tine along the ridges, as in the case of the breaking-in; but this last operation is both easily and quickly performed, the soil now being free and uniform in texture.

2358. To judge of the harrowing of land, the sense of feeling is required as well as that of sight. When well done, the friable portion of the soil seems uniformly smooth, and the clods lie freely upon the surface: the ground feels uniformly soft under the foot. When the land is not enough harrowed, the surface appears rough, the clods are half hid in the soil, and the ground feels unequal under the foot—in some parts resisting its pressure, in others giving way to it too easily.

2359. The well harrowing of land is a point of more importance than seems generally to be imagined. Its object is not merely to cover the seed, but to pulverise the ground, and render it of a uniform texture. Uniformity of texture maintains in the soil a more equal temperature, not absorbing rain so fast, or admitting drought so easily, as when the soil is rough and kept open by clods. Whenever the texture becomes uniform, the harrowing should cease, though the appointed number of double tines have not been given; for it is a fact, especially in light, soft soils, that more harrowing than is necessary brings part of the seed up again to the surface.

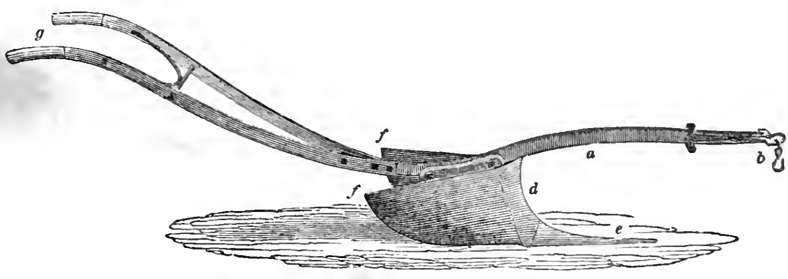
2360. Should the spring wheat be sown early in the season, that is, in January or near to the end of February, the ridges should be *water-furrowed*, in order that, in case of much rain falling, or snow melting, it may find opportunities of running off the surface of the ground by the water-furrow in every open furrow between the ridges. What of the spring wheat is sown late in the spring, that is, in the last of February and beginning of March, the water-furrowing need not be executed until after the sowing of the grass seeds has been finished—and these are usually sown immediately after the sowing of the wheat—but the actual determination of doing so depends upon the relation which the last-sown break of spring wheat bears to the whole extent of the field. Should the last sowing embrace the last portion of the field, then the grass seeds will be sown not only over the last break of the spring wheat sown, but the entire field, and the water-furrowing will be given after the sowing of the grass seeds; but should there still be another break to sow of spring wheat, the grass seeds will be delayed in their sowing until the whole field shall have been sown with the wheat; and in that case the last break of the spring wheat should be water-furrowed immediately after it has been sown. Should the last break of the spring wheat sown be as late as is prudent for the season to sow any more, and there be still a portion of the field to be ploughed, that portion will be reserved for barley, and the grass seeds will be delayed in the sowing until the barley is sown, and then the entire field, including all the portions of it sown with spring wheat, will be sown with the grass seeds at one time.

2361. *Water-furrowing* is the making of a plough-furrow in every open-furrow, for the purpose of forming channels by which the rain-water may flow off the surface of the land. It is executed with a common plough and one horse, or with a double mould-board plough and one horse; and as the horse walks in the open-furrow, the plough following obliterates the horse's foot-marks. The double mould-board plough is a better implement for making water-furrows than the common plough, because it forms a channel having equal sides, and the furrow-slice on each side cast up by the mould-board is small, and cannot prevent the water reaching from the ridge into the water-furrow, whereas the common plough casts up a rather large furrow-slice on one side, and makes a sharp hollow furrow on the other. Either plough is used simply in going up one open-furrow and down another until the field is finished, the horse being *hied* at the turn into every open-furrow. The water-furrowing of spring wheat is always done after the harrowing, and finishes the work of the field for the time.

2362. *The double mould-board plough.* This is an implement not only useful in water-furrowing any kind of soil after it has been sown with grain, but is an essential one in the cultivation of the potato and turnip crops. When duly constructed, it is highly efficient in the formation of drills or ridgelets for the potato or turnip crop, setting up at each turn the half of a ridgelet on each side; while the common plough, so much used for this purpose, sets up only a half ridgelet at each turn, doing, therefore, but half the work. In a variety of farms, also, it is much employed in summer in the earthing up of the potato and turnip crops, for which purpose it is frequently made of wood, but in all cases the iron plough is to be recommended.

2363. Fig. 209 is a representation of a common double mould-board iron plough,

Fig. 209.

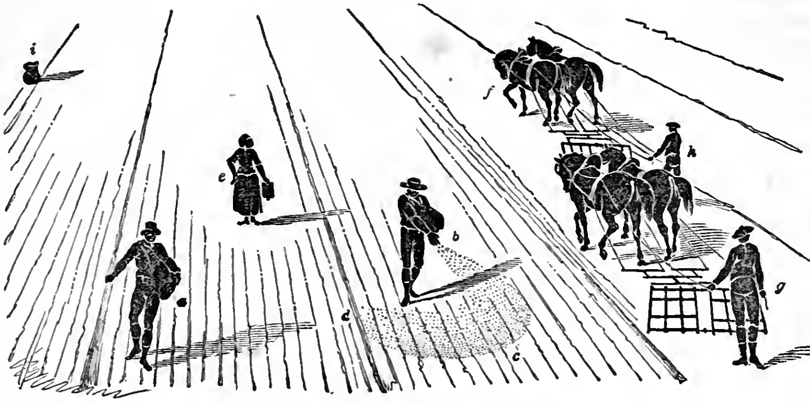


THE DOUBLE MOULD-BOARD PLOUGH.

equipped for the purpose of water-furrowing or earthing-up. The frame-work of it is pretty much in form of the common plough, except that the beam *a* lies right in the central line of the whole plough. The bridle *b* is variously formed according to the taste of the maker, but always possessing the properties of varying the point of draught upward and downward as well as right and left; the breast *d* forms part of the body-frame; the share *e* is plain on both sides, spear-pointed, and is set upon the head of the body-frame; the right and left mould-boards are *f, f*; the handles are *g*. The length of this plough is 10 feet. The mould-boards of such ploughs are liable to great variation in their form: some of them have little or no twist, and others variously contorted. Those of the present figure have been selected as possessing all the requisite qualifications for an earthing-up plough.

2364. The land being thus sown and harrowed, I give in fig. 210 a representation of a field in the act of being sown by hand, as a record of a practice which will probably soon become obsolete: *a* is the sower with his hand swung back, ready to make the cast with the seed—he is furnished with a sowing-sheet; *b* represents the sower after he has made the cast, and the seed has entirely left his hand, and is partly lying in the ground and partly falling from his hand, forming the section of the ellipse at *c*, as formerly described (2319;) *d* is the open furrow between the ridges occupied by the sowers, who are each walking on the third and fourth furrow-slices from the open furrow—this distance allows the seed to fall as much towards the open-furrow as it should do, while it places the sower as far upon the ridge as enables him easily to cover the half of the ridge entirely with seed; *e* is the field-worker who carries the seed—she is in the act of returning to the sack *i* for more seed, taking the rusky with her, after she has served both the sowers with a fresh supply; *i* is the sack containing the seed placed upon the furrow-brow of the ridge, and there is yet as much seed in it as will supply the sowers until they shall have passed it; *f* is the leading pair of horses, drawing the leading pair of harrows; *g* shows the harrows as they cover the ground from the furrow-brow over the crown of one side of a ridge, and from the crown to the furrow-brow of the other side; *h* is the leading ploughman, driving his horses with double reins, and the following-man at *g* is also behind the harrows, having the double reins in his hands, and not going at his horses' heads in a line with the foremost ploughman *h*. There are only two pairs of horses shown in the figure, which can only serve one sower, although two sowers are shown; the other pair of horses may be supposed to be following these, on the ridge immediately beyond the one they are harrowing.

Fig. 210.



THE SOWING OF CORN BY HAND.

2365. Another method of sowing spring wheat, very different from what I have yet described, remains to be mentioned, namely, after grass. In this case spring-wheat takes the place of oats. It is a very unusual practice to sow wheat after grass at all in Scotland, though it is very common in England, and its success there attests the superiority of the English climate. Another circumstance, perhaps, that promotes the culture of spring wheat on lea in England, in preference to oats, is, that the climate is too dry, and too warm in the southern counties, for the perfect growth of the oat; and oatmeal not being wanted for food to the people of England, may also direct the efforts of the agriculturists there to the growing of as much wheat as possible, which efforts the drought and heat of the climate second very materially. The very opposite of these circumstances operate to encourage and maintain the culture of oats in Scotland. The climate is humid, which is congenial to the growth of the oat plant; and it is not so warm, even in summer, as to stint its perfect development, while oatmeal has long been a favourite food of the work-people. Now that wheat bread is more used by the labouring population than it has hitherto been, it is worthy of consideration whether more wheat, and less oats, might not be raised in Scotland. The only way I see of substituting the one crop for the other is by sowing spring wheat on lea; for spring wheat, after turnips, is as extensively cultivated as the nature of the weather in spring permits every year;

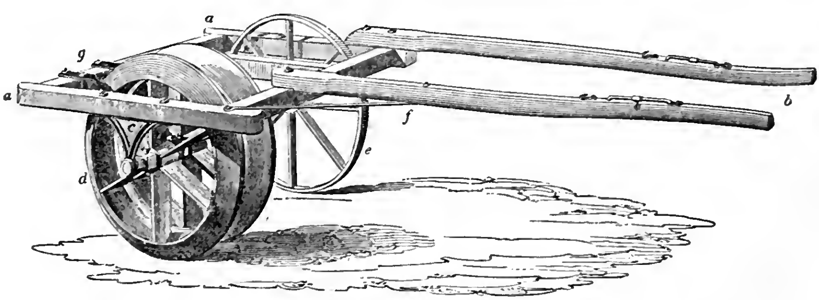
and even now it is not in every season that spring wheat ripens in this country, though this remark refers only to its culture after turnips, instead of barley; and it may prove to be a fact that spring wheat will thrive better after grass than after turnips. Its culture after turnips has long been tried, and experience rather dissuades from extending it; and as that after grass is but of recent origin, experience cannot yet guide the Scottish farmer in the matter. The chief obstacle to sowing wheat in spring is the peculiar effect of the two principal classes of soil on the growth of that plant. Clay soils are too inert in this climate to mature the growth of wheat in a few months; and the lighter soils, though more promotive of quick vegetation, want stamina to support the wheat plant, which really requires a somewhat clayey soil to bring it to maturity: and the lighter soils, besides, are too easily affected by drought in early spring; and it is no uncommon circumstance to experience a severe drought in Scotland in March, in the prevalence of the E. wind in spring which causes it.

2366. As to sowing wheat on lea in autumn, several circumstances deserve consideration before such a practice, extensively at least, can be adopted. Wheat cannot safely be sown in Scotland after the end of October, which is about the time it is sown after potatoes, and that is considered as late as it can be sown in safety until spring arrives. To plough up lea before October would be to sacrifice the aftermath, which is not only good feeding for stock, but the want of it would throw the stock too early upon the turnips, and make too long a winter. One misfortune for Scotland is, that no forage plant exists fit for the use of stock in autumn but the aftermath. The only alternative, therefore, is, to devise a means to consolidate the lighter soils, so as they may be enabled to withstand the inordinate drought of spring, and support the wheat plant until it attains maturity; and the only means, it would appear, we have of doing this is the use of the *presser-roller*.

2367. *The Presser-roller.*—The chief object of the application of the presser-roller is to produce consolidation in the soil over a narrow space, in which space the seeds of plants are to have root; hence its effects are applicable only to the drill system of culture, and that only under the particular circumstance of a consolidated soil whose ordinary texture is too loose and friable for the continued support of the wheat plant, and close contact in the furrow-slices of the soil on being ploughed from grass for a seed-furrow.

2368. The presser-roller is represented in its most common form by fig. 211, which is a view of the machine in perspective, and is of extremely simple construction. The

Fig. 211.

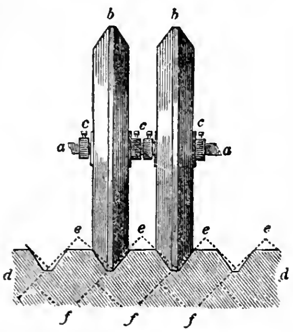


THE PRESSER-ROLLER.

carriage consists of a rectangular frame *a a*. A pair of horse-shafts *b*, are bolted upon the frame, on the nigh side. A cast-iron bracket *c*, supports the frame upon the axle—this axle carries the two pressing-wheels *d d*, which are provided with the means of being fixed at any desired distance apart, though 9 to 10 inches is the usual space. The axle carries also the light carriage-wheel *e*. The off-side shaft *b*, is supported by the iron stay-rod *f*; and two iron-scrapers *g*, are attached to the hind bar, for the purpose of throwing off any soil that may adhere to the wheels.

2369. Fig. 212, is an edge-view of the two pressing wheels detached from the carriage, in which *a a* is the axle, *b b* are the two pressing-wheels as they appear edgeways, their weight being about 2 cwt. each. The pressing-wheels are held at the required distance by the square collars *c c c*: *d d* represents a transverse section of the ground undergoing the pressing process: the shaded part of the section exhibits the state of a soft loose soil when pressed by the roller; and the dotted lines *e f*, *e f*, that of the newly ploughed lea undergoing the operation of consolidation.

Fig. 212.



ACTION OF THE EDGE OF THE PRESSING-WHEELS.

2370. As explained above, and with reference again to fig. 211, the pressing-wheels are to be understood as running always upon the last turned-up furrows but one; while the carriage-wheel *e* runs always upon the solid land, where the horse also walks, the shafts being placed at that side. But the presser is now being more advantageously used as to *time*, in the consolidation of soft soils by being constructed with *four*, *six*, or more pressing-wheels; and in this form the carriage-wheel is not required. In using the presser of this construction, the field must be ploughed for the seed-furrow all over, either entirely or in part, before the pressing is begun; and the field is regularly gone over by the presser, which, from its now increased weight, will require two horses. In this form, with six pressing-wheels, and with two horses, the machine will press-roll from 8 to 9 acres in a day. The entire weight of the six wheel rollers amounts to about 12 or 13 cwt. The price of the two-wheeled presser is about £6, 10s. and for each additional wheel, with its mounting, £1, 12s.

2371. The presser is used in this manner for pressing the soil after lea. It is most economically used in conjunction with two ploughs, by following the last one, and moving the pressing-wheels upon the two furrow-slices they had immediately laid over. It not only compresses the slices into less bulk, but indents a groove on each of them, which receives the seed when it is sown. With 1 presser, 2 acres of ground can only thus be compressed in the course of a day, and, where a considerable extent of spring wheat may be sown, this rate of compression would be too slow. Either the number of pressers should be increased, or a considerable extent of land pressed before it is sown; as it would be tiresome work to sow only two acres a-day of a large field, which might require a fortnight of 2 ploughs to plough. As the weather in spring is precarious, and the season for sowing spring wheat limited, the most convenient plan for most farmers would be to have 2 pressers in operation, and sow the ground compressed every two days—that is, 8 acres—which would be a large enough sowing of spring wheat in one day upon a farm that worked 5 pairs of horses; or, on farms employing a smaller number of horses, the better plan would be to have one of the larger pressers which covers more ground, and is worked by a pair of horses. The former plan, as regards time, may be followed with perfect safety to the wheat crop, as a double tine along of the harrows is quite sufficient to cover pressed spring wheat; and it should receive no more, unless perhaps a single tine again along, in case the surface is not yet sufficiently fine; but cross-harrowing would discompose the seed that had fallen in rows into the grooves made by the pressers. Another plan is to plough and press the lea early in winter, when it would consolidate still more, and then sow an entire field with wheat in spring, when the weather is favourable; and should it prove not so, the ground would be ready for oats. This last plan might be followed on light soils, which are in a rich enough condition for spring wheat: or the lea might be ploughed in winter and not pressed until spring before being sown.

2372. This same instrument may be beneficially employed in compressing light turnip-land when ploughing into ridges, to render it more fit for spring wheat; and in using it for this purpose it might be employed in the same manner as on lea.

2373. But the presser may be employed on even strong lea, and the crop of wheat consequent thereon increased to a sensible degree, as the following case will testify:—"A very striking instance of the utility of this machine," says Mr Hugh Watson, Keillor, Forfarshire, "was exhibited on a field belonging to my friend Captain Barclay Allardyce of Ury, who last season (1832) broke up a piece of grass land near his mansion-house, supposed to have lain out about 100 years. It was a strong soil, and required 4 horses to work the plough, and it was followed by the presser, leaving the work in such a finished state that, although Captain Barclay's intention was to sow the field with oats, after the preparation of a winter's exposure, he was induced to try a crop of wheat, and succeeded beyond his expectation, having reaped 50 bushels per imperial acre; while the probability is, that, if the field had been sown in spring with oats, they would all have rotted. . . . . I have used the presser," continues Mr Watson, "for two seasons, and can with confidence recommend it *on all light soils with every sort of corn crop*."* It would thus appear that the use of the presser is almost of general application, and that the ground may be ploughed a considerable time before it is sown, which renders it of use on a winter furrow. Farmers, both in Forfar and Fife shires, I am aware, have used this instrument for several years, and, from what I can learn, with success.

2374. As regards the probability of success in raising spring wheat in Scotland after lea, theory would commend the practice, provided the presser were used in preparing the soil. The oat plant grows very well in ploughed lea without the assistance of the presser, and why should not wheat? This is an obvious question for a person to put who looks no deeper than the surface of the ground. The root of the oat plant is chiefly fibrous, and extends in fibres around near the surface. The consolidation which the ground receives, as far as the tines of the harrows reach, is sufficient for the oat; but not so for the wheat — as, besides the fibrous roots which it also pushes around near the surface, it sends a strong tap and other roots downwards, which, on finding no sufficient hold in the void spaces so numerous under the furrow-slices of ploughed lea, but where it is necessary to afford requisite anchorage to the plant, they are constrained to descend still farther, until they reach the undisturbed subsoil under the line of the plough draught, where they no doubt find sufficient stability, but insufficient support. The range of the roots of the wheat and the oat plants are as different as that of those of the oak and the Scots fir. Let the soil, however, be compressed by the presser, and the wheat plant then finds the requisite security for its roots; and the decomposed vegetable matter of the lea supports it, as well as it would the oat plant in the same place. Wheat is grown after lea in England without pressing; but I suspect the practice is chiefly confined to good clay land; and we know, besides, that the furrow which the English ploughman gives to the lea is shallow and flat, so that the roots of the plant find no difficulty in pushing through it, and establishing themselves in the subsoil, which is comparatively much nearer the air and manure of the soil than in Scotch lea-ploughing. I suspect also that, were wheat sown after rye-grass lea, it would no more succeed in England than in Scotland, where there is no other species of grass to precede it, there being no pure clover leas or old pasture to prepare for wheat.

2375. With regard to the varieties of wheat which ought to be sown in spring, I cannot advise with confidence. The unintelligible classification of wheat by botanists, into beardless in winter, and bearded in spring, in as far as it affects agriculture, is apt to mislead the farmer; and were he so far to rely on the opinions of botanists as to try these two distinctions of wheat in the season said to be suitable to each, he would certainly be disappointed, and the results would probably be

* *Quarterly Journal of Agriculture*, vol. iv. 545.

the very opposite anticipated. For this reason I quite agree with Mr Lawson in what he has said on the subject. "Botanists," he states, "generally divide the common beardless and bearded wheats into two distinct species, terming the former *Triticum hibernum*, or winter wheat, and the latter *Triticum æstivum*, or summer wheat. But the propriety of the distinction may well be questioned, more particularly as the chief distinguishing character between them consists in the varieties of the former being beardless, or nearly so, while the awns of the latter are generally 2, 3, or more inches in length; and it being an established fact, that the awns or beards in grasses form by no means a permanent specific distinction, and that in many cases they do not even constitute a variety, so much does their presence or absence depend upon the effects of climate, culture, soil, &c. . . . . . But the principal objection to the names commonly used is, that they make no proper distinction between the two great classes—*winter* and *spring* wheats. For instance, under *Triticum hibernum* are included several of the earlier, and, without doubt, the best sorts of spring wheat; and under *Triticum æstivum* are included several bearded wheats equally hardy, and requiring as long time to arrive at maturity as our common winter sorts." * Colonel Le Couteur falls into the same error when treating of the classification of wheat, by dividing all wheats into the two unmeaning distinctions of "beardless or winter wheats" and "bearded or spring wheats," as I have formerly remarked in (1844.) †

2376. Although the subject is thus rendered, by botanists and writers on the cultivated varieties of wheat, sufficiently puzzling to the farmer, yet some considerations may direct you in the choice of spring wheat. I may premise that you cannot make a mistake in regard to a winter wheat; for, however early may be the habit of the variety sown, the very circumstance of its having been sown in autumn, when sufficient time is not given to the plant to reach maturity before winter, will convert it for that season into a winter variety. The wheat plant is a true annual, but when sown late, and the progress of its growth is retarded by a depression of temperature, it is converted for the time into a biennial. It is therefore highly probable, that, as the nature of wheat is to bring its seed to maturity in the course of one season, any variety sown in time in spring would mature its seed in the course of the ensuing summer or autumn. I believe this to be a fact; nevertheless, circumstances may occur to modify the fact *in this climate*. Under the most favourable circumstances, the wheat plant requires a considerable time to mature its seed; and a variety that has long been cultivated in winter, on being sown in spring in the same latitude will not mature its seed that season, should the temperature fall much below the average, or should it be cultivated on very inferior soil to what it had been accustomed; so that, in practice, it is not safe—at least in so precarious a climate as that of Scotland—to sow *every variety* of wheat in spring. Wheat from a warm to a cold climate, will prove earlier in the latter than the native varieties, and, in so far, is better suited for sowing in spring; and if you can ascertain, besides, that the same variety is an early one in the warm latitude—bringing its seed to maturity in a short period, perhaps not exceeding 4 months—then you may safely sow it as a spring wheat, whether it be a red or white coloured — a bearded or a beardless variety.

2377. In my own experience of spring-wheat, the old Lammas red, and another old variety, which I have not heard of for many years, the Cobham red, were considered excellent varieties of spring wheat. Of the Lammas red, I have seen a field of 35 acres sown on the 8th March, and cut, an excellent crop, on 26th August, in that memorable year for all kinds of good crops, 1815. The variety exists at the present day, and is still, I believe, a favourite with many farmers, and deservedly so.

2378. A late variety of spring wheat was introduced into culture a few years since, under the name of fern wheat, and is now termed April wheat, because it may be sown as late as April, and yet be cut

* Lawson's *Agriculturist's Manual*, p. 1-2.

† Le Couteur *On Wheat*, p. 78-9.

down ripe at the termination of the ordinary harvest. By an experiment made in 1833, and related by Mr Lawson, the fern wheat, on being sown on the 26th March, along with common white and Essex red wheat, was cut on the 27th August, after having been only five months in the ground, while the others were not cut until the 30th September, and their comparative produce and weight were as follows:—

	Produce per acre.		Weight per bushel.
	qrs.	bus.	lb.
Fern wheat,	4	4	63¼
Essex red wheat,	3	6	62½
Common white wheat,	3	3½	60¼

The April wheat very much resembles a wheat grown in North America, under the name of the Italian, from whence it probably found its way to this country.

2379. It is awned, the spike very long, 6 inches, and is red coloured. The grain is small, elongated, with the median line well marked, opaque, somewhat flinty, and lively red colour. The produce in East Lothian has frequently been 5 quarters per imperial acre, and the weight from 60 lb. to 64 lb. per bushel. It is well liked by the bakers, and its price rules about the same as other sorts of red wheat of the same weight. The straw is tall, and softer than that of the winter wheat. It requires to be carefully pickled before being sown, being much given to smut; and it should not be allowed to stand until too ripe, as it is liable to shake out of the chaff. Whether it will pay better than barley, in ordinary years, remains to be seen; but, as it is gaining in repute, we may conclude that it does so in many cases.*

ON THE DRILLING UP OF LAND.

2380. While the ploughing and sowing of the turnip land with spring wheat may be progressing in the early spring months, whenever the weather is favourable for the operation, preparation should be making for others of the earliest spring crops, the earliest of which may be regarded the bean and the pea. Beans and pease are usually cultivated on strong land, having a considerable tenacity by means of the clay it contains; and as this sort of land is not in a state to be worked in spring, but only when the weather is dry, unless it has been thoroughly drained, or is incumbent on a porous subsoil, it is not in every season that the bean and the pea can be cultivated. Beans and pease may also be cultivated in lighter and naturally dry soils, provided they are well manured. Whatever may be the state and quality of the soil, one mode of cultivating the bean and the pea is upon drills, in the same manner as the potato and the turnip; and it is therefore requisite that you understand the method of making up the land into drills, before proceeding to the details of the cultivation of the bean or the pea in that particular manner.

2381. *Drilling.*—Drilling is a form of ploughing very different from the ordinary, but not unlike in appearance to that mode of ploughing stubble in some parts of the country, named rib-ploughing, fig. 30, and which I noticed only to condemn. The principal reason for my condemnation was, that while it professed to turn up the soil to the action of the atmosphere, it left untouched by the plough and buried more than the half of it, thus in a great measure frustrating its avowed object. In so far as the drilling is concerned, it also leaves a large proportion of the soil between one side of the drill and the other quite untouched by the plough; but then the part untouched now had been ploughed and cleaned previous to being drilled up, otherwise it could not well be subjected to that operation; so that drilling affects only the operations directly in connexion with the manuring of the soil and the sowing of the seed. On this account drills ought not to be formed on land in a hard state, as the object of making them at all is to afford a sufficient quantity of loose soil to cover the manure deposited in them, and the roots of plants sufficient freedom to roam in search of that manure; and also to afford an opportunity, notwithstanding the presence of a crop, to clear the land of weeds, by stirring it occasionally with the proper implements. There is no way of effecting all these objects so effectually as by drilling. Accordingly, all crops intended to meliorate and clean the ground are cultivated in drills, and these

* Lawson's *Agriculturist's Manual*, p. 18.

are beans, potatoes, turnips, mangold-wurzel, &c.

2382. On entering upon the subject of drilling, the remarks shall be made without reference to the special case of sowing beans, though that has given rise to the subject at present, but rather in reference to the ordinary operations which provide and render the soil in the best state for being elevated into drills. The specialities connected with drilling will be stated when we come shortly to treat of the culture of the bean. After the land has been much ploughed and harrowed, and rolled, to render it friable, it becomes flat, whatever may have been the form of ridge in which it had before been ploughed; and it is in the best state for being ploughed into drills when flat. Yet heavy land which is constantly retained in ridges of a rounded form, such as twice-gathered-up, fig. 26, will exhibit the ridged form even after it has been well pulverised by ploughings, harrowings, and rollings; it will still appear as if gathered up from the flat, fig. 20, and had been harrowed and rolled fine on the surface. Light soil with the same work will appear quite flat, and of a uniform surface throughout, though not with that levelness which implies that every portion of its surface was in the same plane.

2383. This distinction in the appearance of ground that has been ridged and not ridged, should be kept in view, as it will, in a great measure, determine the width of space that should be left between the drills. This distinction is entirely occasioned by the different form in which the different sorts of soils had been previously ploughed. Strong soil is always kept round by repeated gatherings up, fig. 20, or gatherings up based on casting with gore-furrows, fig. 23, which imprint even upon a wrought surface a flatness across the top of the ridge, but with an evident mark along the open furrows; whereas the lighter soils are usually only once gathered up, fig. 20, cast together without gore-furrows, fig. 22, or ploughed two-out-and-two-in, fig. 25, which, after being wrought down, give a flatness across the ridges with a slight waving indentation in the open furrows.

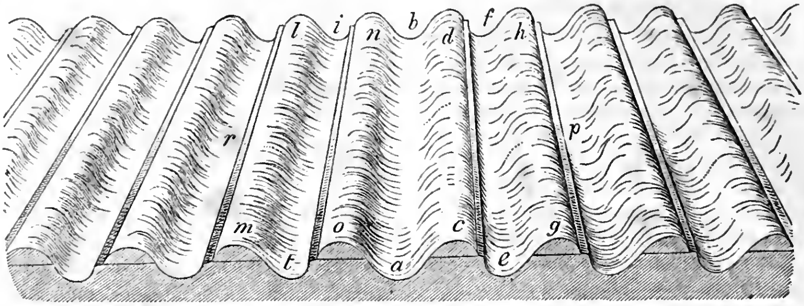
2384. In whichever state the surface may be, whether completely flat or exhibiting a slight indication of rounded ridges, the drills are made of the same form, and in various ways. They are made by one landing of the plough, when they are said to be *single*, or they are made with a bout of the plough, when they are called *double;* and both single and double drills are made either *towards* or *from* the *feering*. The ultimate form of the two different modes are apparently the same, but that which makes them *from* the feering is the truest drill, as I shall show.

2385. In beginning to make drills, let us take one of the simplest cases that present themselves, namely, a field having a straight side at its farthest end, and having the forms of ridges still visible; and as it is requisite in strong land to preserve a form of surface which will keep it as dry as possible, the drills should be so made upon the ridges as to be accommodated between the open furrows. If the ridges are 15 feet in width, 6 drills of 30 inches apart will fill up the space between the open furrows; and if 18 feet wide, 8 drills of 27 inches will answer the same end. When the ground is flat, the width of the drills may be adapted according to will. I have seen it stated in cases of drilling land for turnips in England, that 18 inches was a good distance to be preserved between drills; but what good can be obtained by adopting a space too narrow for the free operation of the implements required to keep the ground clean, I cannot imagine.

2386. Suppose, then, that the ridges present a form of 15 feet in width on strong land, the drills should be made 30 inches wide, and they are made in this way. Begin at the end of the field farthest from the gate, and where the fence runs in a straight line; and set up 3 feering poles, fig. 18, in a straight line upon the highest furrow-brow of the second ridge from the fence, and 15 inches from the middle of its open furrow. Split out the feering along the line of the poles, turning over the furrow-slices first to one hand and then to the other, like the furrow-slices *m* and *n*, along the feering *k l*, fig. 19. The reason that the first feering is made on the furrow-brow is, that when the drills are afterwards split to cover the dung, or whatever else is put in them, the place which the hollow of the feering furrow now occupies will be filled up into a drill, and the present open furrow will then become the hollow between the drills occupying the furrow-brow of both ridges.

2387. In fig. 213, suppose *a b* to be the feering in the furrow-brow of the ridge. On passing up from *a* to *b*, the plough lays over the furrow-slice *c d*, and, the soil having been pulverised, it crumbles down in a round-topped narrow heap upon the firmer land under it. On gaining the head-ridge at the other end of the feering, the horses are *hied*, and the plough comes down the same furrow from *b* to *a*, laying over a similar furrow *n o* upon the firm land, which of course assumes a similar form to *c d*. A similar feering is made in the furrow-brow of the 6th ridge from the last, and so on upon every 6th ridge across the field; but ere the field is all feered for drilling, some of the drills are begun to be formed between the feerings, that the operations may be proceeded with for which the land is drilled.

Fig. 213.



THE MODE OF PLOUGHING SINGLE DRILLS.

2388. To proceed, then, with the drilling at the first feering: a distance of 30 inches, previously determined on as the width of the drill, is measured off from *a* to *e*, and this the ploughman does with his plough-staff, fig. 5, upon which the different breadths of drills executed on the farm should be notched off. The plough then proceeds from *e* to *f*, preserving a parallelism with the feered furrow *a b*, laying over the furrow-slice *g h* upon the firm ground, upon which it crumbles down as did the former furrow *c d*. On *hieing* the horses at the other end of the drills, a similar distance of 30 inches is marked off from *b* to *i*, the plough passes down from *i* to *t*, laying over the furrow-slice *l m* upon the firm ground. *Hieing* the horses again, the plough goes up by *p*, forming another drill like the others, and comes back by *r*, forming another drill. The ploughman does not measure off the width of every drill he makes in this manner, his eye being able to keep him right for a number of drills, across which he then lays his plough-staff, to ascertain how he is proceeding, whether the drills are too narrow, or too wide, and then again proceeds with the work. It will be observed, from this description, that since the making of the feering in the furrow *a b*, one drill is formed every time the plough goes up in the direction of *e f*, and another in coming down in that of *i t*. In this way the horses *hie* round the feering *a b*, and the plough makes 2 drills every bout till 2 ridges on each side of the feering *a b* are drilled up, and the last drill is made close beside the fence.

2389. When this takes place, the ploughman goes to the next feering, where he finds two furrows split out for him as at *a b*, and he forms drills around it in the same manner, till 2 ridges on each side are also drilled. Two ridges having thus been drilled to the right and left of the first feering, and two to the right and left of the second, and as six ridges intervene between the feerings, two ridges of the six have yet to be drilled, upon which the drills are formed by *hupping* the horses from the first set of drills to the second, still turning the furrow-slices upon

PLATE IX.

Gourlay Steell A.R.S.A.

and towards the firm ground. But, in doing this, caution is requisite to make these latter drills of the exact width of 30 inches, that the last formed one, into the open furrow at the junction of the two feerings, shall just be no more, and no less, than the 30 inches in width. The caution is exercised by the ploughman applying his plough-staff frequently to ascertain the breadth of the ground to be drilled, as well as the width of the drills themselves; and should he find that he has more or less ground than he should have for the number of drills he has yet to make, he must modify the width of each drill, so far as that the whole number may be as near the width as possible, and not put any surplus or deficient ground entirely to the last drill. Another caution, of no less importance, is to ascertain if the ground for the last drills is of equal breadth at both ends at the head-ridges; for, if this particular is not attended to, the last drill may run out to a point at one head-ridge, and be too broad at the other. In closing every feering, therefore, the greatest caution is required to preserve the exact breadth of the drills throughout their entire lengths. This a skilled ploughman will execute with great accuracy.

2390. This is one way of forming *single* drills, and the following is another: Instead of splitting out the feering *a b*, fig. 213, as just described, the ploughman lays the two furrow-slices together, and forms a finished drill on the line of feering, in place of a hollow furrow; and this he does by *hupping* the horses instead of *hieing* them, as in the former case. Still *hupping* the horses, and measuring off the width of the drill as formerly, the next drill is made in the direction of *f e*, by laying the furrow-slice towards the drill made upon the line of feering, the outer edge of the furrow-slice sending its crumbled earth to the edge of the plough track, left in making the drill in the feering. The next drill is made in the direction of *t i*, again laying the furrow-slice towards the plough-track. in forming the previous drill. The drills are thus formed around the first feering over the 2 ridges on each side, then over the 2 ridges on each side of the second feering, by *hupping* the horses; and the space of the 2 ridges between them is closed with drills, accompanied with the precautions noticed above, and by *hieing* the horses.

2391. The distinctive difference betwixt the two methods is, that the one is the exact opposite of the other. In the first, the furrow-slices are laid over *from* the feerings towards the *unploughed* land, and the horses are first *hied*, and then *hupped* when closing the two feerings. In the second method, the furrow-slices are laid over *towards* the feerings and the *ploughed* land, and the horses are first *hupped*, and then *hied* on closing the two feerings. The treatment of the horses may be regarded as alike in both cases; but the land is differently treated. In the second method, the furrow-slice being laid over towards the open track left by the plough in making the previous drill, should the land be at all cloddy, when it is strong, or stony when it is light—the clods and stones will roll down the crumbling furrow-slice, and, having acquired an impetus by the action of the ear of the mould-board, find their way into the hollows between the drills; and this is actually found to be the case. When the width of the drills is as much as 30 inches, this inconvenience is less likely to happen than when it is 27 inches, when I have seen it occur to a considerable degree. The immediate inconvenience occasioned by the clods and stones is, the interruption they give to the progress of the bean-barrow when the land is drilled for the bean-crop; and as they occupy the best part of the drill, where the dung is deposited, they are covered up with the dung, remain amongst it, and form obstructions to the roots of plants which push themselves into the manure in search of nourishment. At all events, they do no good there.

2392. In the first method, this inconvenience and every other are entirely avoided. No clods and stones can roll into the furrow when the land, in making the drills, is laid over upon the firm ground; and the next passage of the plough not only sweeps away every clod and stone, but leaves a small stripe of clean ground between the former furrow-slice and its own track, as between *t* and *o*, &c., fig. 213, and which track is thus left clear and open, ready for the bean-barrow, or the dung that may be deposited in it. These advantages are so obvious that no argument in support of them seems necessary; and they warrant the adoption of the method as an invariable practice.

2393. When the ground is flat—that is, when the ridges are not remarkably prominent—the drills are made the common width of 27 inches—some persons make them 28 inches—and their feering is conducted in the same way; but in setting off breaks of feering, when there are no ridges to measure the proper distances, care is requisite to make the breadth of the feering such as to contain a determinate number of drills of the fixed width, otherwise an error will inevitably occur at the closings of the feerings. Thus, if the drills are 27 inches in width, in a feering of 30 yards broad, 6 ridges of 15 feet, which is a very convenient breadth of feering, the number of drills will be exactly 40.

2394. For making *double* drills, the feering is made in a different manner from that for making the single. Suppose, again, that the ridges are visibly marked in the ground, the first feering is taken on the furrow-brow of the ridge nearest the fence, at 15 inches from its open furrow space, and, setting up a straight line of poles, split out the feering by ploughing up and down in the same furrow. Suppose this furrow to be represented by the line *c f* in fig. 19, then set up a square-table at *d*, and mark off therefrom a line with poles at right angles in the direction of the arrow through *s* to *t*. Removing the square-table to *g*, set off a similar and parallel line in the direction of the other arrow through *u* to *v*. Split out these lines with the plough lightly, as straight as the ploughman can, and the bottom of the furrows will form a guide to set off the exact breadth of the feering at right angles to the first feering.

2395. Ploughmen expert at drilling are apt to contemn such guides in forming double drills, because they conceive they can preserve the widths sufficiently well by the eye. And, no doubt, ploughmen are to be found who drill with precision, and I have met with such, though very few in number; but the generality of them cannot be intrusted to drill without a guide of some sort, and there is none more simple and effectual than the one I have described and recommended; and where *single* drilling is to be executed on land on which no ridge is visible, it is impossible for the most expert driller to set off the feerings with sufficient accuracy. Ploughmen, I know, try to do it, and I have seen good ones nearly succeed in it, but never witnessed one who was not obliged to modify the width of the drills at the closings, when he had no such guide as the above.

2396. Strict accuracy in regard to drills is not required in some crops, such as in the bean and potato; but with regard to the turnip, which is sown with a machine set to a given width, unless the drills are very nearly alike in breadth at both ends, the sowing must be imperfectly performed. The means of attaining accuracy being so simple—merely drawing two or three furrows across the field—it is culpable to neglect them. There will be, I am certain, more time spent by the ploughman in measuring the width of the drills with his plough-staff, at every closing over a field, than he would spend in drawing a few cross-furrows at first; and, after all the adjustments, his mind is not entirely satisfied of the accuracy of the work. Nay, with all the assistance cross-furrows can afford him, he will still have to measure the widths of the drills with his plough-staff at every closing; but he is much less likely to err in the measurements, while having the cross-furrows certainly to guide him at right angles to the direction of the drills, than in measuring them at a supposed right angle. This is so self-evident that the most obstinate ploughman must allow that the cross-furrows afford much assistance.

2397. The double drills are formed in this way; and first on the supposition that the ridges are visible at 15 feet asunder. After the furrow-slice *c d*, fig. 213, is laid over at the feering of *a b* along the nigh-side furrow-brow of the ridge nearest the fence, as directed above, the horses are *hupped*, and the plough is made to come down at the prescribed width of drill of 30 inches, along the line *f e*, and to put a furrow-slice against the feering furrow-slice *c d*, in doing which the drill receives a somewhat sharp-pointed crest. At 30 inches this crest is never very sharp, but at 27 inches it may be made as sharp as you please, by making the plough go a little deeper. Then, *hieing* the horses, the plough again goes along *e f*, at 30 inches from *c d*, and lays over the large furrow-slice *g h* on the firm ground. *Hupping* again, the horses come down *p*, and lay a small furrow-slice to complete the drill *h g*; and so on, one drill after another. No breaks of feerings are required in this mode of drilling, as every drill is finished as it is formed; and the precautions required are, that the proper widths of the drills are preserved throughout their lengths, in which they may be easily checked by the assistance of the cross-furrows. This method of double-drilling is analogous to the first mode of single-drilling, (2388,) which lays the furrow-slice towards the unploughed ground.

2398. The other mode of double-drilling is analogous to the second mode of single-drilling (2390.) After the feering-poles are set up, as in the former case, the ploughing is commenced from the other headridge, and the first furrow-slice *n o* is laid over while coming down *b a*. The horses are then *hied*, and the plough is passed up the same furrow in the opposite direction *a b*, and, having little earth to lay over, only a small furrow-slice is laid towards *c d*. *Hupping* the horses, the plough is then brought down *f e*, which being a fresh furrow, the furrow-slice *d c* is large, and completes the drill *d c*. *Hieing* the horses, the plough again passes along the last furrow in the opposite direction *e f*, and, having little earth to take, lays over the small furrow-slice towards *g h*; and then *hupping* again, a large furrow-slice is laid over from *p*, and completes the drill *h g*, and so on, one drill after another, at the requisite width.

2399. The same difference exists in the two modes of making these double drills, as in making the single. Thus, in the first method, the large furrow-slice is laid over upon the firm ground, and the drill is finished by the second and smaller furrow-slice; whereas, in the second method, the smaller furrow-slice is first formed, and the larger one is laid towards the already drilled land, and upon the smaller furrow-slice which was first turned over.

2400. On considering carefully both modes of drilling, it will be observed that the two sides of a double drill cannot be equal. The side which receives the furrow-slice raised from the firm land receives a larger quantity of earth than the one which receives the small furrow-slice derived from the same, though rather wider track, out of which the former large slice had been taken. The immediate consequence of this inequality of earth upon the two sides of a drill is to give it the form of an unequal triangle, and its effect on the growth of any seed deposited within the drill, is to cause the germ of the plant to grow out at the upper part of the side, between the meeting of the two furrow-slices, instead of the top of the drill. This effect is palpably shown by the sloping direction in which a strong stem of beans or potatoes pushes itself out of the drill; and, to obviate any deformity in the future growth of these plants, the tops of the drills are lowered by harrowing as much as to allow the stems to grow upright.

2401. The inconvenience of the unequal form of the double drill attends both modes of making them, but, of the two, the one which lays the large furrow-slice upon the open land possesses two advantages over the other: the first, that no clods, large or small, can roll from the top of the drill into the hollow; and the other, that the finished drills are less trampled by the horses in making the succeeding drills. This last circumstance may be explained by referring to fig. 213. When the plough, for instance, goes up *e f* to commence a new drill, it cuts the firm ground along that line, laying the furrow-slice *g h* upon the firm ground on the right, and leaving on the left a small space of firm ground *c e* and *d f*, between the line of the plough *f e* and the crumblings of the previous large furrow or unfinished drill *c d*. In doing this, the furrow-horse walks up the hollow of the former made drill *a b* to guide him in the exact line he should go, and the other goes up on the firm ground by the side of *e f*. On returning, the furrow-horse comes down *e f*, while the other comes by *p*, while the plough is making up the small side of the drill *d c*; and in doing this the footsteps of the horse that went up the finished drill *a b* are left untouched. This may be considered by some a matter of little importance, as, from the generality of the practice in parts of the country, it seems to be regarded of little importance; and in the case of some horses which walk neatly and narrowly in a drill, the impressions of their footsteps may be almost unobserved in its bottom; but in the case of a horse which walks wide behind, and of all weak horses which stagger under their draught, both sides of the drills are much trampled; and, in strong land, the foot-prints injure the soil by holding water.

2402. The foot-marks may be obliterated in this way: Instead of perfecting the drills one by one in succession, let an intermediate drill remain unfinished between the one that is finishing, and the other that is forming. For example: Instead of finishing the second side of the drill *h g* by returning down the hollow *f e*, let the drill remain unfinished until the new drill *p* is formed so far as to lay over its first furrow on the firm ground. Then let the plough come down *b a*, having the furrow-horse before it, and it will obliterate its footmarks, and let the other horse come down the new-formed furrow *p*. There is another advantage attending this mode—that one of the horses goes in a hollow of a drill formerly made to guide it in the proper line of the drill. With regard to the mode which lays the large furrow-slice towards the drilled land, it seems impossible but to leave the finished drills trampled. For example: When the plough comes down *f e* to lay over the large furrow towards, and to finish the drill *c d*, the furrow-horse comes down *b a*, and the other upon the firm land by *f e*; and again, when the plough passes up *e f*, to lay the small furrow-slice towards *g h*, the furrow-horse passes up *a b*, and leaves it trampled.

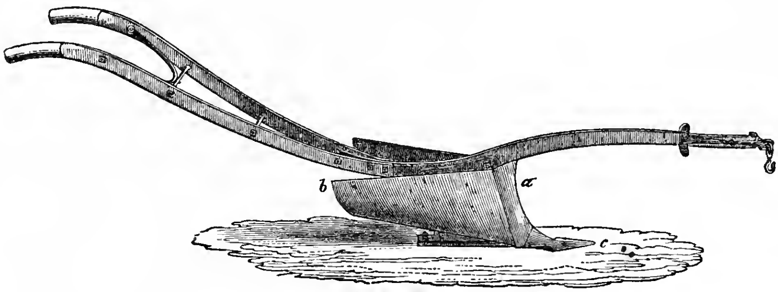
2403. When the ground is quite flat, double drills may be made 27 inches wide, and the same width may be adopted when ridges of 18 feet are visible. A feering of 6 ridges of 18 feet exactly includes 64 drills of 27 inches, so that where drills are desired at 27 inches in width, the land should either be in 18-feet ridges, if ridged, or it should be flat, otherwise 27-inch drills on 15-feet ridges will place some of them in the open furrow, which, in strong land, cannot fail to prove injurious to the turnips on them in winter. When the soil is thorough-drained, it is of no importance where the drills are situated; but, until that operation is performed, it is necessary to attend to the safety of the crop, which is done by avoiding having drills in the open furrow on strong undrained land.

2404. It may have occurred to you to inquire, that if a perfect drill cannot be formed by a bout of the common plough, why should it not be formed by one landing with a double mould-board plough? The inquiry is a natural one, and can receive a satisfactory answer. Were a drill perfectly formed, its vertical section would give a triangle whose height is equal to half the length of the base. The height to which a common plough can elevate the crest of a drill is that of the ear of its mould-board, which, in Small's plough, fig. 2, is 12 inches; and this height conforms to a drill of only 24 inches in width as regards the depth it can go. Such a plough, therefore, to make a drill of the usual width of 27 inches, will either leave a flat space on its top of 3 inches in breadth, or it will leave a tiny sharp-crested drill of 3 inches in breadth at the bottom of the hollow of the drill. A common plough varies in width, from the ear of the mould-board to the landside, from 18 inches (Wilkie's) to 20 inches (Small's.) A bout of Wilkie's plough could thus, apparently, make a drill 36 inches, and that of Small's 40 inches in width in a bout, were it ploughed to the full breadth either was capable of; but the plough cannot lay over two furrows in breadth equal to twice its own width, because the open track of the former furrow would not afford sufficient earth on the land side to resist the pressure of the plough, and not having which, it could not raise a second furrow equal to the first. The second furrow, therefore, must be taken by the plough nearer the side of a drill than in the middle of the hollow between two drills; and it is this expedient which gives every drill one sloping and one more perpendicular side.

2405. A double mould-board plough, constructed as it ordinarily is, would make drills as wide as are required; but when its mould-boards are set to make 27-inch drills, it is found that they are too wide below to allow the plough to go as deep as to give the drills their proper elevation of $13\frac{1}{2}$ inches. But the mould-boards of the double mould-board plough have been so modified in construction as to allow the plough to go as deep as is requisite to form a proper drill, or rather to form two halves of two drills at one landing. This effect has been attained by simply cutting away the under part of the mould-boards.

2406. Where the double mould-board plough is employed for forming drills, the mould-board is made to fit the shield *a*, fig. 214; it then stretches away to a length of 2 feet 6 inches along the upper edge,

Fig. 214.



THE DOUBLE MOULD-BOARD PLOUGH FOR FORMING DRILLS.

the point *b* being at a height varying from 11 to 14 inches above the sole-line. At this point the depth of the mould-board is only 6 inches, so that the lower edge runs off at a considerable elevation, and the surface having not more than 3 inches of twist, it is the lower edge only of the board that effects the purpose of laying up the earth to form the drill.

2407. The sock *c* should be double-feathered, to take a firm hold of the ground.

2408. In working the plough, for the purpose of forming drills, there is frequently a marking-bar jointed to the beam immediately before the breast *a*; the bar folds to either side, and, having an adjustable double-edged scraper fitted to it, a rut is drawn on the surface at the proper distance for the centre of the next furrow.

ON THE SOWING OF BEANS.

2409. The best season for sowing beans is February. The plant taking at least seven months to bring its seed to maturity, unless the seed is sown early, time will not be afforded the plant to arrive at maturity. A very favourable season, indeed, may hasten the plant through its course of vegetation in a shorter time; but an unfavourable one, on the other hand, may so retard that course, when even the seed had been sown in its proper season, as to prevent the formation of the seed altogether. Both effects are frequently experienced; and so much, as is well known, does the bean crop depend on the state of the weather, that it is no uncommon circumstance to raise a superabundant crop one season, whilst in the very next the crop may almost be an entire failure. No dependence, therefore, can be placed, in Scotland, on the result of the bean crop, and on that account it is not cultivated so extensively as it is entirely for the sake of the bean itself, as for that of a crop of excellent fodder from the straw, which is of itself valuable in every farm which rears live stock. Though the crop should fail as a seed-producing one, it never fails in the same season to produce good fodder. A dry season may stint the growth of the haulm, but will produce beans of fine quality, and a wet one may prevent the production of the seed, but will afford a large crop of fodder.

2410. Beans are raised most in accordance with their nature, and with most profit, on clay soils suited to the culture of wheat; and in these soils they may be raised without manure, provided they follow a manured crop or a single cereal crop. And they may also be raised on lighter soils, provided manure is directly applied for their special use.

2411. The portion of ground occupied by the bean crop is not arbitrarily chosen, but follows in a regular course of cropping, succeeding a cereal crop which is not laid down with grass. The ground, therefore, allotted to the bean crop was in stubble in autumn, and, the crop requiring early attention in spring, its ground in stubble would be ploughed early in winter, (774.) In England the bean, in some cases, is raised on lea, and succeeds, of course; but, in such a course of cropping, the bean is put in immediate comparison with the cereal crop which should have occupied the lea, and in a wet season it will stand the comparison very poorly as regards produce.

2412. The particular culture practised for raising beans is not dependent on the nature of the soil, but is meant to suit the nature of that plant's growth, and the state of the soil in reference to cleanliness. From the structure of the plant, which bears fruit-pods on its stem near the ground as well as at the top, it should have both light and air; and its leaves being nearer the top, and its stem comparatively bare, space is afforded near the ground for weeds to grow. The plant possessing these properties, unless the air is admitted below, and opportunity afforded for removing weeds, the crop will not be luxuriant, nor the land be cleaned.

2413. Now, one plan only exists by which both these objects can be secured, which is, to place the plants in *rows* or *drills*. The air will then reach both sides of every row; and if the rows are placed as far asunder as to allow the horse to work between them, the two objects of vigour to the plant, and cleanliness of the soil, will be attained.

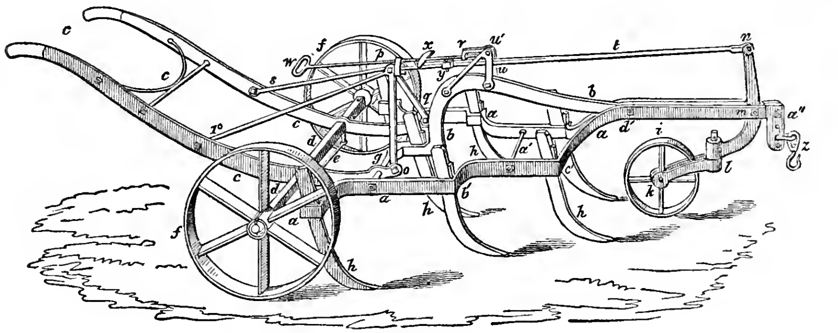
2414. Beans were wont to be sown *broad-cast*; but though the plants had stood as far asunder as to afford them sufficient air, it was almost impracticable to destroy the weeds by hand-hoeing, at least those which grew after the beans were a little advanced. There are farmers in clay land districts who still sow beans broadcast, though their reason for persisting in the practice is not very obvious, even were the land quite clean—which it certainly is not, and never will be, under the broadcast culture. Be the reasons of the preference for sowing beans broadcast what they may, the practice is now limited compared to the drill-method.

2415. If you look at figs. 27 and 28, you will find that the winter-furrows given to land of strong character are cleaving down without and with gore-furrows. The gore-furrows keep the land dry all winter, and it is as good a device for the purpose as is known; and where beans are desired to be raised, the stubble-land would best be ploughed in autumn, with gore-furrows, fig. 28. Suppose, then, you find the land in spring cloven down with gore-furrows, the first operation is to harrow down the furrow-slices *across the ridges*, in doing which, the land being strong, and lying in a rough state, the harrows will take a firm hold of it, and tear it to pieces in a contrary direction from what it had been cut by the plough in autumn; and the immediate effect will be, the filling up of the open furrow *b*, fig. 28, and also of the gore-furrows *a a*: the surface of the land will, in fact, be nearly flat. If the land, however, has become very much consolidated in winter, by reason of snow or rain, and little frost, a cross-harrowing will have little effect. It might then be harrowed along the ridges, which may even prove of little service; and, in such cases, harrowing may altogether be dispensed with. When the land is pretty dry, early as the season is in February, it will harrow well if it has been ameliorated by frost; but should it not be so dry as to bear the horses without sinking, it had better be let alone for a few days, or even a week or two. Dry land and dry weather are both requisite for good harrowing; and in its turn harrowing exposes the land to drought. Every draught of horses should be put to the harrows, to get it done as quickly as possible. Perhaps one double tine will suffice altogether—at all events, it should suffice for the first day; and should the weather continue dry, and the land require it, next day it should receive a second double harrowing in an *opposite direction*, when it will be in a much better state for receiving it after the short interval, than harrowing ever so often at one time.

2416. For strong land a stronger harrow than the common one is employed in some quarters, called the *brake-harrow*, which is only an enlargement of the common implement, wherein every part is increased in size and weight, for the purpose of breaking down and pulverising rough and stubborn land. Brakes are made of various forms, such as rectangular, rhomboidal, and triangular; and every form has its advocates, the preference being given frequently to that which accident had thrown in the way of the experimenter; and, without taking measures to compare its effects with those of other forms, the implement is marked as the most perfect of its kind. There appears no good reason for concluding that any one of the above forms is better than another, provided proper weight is put on the implement, and the tines be of proper length and number, and disposed in a manner that, with a duly applied draught, will make an equal distribution of its pulverising effects over the surface which it covers. The extended application of draining appears in a great measure to be superseding the brake-harrow.

2417. But when the land cannot be sufficiently impressed by the harrows, recourse should be had to the grubber, which is a much better implement, in every respect, than the brake-harrow. Fig. 215 is a view, in perspective, of Kirkwood's grubber,

Fig. 215.



KIRKWOOD'S GRUBBER.

which I consider a good implement of its class, as well in the execution of the work done by it, as for the facility with which the tines are taken out and let down again into the soil. This grubber may be considered as consisting of two parts, the tine-frame, and the carriage with its wheels and handles, the two being connected by means of the apparatus for elevating the tine-frame, and by a joint-rod which is common to both, the whole being constructed of malleable iron, except the wheels. The tine-frame is *a a*; the muzzle *a''* is provided with several holes, in which the draught shackle and hook can be attached, to regulate in some degree the tendency to earth. The beam *b b* is bent upwards at *a'*, above the frame *a*, for the purpose of receiving the bridle *u u'*. The tines, of which this form of the implement contains 7, *h h*, &c. are bent at the point as in the figure, with a slight tendency to *earth*, and are flattened out at the point; and they are secured at any required degree of earth by an iron wedge to each tine.

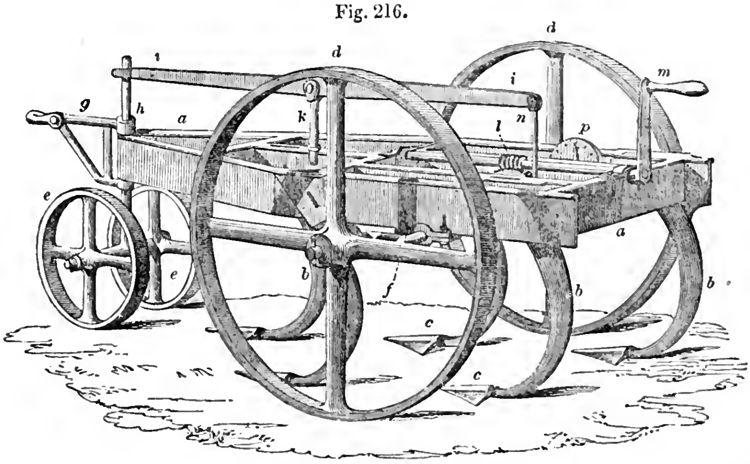
2418. The carriage consists of the axle *d d*, on which are mounted the two handles or levers *c c*. The levers are perforated for the joint-rod *g*, the position of which in the tine-frame is such as just to allow the extremities *o* to pass the axle when the frame is being raised or depressed. The levers extend backward, and terminate in sockets into which wooden helves are inserted. The carriage is supported on the hind-wheels *f f*; and the fore-part of the frame on the castor-wheel *i*, with its shears *k l*, and crank-lever *l n*. The connexions between the carriage and frame also form the elevating apparatus, by which the tine-frame is moved up and down in positions always parallel to the horizon.

2419. In working the machine, it is requisite that the conductor have it in his power to regulate and preserve a uniform depth for the tines, and to be able to withdraw the tines from the earth. To accomplish this part, the connecting-rod *t* has small mortices in it, to the number of 6 or 8, at very close intervals. A nut or slide-box *y'* is fitted to slide easily upon it; and it can be fixed at any point by dropping a pin through this and any required mortise. The bridle *u u'* consists of two similar parts. The handle *v x w* is made of such length as will bring the eye *w* within reach of the conductor—but it can be shortened or lengthened at pleasure; and this is done to make the cross-head fall in behind the end of the connecting-rod when the tines are in the ground, which thus lock them that they cannot rise out of the ground, although, from any malformation of the tines, they might have a tendency to do so were this lock not applied. But while the tines preserve their due form, the lock is not required. A prolonged screw-nut at *p* is also put upon the handle; and when the tine-frame is raised out of the ground for travelling, the nut is adjusted to fall in before the checks of the stays at *p*, and thus keeps up the tine-frame without the continued aid of the conductor.

2420. *Ducie's Grubber*, or cultivator, the production of Earl Ducie, is based, in its construction, on the improved form of Finlayson's and of Kirkwood's grubbers. In this cultivator we have the high wheels raising the tine-frame to a height above the surface of the ground that must greatly prevent the choking of the tines in foul land, by the accumulation of roots about their neck; and this is further secured by the curvature which they possess. The castor-wheel in front, being double, is an improvement on the crank-lever and shears, and decidedly superior to them; and the apparatus for elevating the tine-frame exhibits a fine mechanical taste, though the application and arrangement of the screw, the wheel and axle, and the levers to effect the purpose, is perhaps an example of too much elaboration for the particular case.

2421. Fig. 216 is a view in perspective of this implement. It consists of a frame *a a*, which carries five tines *b b*, &c., with

Fig. 216.



THE DUCIE CULTIVATOR.

which the machine is armed. The frame thus constructed is mounted on two high wheels *d d*, which support the body of the tine frame; and the front or apex of the frame is supported on the double castor-wheels *e e*, which are mounted on a reversed T-form axle, to the stem of which *h*, the draught-shackle *g* is applied in a permanent position, so that the shackle and stem shall turn together, and, by consequence, the wheels also, forming thus a castor-wheel of the most perfect description. The elevating and depressing of the tine-frame is accomplished by a very beautiful combination of parts. When the tine-frame is to be raised, the winch-handle *m* is turned, by a sufficient number of revolutions of the screw *l*; and by reversing the motion of the winch-handle *m*, the frame is lowered—and these movements will be made with perfect accuracy, preserving to the tine-frame a correctly horizontal position at any height within the range of its lift. An index is attached to the main axle as seen at *p*, which is divided in the proportion of inches in depth of the penetration of the tines; but this is one of its least important points.

2422. The weight of the cast-iron grubbers may be averaged at 10 cwt., and their price at £15.

2423. The action of any of these grubbers in the soil is to stir it effectually as deep as their tines descend, and at the same time retain the surface soil in its existing position—an operation which bestows the softness of a ploughed surface, whilst it preserves the original upper surface dry, which the plough cannot do. This advantage is especially appreciated in early spring, when it is precarious to turn over the soil with the plough; and should rain follow, the land would be easily made much wetter, and worse to work with any succeeding implement, than if it had not been ploughed at all.

2424. Should the circumstances be unfavourable—that is, the time limited, the land raw and not very clean, and the weather precarious—the grubber will put the land into a state for harrowing, of which it should receive at least one double tine along the ridges, the grubbing having been given across them; and, should this not be sufficient to reduce the clod to a moderate size, another double tine should be given across the ridges, when the land will be ready to be ploughed for the seed.

2425. Should circumstances be in the most favourable state—that is, with plenty of time, with the soil suited to the crop, the land clean and dry, and the weather fair—instead of using the grubber, the land should be ploughed, and in the reverse order in which it had been ploughed in autumn. It should then be harrowed a double tine along the ridges, and a double tine across them, when it will be ready to be ploughed for the seed.

2426. In one of these two states the soil will be found in the spring; and after the above treatment, according to the state of the soil, the ploughing is conducted on the determination whether the land is to be manured or not, and whether the seed is to be sown in drills or broad-cast.

2427. If the seed is to be sown *broadcast without manure*, a ploughing is requisite in spring—a grubbing will not suffice—and the furrow should be the opposite of the one ploughed in autumn.

2428. If the seed is to be sown in *rows on the flat*, a ploughing is also requisite, and the furrow should also be the reverse of that ploughed in autumn.

2429. If to be sown in *drills*, each drill should be formed in the single way (2388,) when the land is nearly in a clean and tolerably friable state; but if somewhat foul and waxy, the drills should be formed double (2397.)

2430. If the seed is to be sown *broadcast*, *with manure*, the manure may be spread upon the stubble and ploughed in, in autumn, which will much expedite the labour in spring. In that case ploughing is requisite in spring, and the furrow should be the reverse of that given in autumn. The manure, however, can be applied in spring, and should be so upon the surface, formed by the ploughing in autumn, preceded by a double harrowing should the surface still be rough and cloddy, and after being ploughed the land will be ready for the seed.

2431. If the seed is to be sown in *rows on the flat*, the manure may be also conveniently spread upon the stubble and ploughed down in autumn; and the furrow given in spring should be in the reverse order it was ploughed in autumn, when the surface will be ready for the seed.

2432. Though the seed be sown in *drills*, the manure may still be spread broadcast upon the stubble, and ploughed down in autumn, and, on the land being double drilled in spring, it will be ready for the seed. But should the manure be applied in spring, the drills should be of the single form (2388,) in the first instance, the manure deposited in them, and then covered with the double drill (2397,) when they will be ready for the seed.

2433. As this last method is the one in which I think the bean ought always to be sown, I shall describe the remainder of the operation more in detail. On the supposition that the manure is to be applied in the spring, it is taken either from a dunghill, into which the dung has been wheeled, and not trampled down, such as is mentioned in (2013,) or from the dung-shed in the field in which the beans are to be sown, into which it had been wheeled when taken from one of the courts in the course of winter, and forked up into a dunghill without being trampled. Having been brought out in winter, when little fermentation goes on, and being applied only in spring, the dung will be in a good state for spreading on the bean land. On the land being drilled up in the single form, as directed above, the dung is taken by the tilt cart, fig. 175, along the drills, the horse occupying the centre hollow of three drills, and each wheel going into the hollow of the drill on each side. The horses are led from the dunghill by field-workers, while the ploughmen remain at the dunghill filling the carts. The steward takes off the back board of the cart, and slips it on edge upon the nave of the wheel, to carry it, and keeps it there by putting the pin which fastens it usually into the slit of the stud ordinarily occupied by the pins. He then tilts the cart-body a little up in front, which depresses the hinder part as much; and taking the dung-drag, fig. 217—which is 5 feet long, and may have two or three prongs—he pulls out a small heap of dung into the hollow of the centre drill, and so on, heap after heap, until the cart is emptied, the horse being led along the drill by the field-worker who drives him. The moment the heap of dung is pulled out of the cart, and the horse has advanced a few steps, a field-worker divides the heap into three, putting an equal portion into the hollow of each drill on each side of the heap, with a small graip like fig. 82; and then 3 field-workers follow, one in each hollow, having each a small three-pronged graip, fig. 218, which is $3\frac{1}{2}$ feet long, by which she divides the heap left by the preceding field-worker, and spreads it along the drill until it reaches the next heap dragged out by the steward, who is the sole judge of the quantity of manure to be applied.

Fig. 217.

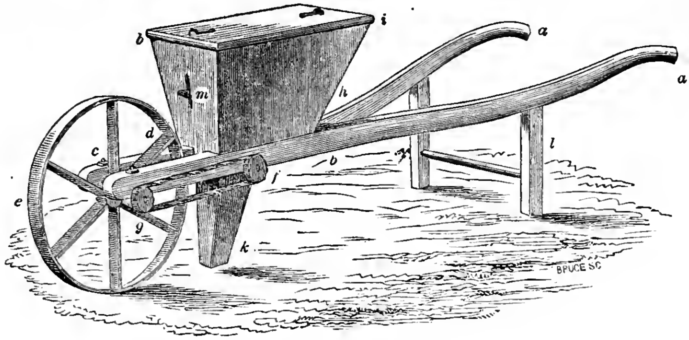
THE DUNG-DRAG.

Fig. 218.

THE THREE PRONGED DUNG GRAIP.

2434. Immediately that three drills are thus manured by the cart, and spread by the field-workers, a man wheels along the top of the dung in each hollow, the *bean drill* or *bean-barrow*, and sows the seed with it. The bean-barrow is one of the simplest in its construction. It is made in a form resembling a wheel-barrow, and hence its name. Fig. 219 is a view in perspective of the machine in its most common form; *a a b c* are a pair of stilts, that, when joined to form the bed-frame of the barrow, has the portion from *b* to *c* parallel; while the parts from *b* to *a* spread out to form the handles of the barrow. The portion from *c* to *d* is open for the reception of the wheel *e*. A small axle carries a small chain-wheel *f*. The principal wheel *e* also carries a chain-wheel *g* upon its axle, and the pitch-chain *f g* is stretched over the two wheels, by which means the progressive motion of the machine on the wheel *e* gives motion to the seed-cylinder on the axle of *f*. A seed-chest *b d h i* is raised upon the bed-frame, and is sometimes covered with a jointed lid, but this is not essential. A spout *k*, is attached to the bed-frame, for the purpose of directing the seed to the furrow in which the machine is moving; and the legs *l l* are attached to the handles to prevent the latter from falling to the ground when the barrow is stopt. The pinching-screw *m* is applied to the purpose of adjusting a slider placed within the chest, for the more correct graduation of the discharge; and the slider is for this purpose armed with a tuft or brush of bristles, that comes in contact with the

Fig. 219.



THE BEAN DRILL OR BARROW.

seed cylinder. The entire fabric is generally of very slender and light construction.

2435. Besides the method here exhibited, of driving the seed-cylinder by means of a pitch-chain, there are other modes of effecting the same purpose. One of these is by attaching short cranks to each end of the axles of the principal wheel and the seed-cylinder, the pair on each axle standing at right angles to each other; and a light connecting-rod passes from the one to the other on each side of the machine. This forms a very perfect communication of the motion from the principal to the minor axle, and is very certain in its operation, but it is more expensive than the pitch-chain. The same is also effected by employing two pairs of small mitre-wheels; but it is equally expensive as the cranks and connecting-rods. Common chain may also be adopted, along with acutely grooved pulleys; but the action of this is less certain than either of the others.

2436. On the seed being sown, the ploughs split the drills formerly made into two, covering the dung with their mould, and finishing the work with the drills in the double form.

2437. When it is determined to manure the land in spring, and sow the seed in rows in the flat, the harrows are first sent over the surface a double tine if it is rough and cloddy, and has not been reduced by the winter's frost, and then the dung is spread broadcast upon the surface. The dung of course has been prepared in the same manner as related for that used in drills. The dung is ploughed in; but as the largest and rankest portions of the dung may not be easily buried by the plough, it is proper to make a field-worker follow each plough, and press down the prominent portions of the dung into the plough-track with the small graip, fig. 218. At every *third* furrow, a man sows the seed along it with the bean-barrow, fig. 219; and the most convenient and expeditious mode to keep the barrow at work in sowing, is to cause *three* ploughs to go before it, one following the other at a short distance, and turn over the three furrows; and as the furrows are about 9 inches in breadth, the three furrows will place the rows of beans at 27 inches apart. This ploughing finishes the operation.

2438. An apparatus for sowing beans in drill is attached to one of the ploughs employed in giving the seed-furrow. It consists of a seed-cylinder, placed in a small case or frame, having an axle passing through the case, which last is surmounted by a small hopper to contain the seed. This apparatus is attached to the plough immediately behind and within the line of the mould-board—in the *bosom* of the plough, as it is termed—having a conductor or spout, from the seed-cylinder to the bottom of the furrow, to conduct the seed to its bed. The motion of the seed-cylinder for the delivery of the seed, is produced in two different ways; first, the axle of the cylinder may be extended from the case to the land-side handle of the plough, or tail of the beam, where it will have a bearing in which it turns round. Upon this extension of the axle, a light iron loop or shears is loosely fitted, and in the shears is placed an iron wheel, whose axle is borne at both ends by the shears. A grooved pulley is fixed upon the end of this axle, and a corresponding pulley upon the prolongation of the axle of the seed-cylinder, while a chain or band encircles the two pulleys. The iron wheel, which is so placed as to run in the bottom of the furrow, will thus, when the plough is in motion, be made to revolve by its contact with the ground, and, through the pulleys and chain, will also cause the seed-cylinder to revolve and discharge the seed as the plough advances; and this will continue as long as the iron wheel remains in contact with the ground. In order to produce a cessation of the sowing process, when required, a cord is attached to the hind extremity of the shears, and is passed backward between the handles of the plough, till it comes within reach of the ploughman, who, by pulling the cord, and hooking it upon a stud provided for that purpose, raises the iron wheel from the ground, and thus stops further motion of the seed-cylinder, and consequently the sowing process. When the plough has again reached the third furrow from the last sown—and this plough should be the hindmost of the three mentioned above—the ploughman relaxes the cord, when the wheel again settles down upon the ground, and the sowing process proceeds as before.

2439. The other method of giving motion to the seed-cylinder is accomplished by giving the extension of its axle a universal joint, and continuing the extension a few inches to landward of the land-side of the plough, but without a bearing upon it. Upon this extremity of the extended axle the iron wheel is placed, which in this case will be required of larger diameter, so that the axle may run clear of the tail of the plough-beam. By this arrangement the wheel will run upon the unbroken land. It will also require a stay of rope, or of light iron rod, extending from a collar upon the axle, forward to an eye-bolt attached to the side of the beam, near the coulter-box. From the collar on the axle also a cord extends backward to the hand of the ploughman, whereby he has the same command over the wheel in this position for setting on and off the sowing process, as just described for the first method—the universal joint in the shaft serving in the present case the same purpose as the shears in the former.

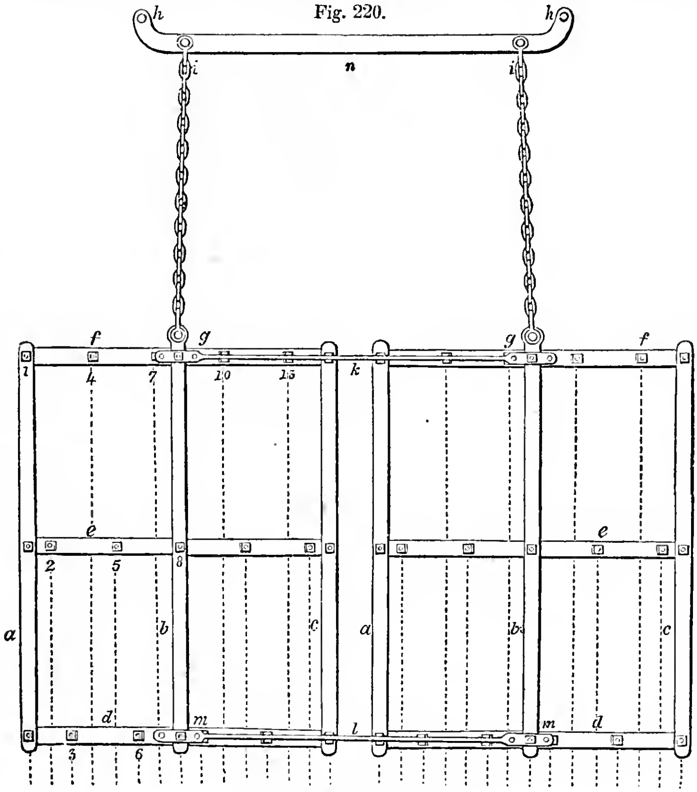
2440. When the land is to be manured in the spring and the seed sown broadcast, the dung is prepared as in the two modes formerly mentioned, and spread broadcast upon the surface, the future part of the operation depending on the state of the weather. Should the weather promise to be fair until the bean-sowing is finished, the dung may be ploughed in, a field-worker burying the prominent portions with the small graip as described above, the seed sown upon the ploughed surface, harrowed in with a double tine, and the ridges water-furrowed. Should the weather seem precarious, which is its ordinary state in spring in this country, the safest plan is to sow the seed broadcast upon the spread dung, and plough in both seed and dung together, when the surface will be safe from further danger.

2441. The ordinary sort of bean cultivated in the fields is the horse bean, shown by fig. 189. I have seen a small white bean, called the Heligoland, tried in the fields, and it might answer as to yield in favourable seasons; but the straw is deficient compared with that of the horse bean, which is an important consideration in a crop whose fodder is valuable, and the yield of whose grain is precarious.

2442. The quantity of beans usually sown is 5 bushels per acre. On inferior soils a little more is allowed, say 6 bushels; and it is considered that the broadcast mode of culture requires more seed than the drill system.

2443. I have said that as the drills, when made up in the double form, are necessarily unequal in their sides (2400.) the germ of the young bean plant would find its way to the air through the upper part of the side of the drill instead of the top, were it not relieved by removing that portion of the mould which causes the inequality in the drill, and this is done by the harrow, which should be made to pass over the drills a single or a double tine, according as the ground is in a rough or smooth state. About a fortnight after the sowing is a good time for harrowing the drills, if the surface is at all dry; and if wet, it should be delayed for a few days, and the first period of a dry state of the surface taken advantage of. The common harrow, fig. 207, is what is best suited for harrowing the ground that has been ploughed flat with a common furrow, whether the seed be sown in rows or broadcast, and it is even used for harrowing down drills; but a better implement for harrowing drills is the *drill-harrow*, of which fig. 220 is a geometrical plan of one of the rectangular form. This harrow is always worked in pairs; and, to render it applicable to its intended purpose, it is made of an arch form, partially embracing the curvature of the drill; and on this account it is best fabricated of iron. The two leaves of the pair *a a* are connected by two coupling-rods *k l*, which are formed to expand or contract to any required width of drills; and each leaf is furnished with a chain *i i* to which a draught-bar or swing-tree *n* is attached, and to which, again, the horse is yoked at *h h*. The bar and chain, in this mode of yoking, serve, by their weight, to produce such a catenarian curvature as to make the vertical line of traction leave the harrows nearly in a horizontal line, giving them thus the fullest effect on the drill.

Fig. 220.

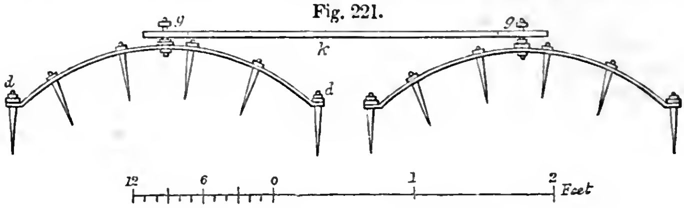


THE DRILL-HARROW.

2444. The harrows are 26 inches from centre to centre of the outside bars or bulls, the length 33 inches, and the number of tines 15: they will draw streaks on the surface at equal distances of $1\frac{7}{8}$ inch nearly. The middle bull *e* of each harrow is prolonged a little forward at *g*, for the attachment of the shackle of the draught-chain. The tines are about 4 inches in length below the bars, and tapering to a blunt point. The pair of harrows are drawn by one horse, walking between the drills; the weight of the pair, with the mounting, is about 90 lbs., and the price from 30s. to 35s. complete.

2445. Fig. 221 shows a cross section, at the front bar, of both the leaves of the harrow, of the arched form and direction of the tines, and the adaptation of their form to the drills. In the front bar *gg*, the right hand tine may be left out, as its place may be taken up by that of the third bar, leaving 5 tines. In the second cross-bar there are also 5 tines, and in the third, 5. The two leaves are connected and kept at due distance by the coupling-rods *k*, which may be placed wider or closer if thought necessary. This construction of the coupling-rods affords the means of adapting the harrows to any width of drills.

Fig. 221.



THE SECTION OF THE DRILL-HARROW.

2446. *Triangular drill-harrows* are considered by some farmers as superior in effect to the rectangular form; with due attention to the division and placement of the tines, they may no doubt be rendered equally effective, and probably more so, but the advantages are not prominently marked.

2447. When land intended for beans is foul, it should certainly not be dunged in autumn, unless there is time to work and clear it with two ploughings and harrowings. Land not well suited for beans, and unable to be dunged in autumn, on account of its state of foulness, or in spring by reason of wet weather, should not be sown with beans for that season.

2448. Cross-ploughing before winter is approved of by some, as a preparation of the land for beans, under certain circumstances. Thus the late Mr Brown, Markle, East-Lothian, after intimating that the first furrow in early winter, for beans, should be a deep one, proceeds to say that "the first furrow is *usually* given *across* the field, which is the *best* method when only one spring furrow is intended; but as it is now ascertained that two spring-furrows are highly advantageous, *perhaps the one in winter* ought to be given in length;" and Professor Low's opinion bears a similar meaning, on light land, when he says, "When the bean is to be sown in spring after a corn-crop, the land should receive a deep ploughing before winter, generally in the direction of the former ridges, so as to keep the land dry. Sometimes, in case of dry land, the *ploughing may be across the ridges;* and then the plough, passing along the former open furrows, is to form new open furrows in the same place. In either case, care is to be taken to prevent the stagnating of water on any part of the surface."* I would deprecate the permitting any sort of land to lie in the cross-furrow all winter, and especially that of such a character as might bear a crop of beans. Having little fear of the consequences, I cross-ploughed a field of 25 acres of hazel loam, resting on a moderately retentive clay subsoil, immediately after harvest, with the view to ridge up the land again before the winter, and to forward the spring-work for the potatoes and turnips, for both of which crops the soil was well adapted. But the weather completely changed, and, instead of being ridged up, the land was only water-furrowed in the open furrow of every ridge, and gaws cut where requisite, in the hope that it would lie in a safe state all winter. In this, however, I was mistaken; it worked very unkindly for the potatoes and turnips, and it never forgot, during the whole course of the rotation, the souring it had received in the cross-furrow; and yet the land was of so pleasant and light a character that I should never have thought of sowing beans upon it.

2449. I cannot agree with Mr Brown, when he recommends sowing beans in every third furrow, instead of in drills, when the season is unfavourable, because, if land cannot be drilled, neither should it be ploughed, nor will it become so soon dry after common ploughing as after drilling. Nor do I agree with him that inconve-

* Low's *Elements of Practical Agriculture*, second edition, p. 267.

niences must be submitted to in adverse seasons, because I would change my mode of culture to suit the season.* Instead of practising questionable modes of culture, after the land had received a good furrow before winter, I would decline harrowing, and immediately drill it in spring with even one horse, which would be quite able to make such a drill as would cover the beans sown by the barrow; and both land and seed might remain in this state for some time without harm. This plan possesses the farther advantage of being in time even after the oat-seed is finished, as the land will require no harrowing to lighten the earth upon the seed, which is no more than covered; and the seed, being so situate, will vegetate 14 days earlier than if it had been ploughed with the ordinary furrow. When dry weather ensues, the land may be worked to advantage, while the crop is growing. Such an expedient may be adopted on land suitable for beans and in clean condition, rather than the crop should be mistimed.

2450. It was an observation of the late De Candolle, that "it is remarkable that the botanical character of the *Leguminosæ* should so strictly agree with the properties of their seeds. The latter may be divided into two sections, namely, the first *Sarcolobæ*, or those of which the cotyledons are thick, and filled with fecula, and destitute of cortical pores, and which, moreover, in germination do not undergo any change, but nourish the young plant by means of that supply of food which they already contain; second, the *Phyllolobæ*, or those of which the cotyledons are thin, with very little fecula, and furnished with cortical pores, which change at once into leaves at the time of germination, for the purpose of elaborating food for the young plant. All the seeds of the *sarcolobæ* are used as food in different countries, and none of those of *phyllolobæ* are ever so employed."

2451. The ancient Greeks had some strange notions regarding the properties of the bean. Thus Didymus the Alexandrian says, "Do not plant beans near the roots of a tree, lest the tree be dried. That they may boil well, sprinkle water with nitre over them. Physicians, indeed, say that beans make the persons that eat them heavy; they also think that they prevent night dreams, for they are flatulent. They likewise say, that domestic fowls that always eat them become barren. Pythagoras also says that you must not eat beans, because there are found in the flower of the plant inauspicious letters. They also say that a bean that has been eroded becomes whole again at the increase of the moon: that it will by no means be boiled in salt water, nor, consequently, in sea-water," &c.†

ON THE SOWING OF PEASE.

2452. Pease are sown to a much less extent than they were some years ago, the change being effected partly from pea-meal having become less an article of food of the labouring population, and partly from a nicer sense of cleanly culture entertained by our farmers. It is a matter of general observation, that annual weeds are much encouraged in growth amongst pease; and the pea being a precarious crop, yielding a small return of grain, except in fine warm seasons, the mere circumstance of a good crop of straw is insufficient to afford remuneration for a scanty crop of grain, accompanied with a foul state of land. Hence turnips have been generally substituted for the pea.

2453. The pea, for a long period, was only sown broadcast; but seeing their tendency to protect weeds, and observing that drill-culture rendered the land clean, it was conjectured that pease sown in drills would admit of the land being cleansed in the intervals. In practice, however, it was found that the straw by its rapid growth soon creeps along the ground, and prevents the use of the weeding instruments.

2454. But the more common practice now is to sow pease and beans together, their seasons of growth coinciding. The stems of the bean serve as stakes to support the bines of the pea. The proportion the pea bears to the bean when thus mixed, is as 1 to 3, or sometimes only as many pease are sown as their straw shall serve to make bands to bind the beans in sheaves at harvest.

2455. It is somehow considered of little moment how the land shall be ploughed when the pea is to be sown by itself. Sometimes only one furrow after the stubble is given; and when the land is tender, and pretty clean, a sufficient tilth may be raised in this manner to cover the seed, which requires neither a deep soil for its roots, which are fibrous and spreading near the surface, nor a deep covering of earth above them, 2 inches sufficing for the purpose. But the single furrow does no justice to the land, whatever it may do for the crop. The land should certainly receive one furrow at least in spring, after

* Brown *On Rural Affairs*, vol. ii. p. 57-59.

† Owen's *Geoponika*, vol. i. p. 82.

the winter furrow; and that furrow may either be a double drilling or an ordinary furrow, according to the móde of culture adopted, or it should receive at least a close grubbing.

2456. Pease are sown by hand when cultivated broadcast, and with the barrow when in rows, in every third, or more commonly in every furrow. When sown with beans, they are deposited by a barrow; when sown on drilled land by the hand, the seed falls to the bottom of the drills, and is covered by the harrows being made to pass across the drills.

2457. Like beans, pease are sown on ploughed lea in some parts of England. In Scotland, the farmers know their interest better than to bestow good grass land, which will yield a luxuriant crop of oats, on so generally thriftless a crop as the field-pea. On lea, the pea is dibbled in on the face of a flat lea furrow-slice, the holes being placed about 9 inches asunder. When varieties of the white pea are cultivated in the field, as in the southern counties of England, these various modes of sowing them by themselves may deserve attention; and also in the neighbourhood of large towns, where the garden pea may be cultivated in the field, and sent in a green state to the vegetable market; but in other respects they are inferior to raising them in company with the bean.

2458. Since the pea can be cultivated along with the bean, it can grow on strong soils; and its spreading roots enable it to grow on thin clays, where the bean does not thrive. The pea thrives best on light soils. In clay, it produces large bulk of straw, and the production of grain depends on the season being dry and warm; and as these are not the usual characteristics of our climate, the probability agrees with the fact that the pea yields but an indifferent crop. On light soils, its straw being scanty, though the yield of grain is large in proportion, it is not usually prolific. Sir John Sinclair states that the pea does not yield a crop above once in ten years.*

2459. Dung is never given to the pea when sown by itself, it having the effect of producing much straw and little grain.

2460. Of the varieties of the field-pea I have shown one, the partridge gray pea, in fig. 190. It is suited to light soils, and late situations, and is considered of excellent quality, and prolific when the crop is full. It is superseding the gray Hastings, which were sown in similar circumstances. The pea least adapted to clay soils, and late in ripening, is the common gray pea, which, taking the same time to ripen its seed as the bean, is suited to sow with the bean, when both sorts of grain are cultivated together. Its haulm is considered excellent fodder, better than that of the early varieties.

2461. Pease are sown thick, 4 bushels per acre being the common allowance when sown in rows and drills, and 4½ bushels when sown broadcast.

2462. When pease and beans are reaped together, they are separated when thrashed simply by riddling, the peas passing through the meshes of the riddle, while the beans are left on the riddle.

2463. Many varieties of the garden pea are cultivated in the field in the neighbourhood of large towns, for the supply of the vegetable market. This species of culture is chiefly conducted in the neighbourhood of London, and in the counties of Middlesex, Kent, and Suffolk. The early Charlton pea has long been in cultivation and is prolific. The pearl, and blue and white Prussian pease are very prolific. The Carolina, blue scimitar, and blue and green tall and dwarf imperial are also good. It is a pity that the Dantzig pea yields so poorly in this country, for a more beautifully round, small, bright yellow coloured, transparent pea cannot be imagined. It is imported, however, for splitting and boiling whole.

ON THE SOWING OF TARES.

2464. As it is very desirable to have tares ready for cutting as a forage crop for horses in the time of harvest, and as

* Sinclair's *Code of Agriculture*, p. 384.

harvest may be early in any season, it is prudent to sow early a small extent of ground with tares; and although the harvest may be delayed longer than expected, and it continue longer than will allow the horses to enjoy the tares before they have become too old, the crop will nevertheless not be lost, as the pigs will be delighted to eat them, when confined in the courts before and during the harvest.

2465. For this reason, tares should be sown as early as the beginning of March, and successive sowings should take place until May, when the crop will continue until the commencement of the consumption of the turnip. In doing this, it should be borne in mind, that the periods of cutting will approach nearer each other, as the sowings approach the summer; so that the farther the season advances, the greater intervals of time should elapse between the sowings, and the larger the space of ground sown at each time.

2466. Tares thrive admirably well on all kinds of soils, and on ploughed lea without even manure; but, in this case, it should be remembered that it displaces an equal extent of the oat crop—an undesirable competition, if carried to the extent of several acres.

2467. They will also grow well upon the unoccupied ground or fallow break, but not without manure. The manure may be spread upon and ploughed down with the stubble in autumn; but if the manuring is delayed till the spring, the culture is precisely that of the pea when sown broadcast.

2468. Tares are almost always sown broadcast; and as the plant, when growing healthily, is succulent and unable to support itself, a few oats are mixed with the seed, whose stems serve to support the bines of the tare. The Hopetoun oat is the best for this purpose, as possessing the strongest stem; and next to it is the potato oat. Wheat could support the tare better than even the oat; but stock dislike wheat when mown as forage, so that the plant would be wasted, whereas the oat plant is a pleasant forage.

2469. From 1½ to 2 bushels of tares and 1 bushel of oats per acre will suffice for seed when the land is good, and has been well manured; but on a light soil, though manured, from 2 to 2½ bushels per acre will be required of the tare, the plant not growing there so rank and strong. When sown alone, which some farmers prefer, from 3 to 4 bushels of seed will be required per acre. I have seen a large proportion of a crop of tares destroyed by rotting on the ground, when too thickly sown, in a season that happened to be moist and warm; and therefore a sprinkling of oats sown amongst them is a wise precaution to support the crop and prevent the rotting.

2470. Tares are cultivated for *seed* as well as forage, and the culture, as far as the soil is concerned, is quite the same. It is recommended to sow beans amongst tares intended for seed, to afford them support in climbing; and the proportion the beans should bear to the tares is as 1 to 4 of measure of the seed. Tares for seed are also cultivated with the bean, sowing the tares in the proportion of 1 to 4 of beans in measure. The tares are easily separated from the beans by riddling. Tares intended for seed should be sown as *early* in spring as the state of the land will permit the work to proceed. Both the pigeon and poultry are fond of the seed of the tare.

2471. The tare belongs to the natural order of *Leguminosæ*, of the system of Jussieu; the order and class *Diadelphia Decandria* of Linnæus; and in sub-class iii. *Perigynous Exogens*; alliance 42, *Rosales*; order 209, *Fabiaceæ*; tribe 3, *Vicia* of the natural system of Lindley. The cultivated tare or vetch is named *Vicia sativa*. In the wild state it is a native of Europe, in corn or cultivated fields; plentiful in Britain; also in North America, about Fort Vancouver. Flower purple. This is a very variable plant in the form of the leaflets, in the size of the stems, and in the colour and size of the seeds. The *Vicia Narbonensis*, Narbonne vetch, and the *Vicia serratifolia*, serrate-leafleted vetch, are cultivated on the Continent. Dr Anderson has recommended the culture of the *Vicia sepium*, hedge-vetch; and a writer in the Bath Papers advocates that of the *Vicia cracca*, tufted vetch. All these are eminently beautiful native plants, but are too tiny in the leaf and attenuated in the stem to render them probably profitable in cultivation. There are 108 described species of *Vicia*—a name said to be derived from *vincio*, to bind together, because the species have tendrils by which they bind themselves to other plants.

2472. The white-flowered or Hopetoun tare, *Vicia sativa, flore albo,* is a variety of tare which "bids fair," as Mr Lawson says, "in a short time to supersede the old summer tare. It was selected from a field a few seasons since by Mr Patrick Sheriff, late of Mungoswells, East-Lothian, the originator of the Hopetoun oat, and several other improved varieties of cereal grains, who, in the beginning of winter 1838, kindly sent to the Highland and Agricultural Society's Museum about 12 seeds of this new vetch, several of which were sown the following spring; and the produce, both in seeds and bulk of haulm, compared with any of the other varieties which were grown alongside, was fully double. Its seeds are of a light bluish or green colour, and possess little of the strong taste peculiar to the common tare; so that, in addition to its other properties, these may become at least useful with the white-seeded variety, or Canadian lentil, for culinary purposes." *

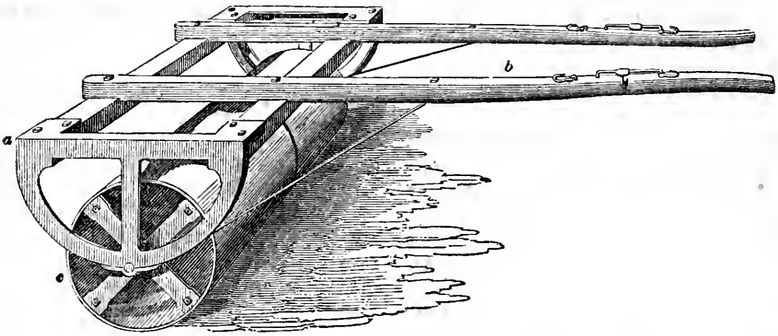
ON THE ROLLING OF LAND.

2473. The common *land-roller* is an implement of great simplicity of construction, the acting part of it being a cylinder of wood, of stone, or of metal. Simple as this implement appears, there is hardly an article of the farm in which the farmer is more liable to fall into error in its selection. From the nature of its action, and its intended effects on the soil, there are two elements that should be particularly kept in view—*weight* and *diameter* of the cylinder. By the former alone can the desired effects be produced in the highest degree, but these will be always modified by the diameter. Thus, a cylinder of any given weight will produce a greater pulverising effect if its diameter is one foot, than the same weight would produce if the diameter were two feet; but then the one of lesser diameter will be much worse to draw; hence it becomes necessary to choose a mean of these opposing principles. In doing this, the material of the cylinder comes to be considered. Wood, which is frequently employed for the formation of land-rollers, may be considered as least adapted of all materials for the purpose; its deficiency of weight and liability to decay renders it the most objectionable of all others. Stone, though not deficient in weight, possesses one marked disadvantage, liability to fracture; this of itself is sufficient to place stone rollers in a doubtful position as to fitness. This brings us to cast-iron, which is undoubtedly the most appropriate of all materials for this purpose. It is unnecessary here to enter into the inquiry as to the most advantageous diameter for a land-roller; the subject has already been elaborately discussed: † let it suffice to say, that experience has proved that a diameter of 2 feet is, under any circumstances, the one that will produce the best effects with a minimum of labour from the animals of draught; the weight being of course proportioned to the force usually applied, which is in general 2 horses. The weight of roller, including the frame corresponding to this, is from 12 to 15 cwt.; but it is better that the roller itself be rather under the weight, and that the carriage be fitted up with a box, in which a loading of stones can be stowed, to bring the machine up to any desired weight. Such a box is besides useful in affording the means of carrying off from the surface of the ground any large stones that may have been brought to the surface by the previous operations. In a large and heavy roller, in one entire cylinder, the inconvenience of turning at the headlands is very considerable, and has given rise to the improvement of having the cylinder in two lengths; this, with a properly constructed carriage, produces the land-roller in its most perfect form.

2474. Fig. 222 is a perspective of the land-roller constructed on the foregoing principles: *a* is the carriage-frame, crossed by the horse-shafts *b*. The cylinder *c* is in 2 lengths of 3 feet to 3 feet 3 inches each, and 2 feet in diameter; the thickness of the metal is according to the weight required. The axle, in consequence of the cylinder being in two lengths, requires to be of considerable strength, and of malleable iron; upon this the two sections of the cylinder revolve freely, and the extremities of the axle are supported in bushes in the semicircular end-frames. Two iron stay-rods pass from the end frames to the shafts as an additional support to the latter. The price of the land-roller, fitted up as here represented and described, is, according to weight, from £10 to £14.

* Lawson's *Agriculturist's Manual*, Supplement, p. 48.
† *Quarterly Journal of Agriculture*, vol. i. p. 700.

Fig. 222.



THE LAND-ROLLER.

2475. In using the roller, the 2 horses are yoked in the same manner as in the double horse-cart, shown in Plate III. The rolling is always effected across the line of ridges, for otherwise the open furrows would not receive any benefit from it. Although the dividing of the cylinder into two parts facilitates the turning of the implement, it is not advisable to attempt to turn the roller sharp round, as part of the ground turned upon will be rubbed hard by the cylinders; and where young plants grow upon those parts, such as young clover, the probable effect would be to kill them. The rolling is executed in feers of 30 yards in width, *hieing* the horses one half of the feering, and *hupping* them in the other half, the same as in ploughing ridges, two-out-and-two-in, fig. 25. It is not necessary to carry the feering-poles to the field for making these feerings; the first line of the feering being easily kept straight across the field by placing clods or stones in the line. When the ploughman becomes fatigued in walking, it is quite allowable for him to sit on the front of the framing, for which purpose a space to sit upon is either boarded or wrought into a seat with hard-twined straw-rope, and thence drive the horses with double reins and whip. With such an indulgence a frail ploughman, employed mostly in ploughing, could take a day or more at rolling, when urgent work was employing at the time the stronger horses in the cart. Were a 6-feet roller to proceed uninterruptedly for 10 hours, at the rate of $2\frac{1}{2}$ miles per hour, it would roll about 18 acres a-day; but what with the time spent in the turnings and the markings-off of feerings, 14 acres a-day may be considered a good day's work—7 acres at each yoking. When the weather is favourable, and a large extent of ground has to be rolled, it is a good plan to appoint 2 pair of horses to work the roller, from dawn to night-fall, each pair working 4 hours at a time. In this way, 16 hours' constant rolling, from 4 in the morning to 8 at night, may be obtained in the course of 24 hours, and $33\frac{1}{2}$ acres rolled within the day with one roller. This roller is an instrument used not so much to crush clods as to render the surface of the ground smooth; at least it effects the latter purpose much better than the former, which is best executed by a class of implements named clod-crushers, to be afterwards described; and the roller should only be used when the surface of the ground is dry.

ON THE TRANSPLANTING OF TURNIP BULBS FOR PRODUCING SEED.

2476. It is quite easy for every farmer to raise as much turnip-seed every year as to serve the wants of his farm.

2477. As 3 lbs. per acre is the most that is required for seed to sow a crop of turnips, and as 30 bushels the acre is a very moderate crop of turnip-seed, at the weight of 50 lbs. the bushel, the small space of 10 square yards of ground will supply all the seed required for every acre of turnips grown on the farm. It is necessary to keep the plants producing the different sorts of turnips at a considerable distance from each other; because, if planted near, it is not only quite possible, but highly probable, that one variety will be impregnated by another; bees and other insects carrying the pollen of the flower of one variety to the flowers of the others.

2478. Let a piece of ground be selected for each of one or more varieties of seed to be raised—and spare spaces and corners of ground exist on most farms, which may be converted into nurseries for such a purpose:—let the ground receive a little dung; and the best mode of procuring a friable mould upon it is to turn it over with the spade, bringing off the stones and weeds that may be found in it.

2479. Then select the best-formed bulbs of the different kinds, such as those in fig. 38, one kind after another, in the fields in which they are growing: take them up carefully, preserving the roots and fibres in the bulbs as entire as possible, and removing the shaw nearly close to the bulb. On carrying each kind to its respective piece of ground, a trench is made in a line, deep enough to contain the bulb with its root. The bulbs are inserted at 12 inches apart, and as deep as to leave their tops only above the ground, when the earth has been returned into the trench. It is generally recommended to place the rows of the plants at 1½ foot asunder, but I should say 3 feet asunder, not only for the sake of obtaining as much air as possible for the plants, but for the purpose of affording room to a person to pass between the rows to watch the seed, when it is near ripe, from the depredation of small birds, which are very fond of turnip-seed. More space will of course be required for the rows placed thus wide apart, but the plants will be stronger, and they will be the better guarded against the birds, which will drop amongst the plants within a yard of the person watching them.

2480. The best time for transplanting turnips is about the beginning of March, before symptoms of spring growth appear in them.

2481. In large and more open pieces of ground, such as a part of the fallow field, the plough may be employed not only to turn over the ground, but to form the trenches for the transplanting, and the harrow may also be employed for reducing the ground into a mould.

2482. This mode of transplanting the bulb takes a part of the crop of turnips from the animals; and on this account, were it desired to raise turnip-seed on a large scale, it is evident that it could not be done but at the cost of a large proportion of the growing crop. In such a case it is quite possible to raise the seed from seeds instead of bulbs, and this method will be described in its proper season.

2483. It may be proper to caution the young farmer that the ground thus occupied for raising turnip-seed should be protected by a fence against stock, otherwise the crop will suffer severely.

ON THE SOWING OF OATS.

2484. Ploughed lea ground is always sown with oats in Scotland, except where spring wheat and tares may be sown to a limited extent; though in England, wheat, whether in the autumn or spring, is very frequently sown upon it. Besides on lea, oats are sown in Scotland, in the more elevated districts, on land after turnips, in lieu of barley.

2485. After what has been said of ploughing lea ground (780;) of the mode of sowing seed by the hand, fig. 202, and by machines, fig. 204; of the properties of different kinds of oats cultivated in this country (1925, &c.,) little requires to be added here on the sowing of oats, but only on the manner in which that operation is *finished*.

2486. Beans and spring wheat are not sown upon every species of farm; the former being most profitable in deep strong soils, and the latter is only to be commended after turnips, eaten off by sheep, on land in good heart, situate in a favourable locality for climate;—but oats are sown on all sorts of farms, from the strongest clay to the lightest sand, and from the highest point to which arable culture has reached on moorland soil, to the bottom of the lowest valley on the richest deposit. The extensive breadth of its culture does not, however, imply that the oat is naturally suited to all soils and situations, for its fibrous and spreading roots indicate a predilection for friable soils; but its general use as food among the agricultural population, and its ability to support the strength of horses, have induced its universal culture in Scotland; and it is a remarkable fact, that this plant has adapted itself admirably to the various circumstances in which it is cultivated, most probably owing to its receiving its favourite food everywhere, namely, the decomposed grasses which enrich the soils it grows upon.

2487. All the varieties of oats cultivated may be practically classed under three heads, the *common*, the *improved*, and the *Tartarian*. The common varieties include all those having a pyramidal spike, soft straw, elongated grains possessing a tendency to become awny, and late in reaching maturity. Among the *named* varieties are the following in common use —early and late *Angus*, *Kildrummie*, *Blainslie*, white *Siberian*, fig. 184, *Cumberland*, *sandy*, and *Dyock*, (which two last are recent varieties,) and others. It is unnecessary to point out the characteristics of each variety, as, in the respective districts in which they are sown, each is considered best suited to the locality in which it is cultivated,—an opinion which may safely be disputed. The four last named are in high repute at present, owing to their recent introduction; and it is probable that every recent variety will answer best for a shorter or longer period. All common oats are sown on the inferior soils, and in the most elevated fields of farms, and the best season for sowing them is the beginning of March.

2488. Of the improved varieties, the *potato oat* was long cultivated as the only one, fig. 183; but, of late years, the *Hopetoun oat* has been added to the list. Before it, the *Georgian* was introduced, but did not succeed. Both the potato and Hopetoun oats have long strong straw, large pyramidal spikes, come early to maturity, and are cultivated on the best and lowest lying ground. The grains are very similar, the Hopetoun being distinguished by a tinge of red on the bosom. These oats are sown a fortnight after the common.

2489. The cultivation of the *Tartarian* varieties, both *black* and *white*, is chiefly confined to England, for the use of horses, and are there called *feed* oats. I am surprised that this oat continues to be cultivated, being so coarse, as well as disagreeable in the barn with its long hygrometric awns. Its panicles grow on one side of the rachis, fig. 186.

2490. The ploughed lea-ground should be dry on the surface before it is sown, as otherwise it will not harrow kindly; but the proper colour of dryness should be distinguished from that imposed by dry hard frost. It will not be proper to wait until every spot of the field is alike dry, as thorough-draining even will not insure that; though spottiness shown in spring is a good criterion whether land has been enough drained, or where it most requires draining.

2491. Should the lea have been ploughed some time before, and from young grass, the furrow-slices will be found to lie close together at seed-time; but when recently ploughed, or from old lea, or on clay land in a rather wet state, the furrow-slices will not lie close together, but be as far asunder as to allow a good deal of the seed to drop down between them; and when this happens, the seed is lost, as oats will not vegetate from a depth of 6 or 7 inches. In all such cases, the ground should be harrowed a single tine before sown.

2492. When oats are sown by hand upon dry lea-ground, the grains rebound from the ground and dance about before depositing themselves in the hollows between the crests of the furrow-slices, and thus accommodate themselves to the form of the ground, and are not so liable to form *happergawin* in sowing as other grains. Were the ground only harrowed along the ridges, so as not to disturb the seed in the furrow-slices, the crop would come up in regular rows as if sown by drill; but as the land is also cross-harrowed, the braird comes up broadcast.

2493. The quantity of common oats usually sown is 6 bushels to the acre; and in deep friable land in good heart, 5 bushels of potato oats.

2494. A man does a good day's work if he sows broadcast 16 imperial acres of ground in 10 hours, that is, scatters 80 bushels of potato oats and 96 bushels of common oats in that time. Some men can sow 120 bushels of common and 100 of potato in the time, that is, 20 acres; and double-handed sowers can sow even more than this latter quantity.

2495. Two sowers keep one seed-carrier fully employed, and if the sacks are not conveniently placed (2311,) one will not be able to supply them both, but 2 seed-carriers will easily supply 3 sowers; and every sower employs 2 pairs of harrows breaking-in after him, with a double tine; so that the number of sowers is regulated by the number of pairs of harrows that a farm can furnish. The arrangement of the labour for sowing an oat-field may be seen in fig. 210, where 2 sowers and 1 seed-carrier are represented, but the harrows of 1 sower are only shown in view.

2496. The tines of the harrows should be particularly sharp when covering in seed upon lea. After the land is broken in with a double tine, it is harrowed across with a double tine, which cuts across the furrow-crests, and then along another double tine, and this quantity generally suffices. At the last harrowing the tines should be kept clean, and no stones should be allowed to be trailed along by the tines, to the injurious rubbing of the surface. On old lea, or hard land, another single turn across or angle-ways may be required to render the land fine enough; and, on the other hand, on free soil a single tine along after the double one across may suffice. In short, the harrowing should be continued as long and no longer than the ground feels uniformly smooth and firm under the foot, there being no hard places, or sinkings by the pressure of the foot. The head-ridges are harrowed by themselves at the last.

2497. The land, after oat-seed sowing, is always *water-furrowed* in every open-furrow (2361.)

2498. It should also be rolled (2475,) according to circumstances; that is, the young braird on strong land being retarded in its growth, when the earth is encrusted by rain after rolling, it is safe to leave the rolling until the end of spring, when the crop has made a little progress, and the weather is usually dry. Light friable land should be rolled immediately after the seed is sown and harrowed, if there is time to do it; but the rolling of one field should cause no delay to the sowing of others in dry weather. There will be plenty of time to roll the ground after the oat-seed and other urgent operations at this season are finished, when rolling can be so speedily performed as described in (2475.)

2499. The cutting of *gaws* should never be neglected in finishing off an oat-field, to carry off water along hollows or by the open-furrow along the lowest head-ridge, as particularly described in (779.) In the best drained fields, gaws may be required in peculiarly hollow spots.

2500. Oats are sown broadcast by machinery as well as by the hand. The machine is the same as is used for sowing spring wheat, and seen in fig. 204. As at first constructed upon two wheels, this machine, when loaded with a full complement of oat-seed, was too heavy for a horse's back, especially on going down hill; but the addition of the third wheel disposes of the objection, and I believe the machine is now extensively employed in the sowing of corn. The land is harrowed after the seed is sown with the broadcast sowing machine, the same as after sowing by the hand.

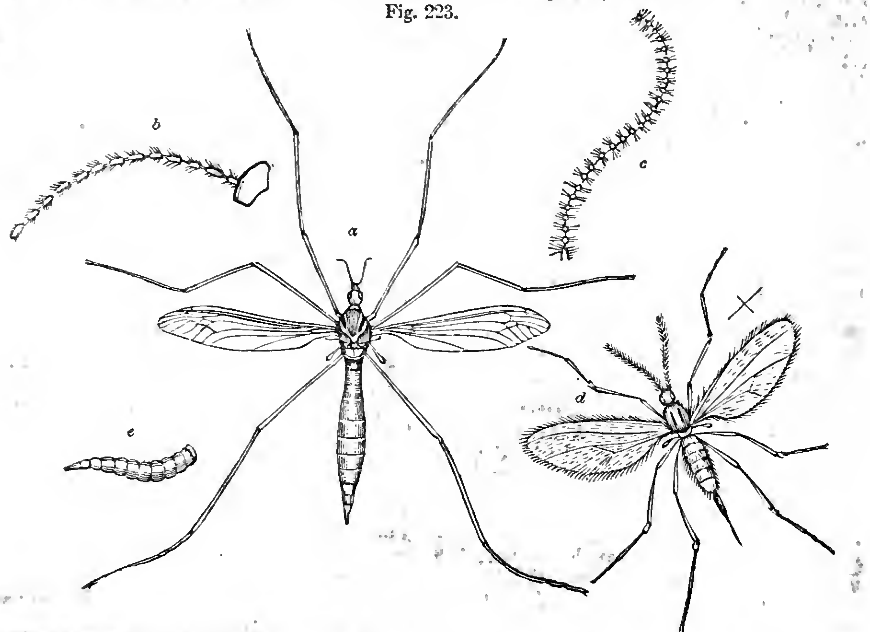
2501. Oats are also sown in rows by such drill-machines as are represented in figs. 205 and 206. In using a drill-machine, the land should first be harrowed, a double tine along, and then a double tine across the ridges, and again a single tine *along*. The drill then sows the oats *across* the ridges, and the land is finished by harrowing a single tine also *across* the ridges. The water-furrowing and rolling should be executed in the manner just recommended for broadcast sowing.

2502. The drill seems to me not well adapted for sowing corn on *lea*-ground. The coulters cannot pass through the soil, even after it has been well cut with the harrows, with the facility they do through ground in other states; and on hard ground and upon old lea, it is questionable whether the coulters can penetrate so far as to deposit the seed at a depth to be out of reach of birds and drought; and every stone in such soil being firmly imbedded, will be apt to cause the drill to go out of its proper course, while the risk of partially displacing the still uncorrupted turf will be imminent. The turf would be less disturbed were drills made to sow the seed along the ridges, as fig. 206. In all these latter cases I would recommend the broadcast machine or the hand in preference to the drill; and I would confine the drill to the sowing of oats on tender land, as in the neighbourhood of towns, where it is made tender by the application of large quantities of street-manure, and where drilling is advisable as affording a facility for clearing the land of surface-weeds, a multitude of which, and especially wild mustard, *Sinapis arvensis*, are apt to spring up from the use of street-manure. In England, however, where the drilling of grain is general, it must be owned that their ploughing with the wheel-plough and sowing with the drill-machine, are so perfect in their effect, that the seed is laid in the furrows with certainty, and without at all disturbing the furrow-slice. The soil of England is probably more generally smooth than that of Scotland.

2503. At a time when a less rational system of husbandry was pursued than now happily prevails—that is, when land was allowed to be overrun with surface-water; when lea was ploughed out of choice in a wet state, because the labour of doing it was easier for half-starved jaded horses; when land was harrowed with small, light, loose harrows, furnished with short blunt tines; when the lea-turf consisted chiefly of the tough roots of perennial weeds—in these circumstances lea-ground required a great deal of harrowing to bring it to a tolerable degree of tilth—eight or nine double tines being considered no more than necessary. The great length of time required to do this, obliged the oat-seed to be begun early, so early indeed as Tusser recommends it in January, and by the time the crop was finished, every man and beast were almost worn out with fatigue. The land being now tender and fertile by draining, cleaning, and manuring, oats have time to come to maturity when sown long after January, and its harrowing is now finished in one-third of the time, and with one-fourth the labour it required then.

2504. The oat-crop, when very young, that is, when the plant has not pushed its leaves more than 2 inches above the ground, is subject to a very severe attack of the grub or larva of a particular insect, the *Tipula oleracea*, *Meadow-crane-fly*, attacking its roots, and causing the plant to decay, and even to die when seriously injured. The perfect female insect is represented of the natural size at *a*, fig. 223, and which will at once be

Fig. 223.



THE LARGE INSECT WHICH PRODUCES THE GRUB IN OAT-FIELDS—THE WHEAT-FLY.

recognised as that well known by the familiar names of *Long-legs, Tailors, Jenny-the-spinner.* Its body is nearly 1 inch long, of a brownish-gray colour, and its wings pale-brown. In the female the abdomen is thickest near the middle, from which it tapers to a point at the hinder extremity; that of the male is thickest at the hinder extremity, which forms a kind of club. "This insect," says Mr Duncan, "is very plentiful during the summer months in all parts of the country. Its long legs are of great advantage to it in the places it frequents, as they enable it to skip over the grass as if on stilts; and it still farther facilitates its motions while so doing, by keeping the wings expanded, to render it buoyant. The female lays a great number of eggs, which are very small in proportion to the size of the insect, and of a black colour. These she places at some depth in the earth, which she pierces for the purpose with her ovipositor. The insects may easily be seen performing this operation; and it will at once be known that they are so employed by the singular position they assume. The body is placed in a perpendicular direction, supported on the hinder feet and extremity of the abdomen, while the wings are expanded, and the anterior legs rest on the surrounding plants. When a sufficient number of eggs have been laid in one spot, the insect moves on to another, without changing the vertical posture of her body, merely dragging herself forward by her fore-legs, aiding her movements with her wings." It is in the larva state that these insects injure crops; meadow-grass not being their only food, they attack different kinds of corn, especially oats, the effects of *grubbing* in which are well known to every farmer. When full grown, the larvæ are in the shape of an elongated cylinder, somewhat suddenly attenuated at both extremities, and are of a dull grayish colour, and without feet. The head is furnished with two hooks, one on each side. The pupa is not unlike the chrysalis of some kinds of moth; and it is nearly of the same colour as the larvæ, the edges of the segments being furnished with pretty strong hairs. The larvæ reside generally about 1 or 2 inches beneath the surface, mining their way among the roots of the herbage, and causing it to wither for want of nourishment. They prefer a soil which has been long undisturbed by the plough; and if it contains some portion of peat-earth, it seems thereby better adapted to their tastes. "In the rich district of Sunk Island, in Holderness, in the spring of 1813," say Messrs Kirby and Spence, "hundreds of acres of pastures have been entirely destroyed by them, being rendered as completely brown as if they had suffered a three months' drought, and destitute of all vegetation except a few thistles. A square foot of the dead turf being dug up, 210 grubs were counted in it; and what furnishes a striking proof of the prolific powers of these insects, last year it was difficult to find a single one."* "After mentioning their extensive devastations, it may occasion surprise," as Mr Duncan well remarks, "to be told that many eminent observers are of opinion, that these maggots eat nothing but the fine mould they find at the roots of plants, and that the injury caused to the latter arises solely from their disturbing the soil, and preventing the rootlets fixing themselves. Such was the opinion of Reaumur; and the generality of subsequent writers on the subject have yielded to his authority. . . Mr Stickney, who has published '*Observations on the Grub,*' made some experiments for the express purpose of determining this point, and they convinced him that the larvæ devour the roots of grasses. Indeed, unless this were the case, it would be impossible to account for the herbage withering to such an extent in places where the maggots prevail; for this could never arise from such small creatures, even though very numerous, burrowing in and loosening the soil. When earth-worms are plentiful, they must produce a considerable disturbance in the soil by their winding galleries; but these, so far from retarding, have always been regarded as promoting the growth of plants. 'The grub of this tipula,'" says Mr Stickney, as quoted by Mr Duncan, "'commits its ravages chiefly in the first crop, after the breaking up of the grass-land, also after clover and beans; the fly from which the insect is produced having deposited its eggs in the soil amongst the grass, clover, or beans. . . . On investigating the habits of this insect, I found that it took the fly-state about the beginning of the month of August; I therefore concluded, as we got our clover-hay from the land a little after midsummer, that, if we ploughed the clover stubble any time after that, and before the month of August, it would be nearly free from the grub, as instinct has directed the fly not to leave its eggs upon the naked soil where no vegetable is growing. I knew of no application to the land,' adds Mr Stickney, 'that will in any way destroy the grub; but we are much indebted to the rook, and a variety of other birds, for keeping its depredations within limited grounds.'† The saturation of the soil," concludes Mr Duncan, "with some caustic fluid, seems the only way by which this maggot can be destroyed. The perfect insects are easily caught; but they are so generally distributed, and usually so plentiful, that their destruction in this way would be a hopeless task."‡

2505. The rook (*Corvus frugilegus*) may be seen busily engaged in turning over every loose turf clod on a grubbed field of oats, after the young crop has evidently assumed an unhealthy hue.

2506. This hue should not be mistaken for the yellowish tint exhibited by the plant when the support derived from the seed is exhausted, and before the rootlets have obtained sufficient hold of the ground to maintain the plant. The grub taint is of a bluish and reddish tint, and many of the plants evidently appear to be dying, and the consequence is, that large spaces are left without a plant. The usual expedient employed by the farmer is rolling the ground, especially in the night; but this is a useless remedy. Crosskill's clod-crusher would be a much more effectual

* Kirby and Spence's *Introduction to Entomology*, vol. i. p. 181.

† *British Farmer's Magazine*, vol. vi. p. 321.

‡ *Journal of Agriculture*, vol. xi. p. 368-72.

instrument for this purpose than the common roller. Holes have been recommended to be made 9 inches in depth, and a few inches asunder, with the dibble, into which the grub, it is said, will fall, and they might then be destroyed by pouring an acid upon them. The ravages are generally committed in dry weather with an E. wind, and when rain falls they cease.

2507. It is surprising how a field will recover the effects of grubbing. One season a field of mine, of fine deep hazel loam, after two years' grass, was dreadfully grubbed, and after trying the usual remedies to get quit of the insects, without effect, a rainy night silenced them. Most of the field appeared bare after having exhibited a beautiful braird, but on the plants renewing their growth, they tillered out with great force, and almost covered the ground as thickly as desirable. At harvest the crop was a very strong one, the straw being difficult for women to cut with the common sickle; the spikes were very large and full; the stooks, when set without hood-sheaves, stood about 6 feet in height, and the yield was not less than 60 bushels to the acre. On good soil I should have no fear of potato oats tillering out after being severely grubbed, sufficiently to afford a good crop; but such a result should not be expected of common oats upon inferior soils.

2508. There are reasons for believing that, in some cases at least, the withering of the wheat crop in spring, which had been sown on lea in autumn, was occasioned by this insect. Rolling with Crosskill's clod-crusher has been tried, and found at least partially successful in destroying the grub, and relieving the crop.

2509. The spring treatment of the oat crop in Germany is thus described by Thäer:—"Oats are annually sown more thickly than any other kind of grain, either because the bushel contains fewer grains, or because oats do not grow so bushy as other kinds of corn, excepting on very rich soils. One half more seed than would be considered as the proper quantity for any other kind of grain must be sown in this case; and on broken-up grass land, which has only had one ploughing, the quantity had better be doubled, because all the seeds do not come up.

2510. "To insure the success of a crop of oats, it is necessary that the seed should be plump, fresh, and uninjured by fermentation. Oats which have acquired an unpleasant taste or smell while in the sack or store-house, certainly come up from the ground like others, but they produce a weakly plant, which perishes at the flowering season. I accidentally obtained proofs of this during the period I was studying agriculture. There is no grain, besides wheat, in which this evil requires to be guarded against so much as in oats.

2511. "The usual period for sowing oats is in April: in broken-up pasture land, they are sown in the middle of March, if possible; but where the situation is warm, the sowing may be delayed as late as the commencement of June; and it is when thus sown that oats succeed best, provided that the weather is favourable: this is occasioned as much by the soil having received a better preparation, as it is by the destruction of the weeds being more complete.

2512. "Oats do not germinate so easily as barley, nor is the process of germination so uniform, excepting where it takes place under a very favourable temperature. The crop does not come up simultaneously, nor do the plants ripen equally. Many weeds which germinate with oats—as, for instance, the wild mustard and the wild radish—tend materially to weaken the crop, and should therefore be destroyed by harrowing."*

ON LUCERNE.

2513. "In Britain," says Mr Lawson, "a great deal has been said in favour of lucerne, as an early plant, for yielding fodder before the red clover; and its cultivation has often been attempted, and attended with various degrees of success. The climate of Scotland has been considered by some as too cold for its growth; but the numerous failures which have taken place may be more justly attributed to an improper choice of soil than to any other cause. The soils which appear to be most congenial to it are those of a very light sandy or dry nature; as, for example, several places in the neighbourhood of Musselburgh, near Edinburgh, where it is found to thrive well, although exposed to the direct influence of the sea-breeze, and to be fit for cutting at least a fortnight earlier than common rye-grass and red clover. Provided, however, the subsoil be always dry, the plant penetrating to a considerable depth with its roots, and particularly if it be of a calcareous nature, it is not indispensable that the surface soil be very sandy, as lucerne, in such cases, is found to grow freely on medium black loams; but lands which have a damp subsoil, or are of a tenacious nature, and damp in winter, are totally unfit for growing it, even although they may be, in the general acceptation of the term, very good soils."†

2514. The mode of culture may have

* Thäer's *Principles of Agriculture*, vol. ii. p. 438-9—Shaw and Johnson's translation.
† Lawson's *Agriculturist's Manual*, p. 159.

some effect on the success of cultivation. Mr William Pepper, of Falcon Lodge, near Sutton Coldfield, in Warwickshire, cultivates lucerne, and he decidedly prefers the broadcast to the drill system; and he has kindly furnished me with these particulars. He says that "a light dry soil should be chosen in the neighbourhood of the farmstead, and the deeper it is the better, as lucerne has a long root, which I have known strike as deep as 6 feet. The ground should be quite free of weeds, and well covered with good foldyard manure, which should either be dug down 18 inches deep, with a double spit of the spade, or ploughed down with a double furrow, by one plough following another. The best time for sowing the seed is about the middle of March, when it should be sown *broadcast* at the rate of 20 lbs. per acre, at a cost of 1s. 8d. per lb. It may be harrowed in with barley, upon land that has carried turnips, as being then in the cleanest state; but it may be sown after grass or stubble, provided the land has been properly laboured and cleaned."

2515. I may relate here, once for all, Mr Pepper's entire culture of this plant. "Towards the latter end of October, or beginning of November," continues Mr Pepper, "the lucerne should be covered with light stable manure, to preserve it from the frosts during the winter; and towards the beginning of March, in the ensuing season, it should be harrowed with light grass-seed harrows, to remove the few remaining weeds, and rolled. After it has been mown in May for the first time, it would be advisable to scatter over it again a light dressing of manure, in order to encourage the growth of the second crop. When the ground is cleared in the end of the season, it will be necessary to apply harrows upon it of a heavier description than those employed in the season before, as early in the season as the crop will admit; and continue to harrow till the ground is free of all weeds, and almost like a fallow, as the lucerne roots will now have got so deep as not to be injured by harrowing; and when immediately covered with manure, it will be found free of weeds in spring.

2516. "This mode of cultivating this useful plant will produce 8 tons of forage per acre; but it should be borne in mind that, when so much is taken from the ground, much manure will require to be given in return. The broadcast plan is very much preferable to drilling. I have known many sow it in drills, and, after a few years, give it up, in consequence of the great trouble and expense incurred in hoeing and cleaning; but the broadcast system saves all that trouble.

2517. "I sowed my lucerne in 1830, and have continued mowing and manuring it every year since; and in some seasons I have got as much as 12 tons per acre. It is a hardy plant, and will endure cold if cultivated in dry soil; but it flourishes best in a hot summer, when I have seen it run to the height of 5 feet 5 inches, though its usual stature is about 4 feet; and when all the other grasses were burnt up, it has remained green and succulent. It is particularly calculated for horses, though pigs will greedily consume the refuse that comes from the stable, and thrive well upon it; but it is too strong in the stalk for cows, and by no means so good for them as tares. If cultivated upon proper soil, an acre will keep three strong cart-horses for 6 months, from 1st May to October; and after the first year may be mowed twice or thrice, according to the seasons."

2518. The lucerne belongs to the class and order *Diadelphia Decandria* of Linnæus; to the family *Leguminosæ* of Jussieu; and to the sub-class iii., *Perigynous Exogens*; alliance 42, *Rosales;* order 209 *Fabiaceæ;* tribe 2, *Loteæ*, and sub-tribe 3, *Trifoliæ*, of the natural system of Lindley. It is the *Medicago sativa* of botanists; roots sub-fusiform, stem erect, flowers large and violet-coloured. Its name is derived from that given by Dioscorides to Median grass.

2519. Lucerne is said to have been brought to Greece from Asia. The Romans were well acquainted with its properties as a forage plant, particularly for horses. Hartlib endeavoured to introduce its culture into England in the time of the Commonwealth, but did not succeed. It is cultivated in many parts of Europe in the fields; but "it is very remarkable that this species of forage, to which so much importance was attached by the Romans, has altogether disappeared from Italy. We are assured by M. Chateauvieux, that not a single plant of it is now to be seen." *

* Dictionary of Greek and Roman Antiquities—Art. *Agricultura*. New edition. This article, by Professor Ramsay of Glasgow, gives the most correct and satisfactory epitome of the agriculture of the Romans I have seen.

2520. As a successful instance of cultivating the lucerne in drills, in the neighbourhood of London, I may mention that a practical writer recommends it to be sown in good, dry, deep soil, well-manured, in drills at 6 feet asunder, and to cultivate the intervening ground with other crops, such as potatoes, savoys, cabbages, carrots, &c.; and the principle upon which he advocates the wide drill system is the abundance of air given to the plant above, and of room to the roots below the ground, whilst the intervening ground can be kept clean by the culture of other useful green crops; and he maintains there is no other mode of keeping the land permanently clean, and that lucerne will not thrive amongst weeds. He observes that "the quick progress of lucerne, where it has room, is remarkable. The first year, only 2 tons 4 lbs., the second, 8 tons 17 lbs., the third, 32 tons, advancing every year to four times the quantity it produced the year preceding. Another remarkable circumstance is, that the same plants produced the third year almost four times the quantity that they did the second, though cut but once more. The second year they produced three cuttings, and the third year but four, yet the produce of the four cuttings was four times as much as of the three. So much more numerous, larger, and juicy were the stalks of these plants, when in vigour, than in poor, cold land, assisted by culture only; and hence some idea may be formed of its extraordinary luxuriance on rich, warm land, well cultivated, and also manured. The results were, £20, 16s. per acre per annum of clear profit, from lucerne planted in this manner for the first three years; but after this, when the leaves of the plants meet, will yield full crops, and then the profits will be much greater—for the value of the lucerne crops alone will be £30 a-year and upwards, and this with less trouble, and much greater certainty, than any other tilled crops in common husbandry. The value of the "lucerne and the other crops," he admits, "will indeed be much lower remote from London, and other populous cities, and for fattening cattle than if raised for sale at market; yet they will still be very profitable, and much beyond the common profits of arable land."* If a near approach to these results be obtained, the lucerne is worth the trial in the neighbourhood of the large towns in Scotland, upon dry rich ground, and I must own the mode of culture seems feasible. This writer says that lucerne should only be cut when in the bloom, and that, in converting it into hay, it loses three-fourths of its weight.

2521. The variety of lucerne named the falcate podded lucerne, *Medicago falcata,* is said to be the kind cultivated in Switzerland, the flowers of which are usually pale yellow, which is the most common colour of the tribe, but occasionally violet and green. There are 81 species of lucerne described by botanists.

2522. The ash of the lucerne contains the following ingredients according to Sprengel:—

Potash,	14·03
Soda,	6·44
Lime,	50·57
Magnesia,	3·64
Oxide of iron, alumina, &c.,	0·63
Phosphoric acid,	13·68
Sulphuric acid,	4·32
Chlorine,	3·23
Silica,	3·46
	100·00
Per-centage of ash,	9·55

2523. Lucerne seed weighs 62 lbs. the bushel, and costs about 90s. per cwt.

ON SAINFOIN.

2524. The sainfoin is a most valuable forage plant in the poor, thin, dry, chalky districts of England and France, where it will grow for eight or ten years. Although hardy enough, it has not extended itself to the north of England, or into Scotland, most probably from the want of calcareous matter in the soil, which it seems to delight in. It does not thrive in strong soils.

2525. It is preferred to be cultivated in the broadcast style, and may be treated precisely in the same manner as that described above, by Mr Pepper, for lucerne. "A very judicious method," as mentioned by Mr Lawson, "which is practised in some parts of England, is to sow it with about half the quantity of barley, or other grain, usually sown for a full crop, which gives it the advantage of being shaded, and kept moist during the first summer, without the chance of the plants being weakened from the closeness of the corn crop. In cases where the barley or corn is drilled, the sainfoin should be drilled across the field—that is, the drills running at right angles to those of the corn crops." †

2526. The seed of sainfoin is large and light; so light that, in harrowing the ground too much, it is apt to be again brought to the surface. On this account it had better be sown with a drill machine; and in that case the crop should be in drills, instead of broadcast.

2527. The plant comes to full maturity

* *The Improved Culture of Lucerne,* p. 177-80. 1775.

† Lawson's *Agriculturist's Manual,* p. 165

of growth in 3 years; and, though it will not bear to be cut so many times in the year as lucerne, it makes an excellent easily made hay, yielding from 1 to 2 tons per acre, and a pleasant aftermath for stock.

2528. It is possible to cultivate sainfoin as a one or more years' crop of grass, in rotation with corn crops, instead of red clover; but in that case it would be better to be accompanied with white clover and rye-grass; and, being a perennial, it would have the advantage of red clover of remaining longer than one year in the ground, should it be desired to retain the grass beyond that period.

2529. The sainfoin belongs to the class and order *Diadelphia Decandria* of Linnæus; to the family *Leguminosæ* of the natural system of Jussieu; and to the sub-class iii. *Perigynous Exogens;* alliance 42, *Rosales;* order 209, *Fabiaceæ;* tribe 3, *Viciæ,* and sub-tribe 3, *Heydsareæ* of the natural system of Lindley. It is the *Onobrychus satira*, the cultivated sainfoin of botanists, roots sub-fusiform, stems erect, flowers in spikes or long foot-stalks, of a beautiful pink or flesh colour. Its generic name is derived from the Greek, signifying plants grateful to the ass; its ordinary name is evidently from the French, meaning consecrated hay—from its property of producing an excellent sort of hay. The name was doubtless derived from France along with the plant.

2530. The intelligent practical writer whom I quoted above, on the subject of the lucerne, also treats of the culture of sainfoin, and he is a decided advocate of the drill system. He recommends sainfoin to be cultivated solely to be made into hay, as being the most profitable mode of cultivating it, and to be sown in double rows of 12 inches apart and 30 inches between the double rows, or in single rows at 24 inches apart, and the plants 4 inches asunder in the row. This method admits of the land being thoroughly worked, cleaned, and manured whilst the crop is growing, and then the plants will meet in the rows. And he makes the sensible remark, that if we expect to reap a heavy crop three or four times in the season, we must lay our account to manure the soil well.

2531. The sainfoin yields by much the finest quality of hay when cut before the blossom comes out. "This hay, so cut before blossoming," says Jethro Tull, "has kept a team of working store horses, round the year, fat without corn, and when tried with beans and oats, mixed with chaff, refused it for the hay. The same fatted some sheep in the winter in a pen, with only it and water; they throve faster than other sheep at the same time fed with pease and oats. The hay was weighed to them, and the clear profit amounted to £4 per ton. They made no waste, though the stalks were of extraordinary bigness; they would break off short, being very brittle. This grew on rich land in Oxfordshire. The second sort of sainfoin hay is cut in the flower; and though much inferior to the virgin hay, it far exceeds any other kind, as yet commonly propagated in England; and, if "it be a full crop by good culture, may amount to above 3 tons on an acre. This is that sainfoin which is commonly made, and the larger it is the more nourishing for horses. I have known farmers, after full experience, go three miles to fetch the largest stalky sainfoin, when they could have bought the small, fine, leafy sort at home, for the same price, by the ton. The next and last sort of sainfoin that is cut only for hay is the full-grown, the blossoms being gone or going off: this also is good hay, though it falls short, by many degrees, of the other two sorts. It makes a greater crop than either of them, because it grows to its full bulk, and shrinks little in drying." †

2532.—"The season for sainfoin hay," says the former writer, "lasts from the end of April, or beginning of May, to the first or second week of October, or between five and six months; in which time, there is no doubt that from good land, cultivated as above, 3 good cuttings will be obtained, amounting to 7 or 8 tons of prime hay per acre, or about 30 tons of green fodder.

2533. "It is no small commendation of this plant that the occupier of any ordinary land may raise good sainfoin upon it; that will keep a dairy, or fatten beasts and sheep, even upon land that did not before produce tolerable pasture for them. This is of inestimable benefit to hill farmers, whose dry lands are of little profit to them, but, by the proper cultivation of sainfoin, may thus be made of almost equal value to the rich low lands in dry seasons, and in wet seasons superior to them." ‡

2534. These commendations may not suit our Scottish practice, in which sainfoin is unknown; but now that red clover has become so precarious a crop, and is at all events only an annual, it is but right to look about for substitutes which will answer for as long a period at least as to postpone the return of the red clover for a number of years, and allow the land, in the meantime, to be rendered again fit to receive it. But as to making sainfoin and such plants permanent retainers of the soil, Professor Low makes these just observations. "If ground is to be mown for successive years for forage in such soils as are suited to it, scarce a better crop can be cultivated than sainfoin, which is easily grown, hardy, and productive. But, with regard to this particular mode of cultivation, it cannot be at all recommended. It is not the most beneficial mode of raising crops for forage; for, independently of the smaller produce, the keeping of land under any one kind of crop, and manuring it upon the

* Tull's *Husbandry*, p. 174-5,—1762.

† *Improved Culture of Sainfoin*, p. 251.

surface, is to deprive the cultivated land of manure for an object which may be better attained by other means." *

2535. The ash afforded by sainfoin contains the following ingredients, according to two authorities :—

	Sprengel.	Buch.
Potash,	29·57	6·75
Soda,	6·28	21·46
Lime,	31·55	31·01
Magnesia,	4·14	8·57
Oxide of iron, alumina, &c.,	0·95	1·74
Phosphoric acid	13·17	26·64
Sulphuric acid,	4·90	1·68
Chlorine,	2·26	1·31
Silica,	7·18	1·10
	100·00	100·26
Per-centage of ash,	6·96	

2536. It may be proper to mention that the sainfoin seed ought to be new, or it will not germinate. It weighs about 28 lbs. per bushel, and varies in price from 40s. to 70s. per quarter, according to the demand.

2537. *Giant Sainfoin.*—"The introduction of this variety of sainfoin," says Mr Joseph Hine, Newhaven, near Baldock, Herts, "was purely accidental: it was clearly a foreign species; but although various purchases of foreign seed have subsequently been made, in hopes of obtaining the same variety, they have hitherto proved unsuccessful. It was not until 1842 that my father, who was the then tenant of the farm I occupy, sufficiently overcame his sceptical notions in reference to its peculiar properties as a distinct species, as to induce him to give it a fair trial; then, however, he procured of the introducer four bushels of seed, which cost him 80s. per bushel. This was dibbled between the rows of wheat sown upon a pea stubble; and the seed being expensive, we endeavoured to drop one seed in a hole, making them from three to four inches apart, which carried it over nearly three acres. The stubble of the wheat crop was left upon the land during the winter, but beat down and raked off in the spring. The crop was good for a thin plant, and would have cut more than 30 cwt. of hay per acre; but my father, hoping to get two crops of seed, let it stand, which was injudicious, experience having proved that it is very reluctant of going to seed in a maiden crop; and the second crop, although it went to seed again, was too late to be successful. In 1844 the entire piece was sown for hay, and produced from five to six tons, and early in September it was mown again for seed, which produced about 20 bushels per acre; this was sown in 1845, upon a red loam with a chalk subsoil, after beans and pease, which had been well manured for the same, at the rate of 2, $2\frac{1}{2}$, and 3 bushels per acre, upon $24\frac{1}{2}$ acres of land, which has this season produced more than 50 tons of hay, the thickest sown answering the best. In August it was mown again for seed, and subsequently produced a good eddish for feed. The species has now been tested in this and the adjoining parish for 15 years, and the price of the seed has varied during that period from 50s. to 80s. per bushel. It is quite clear that it will, like lucerne, produce three crops for hay or soiling in one season; and the food in either case is much more nutritious. I had 12 acres drilled last spring, 1846, upon pea stubble wheat, at 3 bushels per acre; the wheat was very fine, and partially down, but the plant of the sainfoin is good. I shall now introduce it in regular course, sowing about 12 acres in each season upon pea stubble wheat, to remain three years, and then to break up for wheat—by which method it will be perceived that only the barley crop is sacrificed in one round. In this way, if successful, I shall obtain 36 acres for hay each year, and 36 acres for seed, or second and third crop, as may appear advisable. This will furnish me with all the hay I require, leaving my clovers wholly for sheep feed; but whether this will prove the more excellent mode of turning this peculiar variety to the best account, experience alone can determine. I shall only add, that I have a very large portion of my crop of hay remaining, 1847, and a small quantity of the seed in an unthrashed state, with 36 acres in plant." †

ON THE LAMBING OF EWES.

2538. The lambing season of Leicester, and other heavy breeds of sheep, reared in the arable part of the country, commences about the 11th of March, and continues for about the space of 3 weeks.

2539. There is no labour connected with the duties of the shepherd which tests his attention and skill so severely as the lambing season; and a shepherd, whose unwearied attention and consummate skill become conspicuous at that critical period of the flock's existence, is an invaluable servant to a stock farmer—his services, in fact, are worth far more than the amount of wages he receives; for such a man will save the amount of his wages *every year*, when compared with the losses sustained by the neglect of an unskilful shepherd, and especially in a precarious season, when, by treating the ewes and the lambs in the most proper manner under the circumstances, the lives of many are preserved that would otherwise have been lost. To make my meaning more plain, suppose a shepherd who, having attentively observed

* Low's *Elements of Practical Agriculture*, 2d edition, p. 416.
† *Bell's Weekly Messenger*, for February 1847.

the tupping, and marked the reckoning of every ewe, puts the ewes in proper time in a suitable place to lamb in,—renders them requisite assistance, and no more, at the proper instant of lambing, and treats them afterwards according to the circumstances of the weather, — sees that the lambs are supplied with milk, when mothers happen to be unkind, or, the ewe wanting milk, feeds them with milk obtained elsewhere,—knows how to afford relief to the ewe in case of sickness and inflammation after lambing, and castrates the lamb at the proper period of its strength, and in the proper state of the weather,—knows the manner how, and the time when, to put an additional lamb to a ewe that has abundance of milk, and take it from another which has too little for a pair,—suppose that by doing all this in a skilful manner, night and day, until the lambing is not only entirely completed, but the lambs reared are beyond danger, he saves the lives of 10 ewes worth 40s. each, and of 20 lambs, that will come to be worth 20s. each, and this is no extravagant supposition in a large standing flock of 15 score of ewes, it is clear that, in so doing, he will save the amount of his wages, namely, £40. Few shepherds are so successful, although I have known two instances of such success; and no better proof need be adduced of the scarcity of skilful shepherds, than the loss which every breeder of sheep sustains every year, especially in bad weather. I knew a shepherd who bestowed unabating attention, but was deficient in skill, and, being over-anxious, always assisted the ewes in lambing before the proper time; and as, in his want of skill, he kept the ewes in too high condition, the consequence was that every year he lost a large number of both ewes and lambs, and in one season of bad weather the loss amounted to the large number of 26 ewes, and I forget how many lambs, in a flock of only 10 score of ewes. I knew another shepherd who was far from being solicitous about his charge, though certainly not careless, yet his skill was so certain that his success was eminent, and the loss of a ewe or of a lamb under his charge was matter of surprise. Of these two sorts of shepherds, the attentive and the skilful, it would appear that the skilful is the safer, and of course the more valuable—evils will be *prevented* by skilful attention, and *cured* by attentive skill; but it is only by the union of both qualities that a perfect shepherd is constituted. Such a perfect shepherd I had the good fortune and happiness to possess all the time I farmed. I cannot assert that no deaths occurred in the flock under his charge; but when a death ensued at any time, it was more the fault of the times than of his: the diseases of sheep were not so well known as now, and no veterinarians were established in practice in the country then, as now. His acuteness perceived when a sheep was affected long before any one else could detect it; but a remedy, however early and well applied, will at times fail.

2540. In contradistinction to a skilful shepherd, let me advert to some particulars mentioned by Mr Price, occurring, apparently as a matter of course, in the lambing season. He says that, in preparing ewes for lambing, "the ewes are driven into a pound, and the looker takes them singly, *throws them down*, and removes with the shears the wool on their tail, udders, and inside of their thighs." If this is a common practice, think of its barbarity, of throwing down ewes on the ground on the eve of lambing, to remove a trifling impediment to the lamb's sucking, which can be removed at any time after lambing. But there is a reason, it seems, for this treatment, called *clatting*, and it is this,—"The removal of the wool renders the part much *neater*," (appearances, it seems, being preferred at this particular time to the ease of the animal,) "and enables the lamber to see *when the ewe has lambed*, from a stain which generally appears on the back part of her udder. Were *not* this appearance to take place, the *lamber would sometimes be at a loss*, as the young ewes frequently desert their young, and endeavour to escape along with the other ewes, grazing with as much unconcern as if nothing had happened." Observe the great skill of that shepherd who is at a loss to know whether or not a ewe has lambed, or whether or not it has strayed from the pound without his knowledge; and who even does not know whether or not a ewe is in lamb, until he has thrown her down to remove the wool; for "the barren ewes, or those which are not pregnant, *are distinguished, at the time of clatting*, by not having any swelling in their udder or belly, and by their skipping about nimbly." Think also of what sort of care is bestowed on a newly lambed flock in a low country, when such losses as these are incurred:—"I have known thousands of lambs lost from being drowned in a wet stormy night; I once beheld 30 or more lying together drowned in a ditch. The ewes and lambs seek the corners of pasture-fields during the continuance of severe weather; and when the lambs get under these high banks and fall in, it is utterly impossible for them to extricate themselves; besides, as there are many huddled together, they often push one another in." That lambing pound must be a strange place which presents such a scene as this:—"Lambing presents a scene of confusion, disorder, and trouble, which it is the lamber's business to rectify, and for which he ought always to be prepared: some of the ewes perhaps leave their lambs, or the lambs get intermixed, and the ewes which have lost their lambs run about bleating, while others want assistance." It is no wonder that such a shepherd cannot recognise the lambs of ewes, and therefore they must be marked:—"The twins are marked with a mixture of tar and lamp-black, by means of small figures fixed in an iron handle about 8 inches long;" "and the twin lambs are easily separated, for the ewe very frequently walks away with one lamb, leaving the other in the field, *to the confusion of the lamber; therefore* they should be marked as early as possible to prevent this confusion." "The lamber must take the lamb to its mother, which he will find out by its number;" and yet the number, it seems, will not always enable the lamb to be found for the mother; for, if the lamber finds a young lamb, and is *not certain which may be its mother*, a circumstance which sometimes occurs when ewes drop twins, and leaves one of them, he may readily discover her by taking away the lamb she is fostering, and putting the doubtful one on in its stead, when she will display evident tokens whether it belongs to her." This method of trial and error the shepherd will, of course, have to make with every ewe before he discovers the true mother; and, as he knows neither mother nor lamb, the lamb may chance to belong to a ewe which has a single lamb as well as to one which has twins, unless the single lambs are left unmarked; or, at any rate, he may present the marked and known-to-be-a-twin lamb to a ewe that has lambed only a single one, as readily as to one that has lambed twins. It will excite no surprise to learn, that with shepherds so wretchedly disqualified for their profession, as the above particulars show, in "most years not more lambs than one to each ewe" were obtained; and that out of 800 ewes of a certain flock only 100 pairs were saved, though it is stated by Mr Price, that with more skill afterwards the number of pairs increased to 200. Here, then, is an instance where the improved skill of one man saved the lives of 200 lambs, which would come to be worth £200, equalling the wages of at least 4 good shepherds.* I would not have noticed these egregious blunders, said by Mr Price to be committed by shepherds in a low country like Romney Marsh, in Kent, so particularly, had not the late Mr Youatt adopted the sentiments of Mr Price in the very particulars quoted above, in his excellent treatise on the history and diseases of sheep.† Were a shepherd of a Leicester flock in Scotland so ignorant of his profession, he would not only be quite ashamed, but no man would hire him; and neither would the shepherds be of the hill country, who cannot have so intimate a knowledge of every individual of their flock, which occupies a wide range of mountain land, as shepherds tending flocks within limited bounds.

2541. Before the season of lambing arrives, the shepherd should have a small paddock of 1 or 2 acres, or, where there is no paddock, a sheltered corner of a grass-field of small size, conveniently situated as near the steading as possible, fenced round with nets, and fitted up with sheds made of hurdles set up in the most sheltered part against a wall or hedge, and lined in the inside and comfortably roofed with straw. A shed of this temporary construction may be seen on the right hand of Plate VII., beyond the Leicester ewe and lamb. Such straw-sheds form most comfortable places of refuge for ewes that lamb in the night, or have lambed in the

* Price *On Sheep*, p. 115-26.

† Youatt *On Sheep*, p. 500.

day, and require protection from frost, snow, rain, or cold in the night, until the ewes are perfectly recovered from lambing, and the lambs sufficiently strong to bear the weather in the open field.

2542. The lever hand turnip-slicer, fig. 48, will be found on such occasions a convenient instrument for cutting turnips into such turnip-troughs as fig. 50, for the ewes in the paddock, or into small boxes for them in the shed

2543. Common kale or early greens is excellent food for ewes that have lambed; being mucilaginous and soluble, it is beneficial in encouraging the necessary discharges from the ewe after lambing. According to the late George Sinclair, 1 lb., or 7000 grains of green curled kale (*Brassica oleracea viridis*,) yields 5680 grains of water, 880 grains of woody fibre, and 440 grains of nutritive matter, which last is all soluble in water.* In these respects kale is better food for ewes *after* lambing than raw Swedish turnips, which become rather too fibrous and astringent in spring for the secretion of milk.

2544. A lantern, such as fig. 89, is a great assistant at night to a shepherd; and he should be provided with his crook, to catch a ewe quickly should she be troublesome,—which some are apt to be when the pains of lambing are coming upon them.

2545. As foxes are apt to snatch away young lambs at night, even close to the lambing-houses, I have found an effectual preventive to their depredations in setting a sheep-net, as in fig. 44, directly in front of the lambing-houses, leaving a sufficient space for a few ewes with their lambs making their lair within the net. When thus guarded, with the lantern burning outside, the foxes are afraid to enter the net, being apprehensive of a snare. Such an expedient is even more necessary in the corner of the field chosen for the lambing-ground. Besides alarming the fox, the lantern will be found a useful assistance to the shepherd in showing him the ewes as they evince symptoms of lambing. A net and lantern are also good safeguards against foxes at night in the grass-field occupied by the ewes and lambs, and where they should be gathered within the net every night. This expedient of net and lantern I was induced to try, after losing, for a year or two, several lambs by the fox; and such was its efficacy in deterring that nightly prowler from visiting the lair of the ewes and lambs, that not a lamb was lost ever after. A fox will not meddle with a lamb above a month old.

2546. Being thus provided with the means of accommodation, the shepherd, whenever he observes the predisposing symptoms of lambing in as many ewes as he knows will lamb first, — and these symptoms are, enlargement and reddening of the parts under the tail, drooping of the flanks, patting the ground with the feet, and desire for separation from their companions,—he places them, of an afternoon, within the enclosed lambing ground in the paddock, and provides them with cut turnips. The more immediate symptoms of lambing are—when the ewe stretches herself frequently; separating herself entirely from her companions; exhibiting restlessness by not remaining in one place for any length of time; lying down and rising up again as if dissatisfied with every place; pawing the ground with a fore-foot; bleating as if in quest of a lamb; and appearing fond of the lambs of other ewes. In a very few hours, or even shorter time, after the exhibition of these symptoms, the immediate symptom of lambing is the expulsion of the bag of water from the vagina, which, when observed, the ewe should be narrowly watched, for the pains of labour may be expected to come upon her immediately. When these are felt by her, she presses or strains with earnestness, changing one place or position for another, as if desirous of relief. Up to this time, not a hand should be put upon her, nor until the yellow hoofs of the fore-feet of the lamb and its mouth lying upon them, are distinctly seen to present themselves in the passage.

2547. The natural presentation of the lamb is the same as that of the calf, described in (2204.) When time has been given to observe that the ewe is not able

* Sinclair's *Hortus Gramineus Woburnensis*, p. 407, edition of 1824.

to expel the lamb by her own exertions, it is the duty of the shepherd to render her assistance, before her strength fails by unavailing straining. The exact moment for rendering assistance can only be known by experience; but it is necessary for a shepherd to know it, as there is no doubt that a hasty parturition often superinduces inflammation, if not of the womb itself, at least of the external parts of the ewe. When assistance should be rendered, the ewe is taken hold of as she lies, and laid gently over upon the ground on her near or left side, with her head up the hill, where the ground has an inclination; and, to save her being dragged on the ground when the lamb is being extracted, the shepherd places the heel of his left foot against the lower part of the belly of the ewe, and kneels on his right knee on the ground, pressing against her rump, having the body of the ewe below his own body, between the heel and knee. Having his face towards the tail of the ewe, and both his hands free, he first proceeds to push out *from* him, with both hands, one leg of the lamb and then the other, as far as they will stretch; then seizing both legs firmly, above the fetlock joints, between the fingers of his left hand he pushes the legs from him rather downwards from the ewe's back, with considerable force, whilst by pressing upon the space between the tail of the ewe and the head of the lamb *towards* him, with the front side of his right hand, he endeavours to slip the vulva of the ewe over the cantle of the lamb. The action of both the hands must be made simultaneously with the strainings of the ewe, only to assist her, and keep good what is obtained at each strain, and not to tear the lamb from her prematurely by force. Whenever the lamb's head is clear, the shepherd seizes the upper part of the neck behind the head with his right hand, and pulls out the body, which will now slip out with comparative ease. The lamb is then placed at the ewe's head, for her to lick and recognise, which she will instantly do, if her labour has not been severe; but if so, she will likely become sick, and be careless of the lamb as long as the sickness continues, which is evinced by quick oppressed breathing. If the pains have been sharp, and this her first lamb, and she is not overcome by sickness, the ewe may probably start to her feet, and run away from the lamb. The attempt at escape must be prevented, and the end of the tail of the lamb put into her mouth, to make her notice it. If she continues to lie on her side, her abdomen should be felt, to ascertain if there is another lamb to come; and if there is, the pains accompanying its passage may have been the cause of her carelessness for the first lamb; and if the second lamb is in a natural position, it will most probably, by this time, be showing itself in the passage, which if it be, the best plan is to take it away at once in the same manner as the first, and the ewe, feeling the attempt, will at once assist on her part by straining. The existence of a second lamb is worth attending to immediately on another account—some ewes become so engrossed with the first lamb, that the pains attending the second are neglected for a time. When a second lamb is found in her, she must be watched, that whenever it comes into the passage it may be taken away; but unless it actually makes its appearance there, it should not be attempted to be taken away. Should it not make its appearance in a reasonable time, it may be suspected that the lamb is either dead, or not in a natural position, and examination should be made by the fingers into the state of the case. In all cases of twins, examination should be previously made that they present themselves separately. A dead lamb is easily known by the feel, and should be extracted immediately, as it can afford no assistance of itself; but should the lamb be alive, it may be necessary to introduce the hand to ascertain its position. Before the hand is introduced, it should be smeared with goose-fat.

2548. The extraction of a lamb, as described above, is performed by a shepherd who has no assistants; but when he has them, he adopts another and more easy mode for the ewe and himself. An assistant holds the ewe upon her side, in any way the most easy for her and himself, to prevent its body being dragged along the ground while the shepherd is extracting the lamb; and in doing this, the shepherd places himself behind the ewe, and, on ascertaining the position of the lamb, pulls its legs *towards* him, whilst the assistant endeavours, by the pressure of the side of his hand below the tail, to make the vaginal skin pass over the lamb's head, which when accomplished, the shepherd seizes the back of the neck by his left hand, and holding the legs still in his right, takes away the lamb as quickly as he can, and places it before the ewe.

2549. There is great difference in the disposition of the ewes themselves to assist in the lambing. Some, when they find they are assisted, give themselves little trouble; others strain with vigour from first to last; and some only strain at long intervals. A ewe that strains strongly and continuously, will become sooner exhausted than one that takes the matter more leisurely; and in the former case there is greater danger in neglecting to make examination of the presentation in time, before the ewe has become exhausted. I remember of seeing, on a friend's farm, a lamb's head alone hanging out, and, being allowed to remain in that state too long, the lamb was strangled to death. This was a case of neglect, as the head should not have been allowed to come out without one accompanying leg at least. I remember of another case in which there was no appearance of a lamb, though the ewe had strained for a considerable time. On examination, it was found that the mouth of the womb was closed up. Inflammation had probably at one time existed, and a discharge of lymph had caused the adhesion. The shepherd, nothing daunted, very ingeniously introduced, with his smeared hand, a pen-knife between the middle and fore-fingers and thumb, and cut an incision across the pursed mouth of the womb, and liberated two lambs, the ewe not being the least the worse for the operation.

2550. When lambing has taken place in the day, in fair weather, the ewe with her lambs are best at liberty within the enclosed area of the lambing ground; but in rain or snow, and at night, she should be taken into the shed to lamb, and kept there for some time until the weather proves better, or she is recovered from the effects of the parturition. In the day, it matters not for lambs how *cold* the air is, provided it be dry. It is considered a good sign of health when a lamb trembles after birth. The cleansings or placenta generally drops from the ewe in the course of a very short time, in many cases within a few minutes after lambing. It should be carried away, and not allowed to lie upon the lambing ground. The lamb is fondly licked by the ewe at first, and, during this process, makes many fruitless attempts to gain its feet, and it is truly surprising how very soon after an easy birth it will stand; and the moment it does so, its first effort is to find out the teat, expressing its desire for it by imitating the act of sucking with its lips and tongue, uttering a plaintive cry, and wagging its still wet long tail. There are various obstacles to its finding the teat at first,—the long wool on the ewe's flank hides it,—that on the udder interferes with it—and, what is still more tantalising, the intense fondness of its mother urges her to turn herself round to it, in order to lick it with her tongue, muttering affectionate regards, while the wheeling about has the effect of removing the teat, the object of the lamb's solicitude. When at length a hold of it is obtained, it does not easily let it go until satisfied with a good drink. When a fond ewe has twin lambs, one can easily obtain the teat, while she is taken up in caressing the other. This is the usual behaviour of strong lambs; and on once being filled with warm milk, they increase in strength rapidly, and are soon able to bear very rough weather.

2551. But after a protracted labour, the first lambs of young ewes are so weakly at first as to be unable to reach the teat by their own strength, when they must be assisted—and the assistance is given in this way: Turning the ewe over upon her rump, the shepherd kneels upon the ground on his right knee, and reclines her back against his left leg, which is bent. Removing any wool from the udder by the finger and thumb, which is all that is necessary, he first squeezes the wax out of the teats, and, taking a lamb in each hand by the neck, opens the mouth of each with a finger, and applies the mouth to a teat, when the sucking proceeds with vigour.

2552. A young ewe or gimmer is apt to be shy to her first lamb, but after she has been suckled, either in this or in the natural way, she will never forsake her offspring. When the lambs do not succeed at once in sucking, it is the best plan for the shepherd soon to give the lamb its first suck in this way, which not only saves *it* much trouble, and gives it strength, but affords himself a favourable opportunity of examining the state of the udder, whether it is well, or feels hard, or is inflamed. Gimmers generally have so scanty a supply of milk, that it is expedient for the shepherd to support their lambs partially on cow's milk until they have the requisite supply, which will be induced partly by suckling, and partly from increased nourishment from the new grass.

2553. When the shepherd has lambs to support for a short time, he should supply them with the cow's milk at regular hours, such as in the morning and evening, immediately after the cows have been milked, and see the lambs suckled by their mothers during the day, and thus endeavour to bring on a sufficiency of milk. The dairy-maid should put the cow's milk for the shepherd in bottles, when the cows are milked in the morning and evening, and he should feed the young lambs while the milk is warm from the cow,—and he feeds them in this way: Sitting down, he takes a mouthful of milk from a bottle, and holding up the mouth of the lamb open, he lets the warm milk drop into it in a small stream from his mouth, which the lamb drinks as fast as it comes; and thus mouthful after mouthful until the lamb is filled. The auxiliary supply of milk should be withheld whenever the ewe can support her lambs, for cow's milk is not so good for the lamb as that of its own mother.

2554. The ewes are kept on the lambing ground till they have recovered from the effects of lambing, the lambs have become strong, and the ewes and lambs have become well acquainted with each other. The time required for all this depends on the nature of the lambing, and the state of the weather: the more severe the lambing has been, and the more broken the weather, they are kept the longer in ward.

2555. When quite recovered, the ewes, with their lambs, are then put into a field of new grass, where the milk will flush upon the ewes, much to the advantage of the lambs. It is generally a troublesome matter to drive ewes with young lambs to any distance to a field, as the ewes always turn round upon and bewilder the lambs. A dog more frequently irritates the ewes than assists the shepherd in this task. I believe the best plan is to lead the flock instead of driving it, by carrying a single lamb, belonging to an old ewe, by the fore legs—which is the safest way of carrying a lamb—and walking slowly with it before the ewe, and she will follow bleating close at the shepherd's heels, while the rest of the ewes will follow her. If the distance to the field is considerable, the decoy lamb should be set down to suck and rest, and another taken for the purpose.

2556. With plenty of food, and a safeguard of net and lantern at their lair at night, to keep off the foxes, the flock will thrive apace. Such a safeguard is rarely adopted. To know whether the fox has attacked a lamb, he always seizes it by the neck behind the head, and, if scared at this moment, distinct holes made by the teeth will be found on each side of the neck; whereas a dog seizes any part of the body, and worries by tearing the under part of the neck. The fox, if not immediately disturbed, carries off his prey, whilst the dog leaves behind him what he does not eat. Some ewes will fight off either dog or fox, and be able to protect a single lamb; whilst others become so afraid at once by an attack, that they know not whither to flee for refuge. After such an attack, the bleatings of the ewes and lambs in search of each other—an unusual occurrence at night—will soon acquaint the shepherd at a distance of the disaster that has happened to his flock.

2557. In unnatural presentations, if the head is bent back, it must be brought forward, and if one or both legs be folded back, they must also be brought forward, one by one, into their proper position. In short, all the unnatural presentations offered by a lamb require the same means to be used to place them in a proper position as with the calf; but with the Leicester ewe is the additional difficulty over the cow, of two, and even more lambs at a birth, and the increased chance of mistaking a leg of one lamb for that of another.

2558. The preceding cases of lambing are all easy to the shepherd; but others occur which put his skill to the test. Malformations of the body of the lamb create difficult parturition, and endanger the life of the ewe. It is almost impossible to bring the head of a wry-necked lamb into the passage of the womb, but it must be done before the entire body can be extracted; and, if it cannot be done, the head of the lamb should be taken off rather than the ewe should lose her life.

2559. Sometimes twin lambs die in the womb several days before the period of lambing; and as they cannot present themselves in the berth, they must be extracted by force, or even cut away in pieces; and when corruption has proceeded a considerable length, they may be pulled away in pieces. In such a case the placenta will be corrupted, and it may be a considerable time before it is entirely got rid of by the straining of the ewe. I have seen it so corrupted as to come away in small discharges as black and viscid as tar.

2560. A breech presentation is a difficult one, and the extraction is impracticable until the hind legs are first brought out; and in extracting by the breech, the operation should be done quickly at the last to prevent the lamb drowning in the liquor amni. In all cases of extraction, it should be made a point to have the back of the lamb next to the back of the ewe. To obtain these ends, it may be necessary to place the ewe upright upon its shoulder on the ground and its tail uppermost, to cause the lamb to retire into the womb while the shepherd introduces his hand to arrange and bring forward the hind legs in the proper position. Such an operation should be done quickly, though with all gentleness, in case of setting up an inflammation. A small hand is of great advantage to a shepherd.

2561. Much trouble is imposed on shepherds when the ewes will not take their own lambs. In every case of a ewe refusing to let her own lamb suck, the shepherd should particularly examine the state of the udder, and ascertain the cause of uneasiness; and, if it be inflammation, remedial measures must be used to reduce it, but if well the ewe must be put under discipline.

2562. The discipline consists of immediately putting her into the shed, and confining her to a spot by a short string tied above the fetlock joint of one of her fore legs, and fastened to a stob driven into the ground, or to the hurdle. As she endeavours to leave her lamb, the string pulls her foot off the ground, and while her attention is taken up struggling with the string, the lamb seizes the teat and sucks in the mean time. The stratagem often repeated, makes her take with the lamb. It is surprising how soon a lamb learns to steal a suck from the ewe; if it cannot approach by the flank, it will seize the teat from behind between the hind legs. When a ewe will allow but one of her twins to suck her, she should be held till both do it, and in a short time she will allow both.

2563. It is not surprising that one ewe should refuse to take the lamb of another; and yet it is necessary when a lamb is left an orphan, or happens to be a supernumerary, to *mother* it, as it is termed, upon another ewe. When a gimmer that has little milk has twins at a time when another ewe that has plenty of milk produces a single lamb, it is for the benefit of one of the ewes and two lambs, that the ewe which has plenty of milk should bring up two lambs; and the transference is easily accomplished while all the lambs are still wet, and two of them are placed before the ewe at the same time; but when a ewe does not die till two or three days after she has lambed, it will be difficult to make another ewe that lambs a single lamb, at the time the other ewe dies, take the older lamb along with her own. The usual plan is, to rub the body of the older lamb with the new dropped one, before the new lambed ewe has had an opportunity of recognising her own lamb, and to place both before her at the same time, and she may take them both without scruple; but the probability is, that she will reject the older one. She should then be put into a dark corner of the shed, and confined in it by a board placed across the corner, only giving her room to rise up and lie down, and to eat, but not to turn quickly round upon the stranger lamb to box it; while rubbing itself against her wool, and sucking her against her inclination, it will acquire the odour of her own lamb, and ingratiate itself in her favour. If she persist in refusing the lamb, the discipline of tying the leg must be resorted to. Another troublesome case is, when the lamb dies at birth and the ewe has plenty of milk, while another ewe has twins which she is unable to support. The expedient is to let the ewe smell her own new-born dead lamb, and then to strip the skin immediately off it, and sew it upon the body of one of the lambs belonging to the other ewe, and present the foster-lamb to her. It is possible that the dark corner will require to be used before a cordial reception be given to the foster-lamb.

2564. Should all the above expedients fail to *mother* the lambs upon the ewes—and they *may* all fail, though with a skilful shepherd they seldom do—the lambs should be taken away and brought up as *pets* on cow's milk.

2565. A *fat* ewe has always a small lamb, though plump and lively, and she runs a great risk in lambing of inflammation in the passage of the womb. A *lean* ewe bears a lamb with large extremities, and thin and weak body. A very *old* ewe's lamb is both small and weak. A gimmer bears a small lamb, and not having sufficient milk to rear it, it continues small. A hogg's lamb is still smaller and weaker, and generally requires to be brought up as a pet.

2566. The best mode of managing ewes for rearing good lambs, is to keep them in fair condition until they have lambed, after which they should have the best grass the farm can afford. New grass always produces abundance of milk, and it is ready earlier than old. In case of snow covering the ground in spring, when the ewes are heavy in lamb, they should get a few turnips and plenty of hay—clover-hay if possible—until the ground is again clear; but in open weather in winter, there is nothing better for them than grass which had been kept rough for the purpose in autumn. While confined on the lambing-ground, the ewes should have turnips and hay to support them; before lambing and after lambing, nothing is better for them than cabbage or kale, and in lieu a little oil-cake will encourage the necessary discharges and purification of the womb. New grass also operates medicinally on the system of the ewe.

2567. It is necessary to say a few words on the rearing of *pet lambs*. These consist of orphans or supernumeraries, and, in either case, are deserted creatures which would die were they not reared by hand. As a remarkable instance of lambs being obliged to be made pets from supernumerary births, I remember one season, in a small flock of 50 Leicester ewes, 48 of them had twins, and 2 trins. The two lambs which formed the trins were properly taken away to relieve the ewes, and brought up by hand as pets. When ewes die it is scarcely possible avoiding having pets, on account of the improbability of ewes lambing single lambs just in time to receive those which have become orphans. Pet lambs are supported on cow's milk, which they receive warm from the cows each time they are milked, and as much as they can drink. In the intervals of meals, in bad weather, they are kept under cover, but in good weather they are put into a grass paddock during the day, and under shelter at night until the nights become warm. They are fed by hand out of a small vessel, which should contain as much milk as is known each can drink. They are first taught to drink out of the vessel with the fingers like a calf (2276,) and as soon as they can hold a finger steady in the mouth, a tin tube, about 3 inches in length, and of the thickness of a goose quill, should be neatly and firmly covered with folds of linen, and used as a substitute for a teat, and with this they will easily drink their allowance of milk. A goose quill would answer the purpose, were it not that it is easily squeezed together by the mouth. When the same person feeds the lambs, who ought to be the dairy-maid, the lambs soon become attached to her, and will follow her everywhere; and to prevent them bleating in her absence, and annoying her during the day, an apron or a piece of cloth hung upon a stake or bush in the paddock, will content them and keep them together in quietness.

2568. It is a common practice with the shepherds of Leicester sheep, when they wish to catch a ewe to give a weakly twin lamb a suck, or to examine the state of her udder, to stoop down and run in upon her from behind and seize her by a hind leg. This is a safe mode of catching a sheep when dexterously done; but when it fails, by the captor not keeping himself out of view until he seizes the ewe, she will start and run off, and alarm the other ewes beside her—and every alarm to a ewe, whether lambed or about to lamb, is injurious, and at any rate cannot do any good. In the circumstances, a *crook* does the thing quietly and securely. It consists of a round rod of iron, bent in the form shown in fig. 224, and terminating at one end in a knob, and at the other end in a socket, which receives and is fixed to a wooden helve, 5 or 6 feet long, according to fancy. The hind leg is taken in at *a*, from behind the sheep; and as its narrow edge fills up the narrowest part beyond *a*, it has plenty of room to be free in the looped space in which the animal is secured, and its foot easily slipped through the loop. Some caution is required in using the crook, for should the sheep give a sudden start forward to get away, the moment it feels the crook touch its leg, it may forcibly draw the leg through the narrow part, and strike the fore edge of the bone with such violence against the bend of the loop as to cause the animal considerable pain, and even occasion lameness for some days. On quietly embracing the leg, at first from behind the ewe, the crook should be quickly drawn towards you, so as to bring the bend of the loop against the leg as high up as the hock, and to lift the foot off the ground, before the sheep is aware of the movement; and being thus secured at once, its struggles will cease the moment your hand seizes the leg. The crook is held in the figure to catch the near or left hind leg.

Fig. 224.

THE SHEPHERD'S CROOK.

2569. When the male lambs, not to be kept as tups, attain the age of from 10 days to a month, they are *castrated*. Some breeders advocate castration in a day or two after birth, whilst others will not allow the operation to be performed until the lamb is one month old. My opinion is, that both these periods are extremes. A lamb of a day old cannot be confirmed in all the parts and functions of its body, and in many instances I question that the testicles can then be found. At a month old, on the other hand, the lamb may be so fat and the weather warm, that the castration may be followed by febrile action. I prefer the operation being performed from 10 to 15 days, when the lamb has attained some strength, and yet no part has had time to become rigid.

2570. Great caution is required in castrating lambs; it should not be done in rainy, cold, or frosty weather; nor should the lambs be heated by being driven before the operation. It is best performed early in the morning, in fresh weather, with a westerly breeze. The ewes and lambs should be driven gently to a corner of the field, not by the dog, whose duty is only to prevent a ewe breaking away. One assistant should catch the lambs, and another hold them while the shepherd operates. It is not easy to catch the leg of a lamb with a sheep's crook, their small active limbs easily escaping through the loop, but it may be effectually used in hooking the neck, when the captor rushes in upon the lamb and secures it. Where there is a bught or open shed in a field, the lambs and ewes may be driven loosely in and the lambs captured there. Hill lambs should be driven the night before they are castrated into a bught or enclosure, where they will be ready and cool for the operation in the morning.

2571. Castration is performed in this way: Let the assistant hold up the back of the body of the lamb against his left breast and shoulder, and with each hand raise a hind leg towards the body, securing them by the shank; while, to prevent farther struggling, a fore leg is held firmly in connexion with a hind one of the same side. The effect of this arrangement is to exhibit the scrotum to full view, as represented at *a*, in fig. 225. The shepherd with his left hand then causes the testicles to make the point of the scrotum *a* smooth; and cutting through the integuments of the scrotum, with a knife in the right hand, first to one testicle and then the other, he pushes out both testicles into view with both his hands, and first seizes one with his teeth, and draws out the spermatic cord until it breaks, and then the other in the same manner, when the operation is finished.

Fig. 225.

THE MODE OF HOLDING LAMBS FOR CASTRATION.

2572. The old-fashioned mode of castrating lambs, was to cut off the point of the scrotum, andextract both testicles through the large opening caused by the amputation; but the extensive wound thus made took a considerable time to heal, whereas the simple incision now made almost always heals by the first intention.

2573. Advantage is taken of the opportunity to dock the tail, which is left from *c*, fig. 225, as long as to reach the meeting of the hams. In performing docking, the division should be made in a joint, otherwise the portion of the vertebra which has been cut through will have to be sloughed off before the wound can heal. The lamb, after being docked, is let down to the ground by the tail, which has the effect, it is said, of putting the parts right after the castration. Ewe lambs are also docked at this time, but they are not held up in this manner for the operation, being merely caught and held by the shepherd between his legs until it is done. In England, docking is performed at the third joint, which leaves a mere stump of a tail. The object of docking is to keep the sheep clean behind from filth and vermin; but as the tail is a protection against cold in winter, it should not be docked so short in Scotland as is done in England. Tup-lambs are allowed to retain their full tails until a year old, in order to strengthen the back-bone.

2574. The opportunity is taken to mark the ears of lambs; and in the case of stock on hill farms, where it is not easy to gather the flock frequently, the operation is very properly performed now; but as Leicester lambs are not marked in the ear at this time, I shall defer describing that operation until its proper season in summer.

2575. The scrotum does not bleed in castration, but the tail often bleeds in docking for a long time in two minute and forcible streams, though usually the bleeding soon stems. Should it continue as long as to sicken the lamb, a small cord should be tied firmly round the end of the tail; but this must not be allowed to remain on above 24 hours, as the point of the tail would die by the stoppage of the circulation of the blood, and slough off.

2576. In some cases inflammation ensues, and the scrotum swells, and even suppurates, when the wound should be carefully examined, the matter discharged, and the wound soon heals. The advantage of performing the operation in the morning is, that the several cases may be observed during the day; and should the weather have changed for the worse towards the afternoon, the ewes, with the lambs that have just been cut, should be brought under shelter all night. Besides the state of the weather, one cause of inflammation is the scratching of the wound of the scrotum by the points of the stubble amongst the new grass, and this irritation is most likely to be induced when the castration has been performed by cutting off the point of the scrotum. To avoid this source of irritation, the new-cut lambs should be put into a field of new grass, where the stubble has been mown short, or into a field of old grass, for a few days. The practice of applying turpentine to the incision on the scrotum gives unnecessary pain, and serves no good purpose.

2577. Sometimes one of the testicles does not descend into the scrotum, in which case the lamb becomes what is called a *chaser*, that is, one which constantly follows the females of the flock, when near him, from insatiable desire.

2578. Ewes and lambs are subject to these various risks, until they may be said to be beyond danger; and when they have passed through those several trials in safety, the shepherd may calculate on the result of his success,—he may then endeavour to ascertain whether he has increased the breeding part of his flock in the proportion it should have increased. He should not be satisfied with his exertions, unless he has preserved one-half the number of ewes with twin-lambs, nor should he congratulate himself if he has lost a single ewe in lambing. I am aware these results cannot always be commanded; but I believe an attentive and skilful shepherd will not be satisfied for all his toil, night and day, for three weeks, if he has not attained those results. The ewes may have lambed twins to greater number than the half, and yet many pairs may have been broken to supply the deficiencies occasioned by the deaths of single lambs. The death of single lambs is a vexatious matter to a shepherd, as it not only breaks the pairs, but imposes very considerable trouble on him in *mothering* the lambs of broken twins upon the ewes which bore the single lambs; and yet the trouble must be undertaken, to retain the ewes in milk that have lost their lambs, and also to maintain them in a breeding state for future years.

2579. In fine steady weather, the shepherd proceeds with his labour in comparative ease; but when stormy or wet weather prevails, or comes at unexpected intervals, the number of lambings are not only accelerated; but every ewe most probably creates some trouble, even in the day-time. "Daylight has many eyes," and permits him to observe casualties in time to remedy their effects; but at night, in bad weather, with glimmering light, difficulties increase tenfold; and so sensibly have I witnessed such difficulties myself, I am convinced every farmer of a large flock would find it repay him at the end of the lambing season, in the increased number of preserved lambs and ewes, to afford the shepherd assistance *at night* in the most busy period of the lambing season, according to the circumstances of the case.

2580. In regard to the yield of lambs of the Cheviot breed, it is considered a favourable result to rear a lamb for each ewe; with South-downs a little more; and with Black-faced ewes, 18 lambs out of the score of ewes is perhaps one as favourable. Cheviots yield a few pairs, South-downs a few more, Black-faced very few, and half the number of Leicester ewes should have twin lambs. The Cheviot and South-down ewe sometimes requires assistance in lambing, the Black-faced seldom, the Leicester always.

2581. The state of the new grass-fields occupied by ewes and lambs requires consideration. Ewes bite very close to the ground, and eat constantly as long as the lambs are with them; and as they are put on the new grass in the latter end of March, before vegetation is much advanced, they soon render the pasture bare when overstocked, in the most favourable circumstances, and especially when the weather is unfavourable to vegetation. In cold weather in spring, bitten grass soon becomes brown. Whenever the pasture is seen to fail, the ewes should be removed to another field; for if the plants are allowed to be bitten into the heart in the early part of the year, the greater part of summer will pass ere they will recover from the treatment. In steady growing weather there need be little apprehension of failure in the pasture. Of the sown pastures, consisting chiefly of red clover and rye-grass, the clover is always acceptable to sheep; and in the early part of the season young shoots of rye-grass are much relished by ewes. On removing the ewes from the first to the second field, it is better to eat the first down as low as it safely can be for the plants, and then *hain* it—that is, leave it unstocked for at least a fortnight, to allow the young plants to spring again, which they will do with vigour, and with a much closer bottom—than to pasture every field for a longer time with fewer stock. Such a field, eaten down to the end of May, or beginning of June, and then *hained* and allowed to spring afterwards in fine growing weather, will yield a heavier crop of hay than if it had not been pastured in spring at all. Although the whole of the young grass on a farm, pastured lightly with ewes and lambs in the spring, were to grow as the season advances more rapidly than the ewes could keep it down, it will never produce the fine sweet fresh pasture which field after field will yield that has been eaten down in succession, and then hained for a time. But in removing ewes and lambs from a short to a full bite of grass, considerable caution is requisite in choosing the proper time for the removal. It should be accomplished in dry weather, and in the afternoon; because, continued damp or rainy, or cold wet weather, renders new grass so succulent and fermentable as almost certain to produce the *green skit* in the lambs, although that sort of weather increases the milk of the ewes. In the after part of the day the ewes have not time to eat too much grass before night-fall.

2582. Carse farms have neither a standing nor a flying stock of ewes, and consequently have no lambing season; neither have farms in the neighbourhood of large towns, nor dairy farms, nor pastoral ones for the breeding of cattle alone; so that ewes and lambs are only found on pastoral farms devoted to the breeding of lambs, and on farms of mixed husbandry.

2583. But pastoral farms rear breeds of sheep very different in their nature from the breed whose lambing season we have been contemplating, — a portrait of a ewe and lamb of which may be seen in Plate VII. On our hills the Cheviot and Black-faced, or Heath sheep, were long the only inhabitants, but now the valuable South-down is added to the list. The Cheviot and South-down thrive in semi-upland green mountain pastures, such as the Downs and the green hills of Cheviot, in England, and the green hills of Ochils, Sidlaw, and Lammermuir in Scotland; while the Black-faced are found on the highest mountains, not only as far as a plant of heath can grow, but even beyond it, in the region of the cryptogama.

2584. In as far as the assistance of the shepherd is required to be given to ewes in lambing, the observations I have made in reference to the lambing of Leicester ewes will apply to those of the Cheviot, South-down, and Black-faced breeds; but the ewes of these breeds do not require assistance nearly to the same extent as Leicester ewes, the lambs of the latter being generally larger in proportion to the ewes, and more square-built in form. Single lambs of the other breeds are usually brought forth without much assistance, and twin-lambs are so few that the ewes bearing them may be singled out for particular attention. A Cheviot single lamb soon gets on foot after being lambed, and its acute instinct as soon directs it to the teat. The Black-faced lamb is fully more active after being dropped, gaining its feet in a few minutes, and its rough coat of wool serves to protect it at once from the weather.

2585. Placed in shelter derived from one of the many natural inequalities of the ground common in a pastoral country, both these breeds may easily be tended in the lambing season during the day; but the constant attention required of the shepherd limits his ability to superintend, at this particular period, a lambing flock beyond a certain number: 400 ewes are as many as one shepherd can superintend in the course of the day, to render them the assistance they may stand in need of; to place the new-lambed ewes and lambs in shelter until they have both perfectly recovered, and are able to take to the pasture; and, in case of bad weather, to supply them with turnips and hay, to enable them to support their lambs until the weather becomes favourable. If one shepherd fulfils these duties in the day, he does quite enough; so that it will be necessary to have an assistant for him in the night, to gather the ewes into shelter at night-fall, and to take a weakly lamb, or all the lambs that have dropped during the night, into sheds erected on purpose as a protection against bad weather. To ascertain the state of his flock, he should go through them with a lantern, at least every two hours, and oftener if necessary. Lord Napier recommends the construction of a "*lambing park*," for the use of ewes, and gives the cost of making one to comprehend 25 acres of ground, which shall accommodate 200 ewes for two months, with 2 stells and 2 stell-houses, and hay-racks, at £90, which, at 7 per cent interest, with repairs of racks, &c., will incur an annual cost of £7, 5s. 8d.* Such a place of shelter and of enclosure would, no doubt, be useful to a certain extent, but only to a limited extent; for such a park can only be formed in one part of the grazings, where at times it will no doubt be exposed to the weather, and as 25 acres would only contain one-fifth of the flock at a time, in stormy weather the rest, whether already lambed or yet to lamb, require shelter as well as ewes expected to lamb; and the dividing of the flock every day to get the 200 ewes with their lambs out, and other 200 driven in, would make a serious commotion amongst the ewes at a very critical period. I cannot help thinking that a chosen spot selected to afford shelter, according to the circumstances of the weather, to all the ewes yet to lamb within a given time, and where they could be partly supported on artificial food, whilst those which have lambed could occupy at night a sheltered part of the best portion of the pastures, would disturb lambing ewes far less than a lambing park which was not constantly occupied by all the ewes. It should be remembered that hill sheep cannot be so easily shifted from one place to another as Leicester sheep, and especially in a grazing which has few or no enclosures.

2586. Small pieces of English blanketing, to be kept dry when not in use, to wrap round and keep warm a weakly lamb in the shed, until

* Napier *On Practical Store Farming*, p. 155.

it becomes strong by the effects of its mother's milk, or of warm cow's milk administered by the shepherd, will be found useful articles by every shepherd, and may be the means of preserving the life of many a lamb. Many a lamb I have seen recruited by this means, when it would have otherwise perished of inanition.

2587. The period of lambing, in hill sheep, is longer than that of Leicesters, because the gimmers are not tupped in the autumn until a fortnight after the ewes, and, of course, do not begin to lamb in the spring until a fortnight later. The ewes begin to lamb about the 20th April, and the gimmers a fortnight after.

2588. To strengthen the gimmers, and to bring a flush of milk upon them, they are separated from the ewes about a month before *their* lambing time, and are supplied with turnips to the amount of a double horse-load, say 15 cwt., to every 100 or 120 gimmers. About a fortnight before the ewes lamb, they get the same quantity of turnips for every 160 ewes. In mountain farms, where there are no turnips, hay should be supplied in the same manner to the gimmers and ewes. A quantity of hay, expended at this time, will be more than repaid in the safety of the lambs and the vigour of the ewes, especially in unfavourable weather.

2589. A few observations by Mr Little on the qualifications of a *hill shepherd*, are worth your perusal, as containing much good practical sense. "Much," he says, "of the success in sheep-farming depends on the skill and application of shepherds, as well as on the judgment of farmers. As the situation of a shepherd is one of considerable trust, he ought to be honest, active, useful, and of a *calm temper;* for if at any time a shepherd gets into a passion with his sheep, it is attended with great disadvantage in herding, or in working among them. I have known a hasty passionate man, with a rash dog, give himself double the trouble in managing a hirsel of sheep, besides abusing the sheep, that a calm good-tempered man, with a sagacious close-mouthed dog, would have had in the same circumstances. The qualification required in taking care of a hirsel of sheep, is, not in running, hounding, and training dogs, nor in performing a day's work of any other kind; but in directing them according to the soil, climate, and situation of the farm, in such a manner as they shall obtain the greatest quantity of food at all seasons of the year. Their health and comfort should be carefully looked after by the shepherd: and if his exertions are made with judgment, they are of very great consequence to the farmer. It is not by walking much, and doing a great deal, that a shepherd is a good one; but it is knowing *where* to walk, so as to disturb the sheep the least, and by doing at the time whatever is necessary to be done. There is not an experienced shepherd, who has been any length of time on one farm, who does not, as soon as he rises in the morning, and observing the state of the weather, know almost to a certainty where to find every sheep on the hill, and will accordingly take his course to the places where he knows his presence is most wanted. The object in looking over a hill every evening and morning, is to ascertain if there be no trespassers nor disease among the sheep which require looking after. If any of your own or neighbour's sheep have trespassed, it is very foolish to dog or abuse them, for the more gently you can turn them back the better. If the boundary should be on the top of a height, to which sheep are apt to draw at night, it is better to turn your own a little closer to the boundary in the afternoon, than to turn back your neighbour's, and it will answer the same purpose; and if the two flocks are gently divided in the morning, without dogs, they will become so well acquainted with their own side, that at the very sight of the shepherd they will take to it without farther trouble. Those shepherds who dog, force, and shed much about a march, I consider them as bad herds for their masters as for the neighbouring farmer. If the boundary be a brook or low ground, where the sheep graze in the middle of the day, and if trespasses are likely to be considerable, the same plan of turning the sheep should be taken as on the height, except that they are to be turned down in the morning, and set out in the afternoon. When a sheep dies on the hill, or any disease appears among them, the dead or diseased sheep should be removed immediately, but particularly so if the disease is of an infectious nature. Looking regularly over a hill is of great consequence, also, in case of any sheep falling into a ditch, or lamb losing its mother, or when they are annoyed by flies or maggots, or by foxes or dogs worrying them, or when they fall on their back and cannot get up again. All these incidents an active shepherd with a good eye will soon discover, however much a flock may be scattered over a farm. . . . In good weather the shepherd may possibly do all that can be done among the ewes in the lambing season; but in bad weather it is the farmer's interest to afford every necessary assistance, for the want of which, serious losses have often been incurred. . . . Knowing sheep by head-mark often saves a shepherd much trouble, particularly in the lambing season, and at all sortings of the sheep; yet there are many good shepherds who do not know sheep by head-marks, and there are some very ordinary ones who have a talent in that way. Every individual may be known by the *stock* mark. To possess the knack of *counting* sheep readily is of no small service to a shepherd, for he ought always to be able to count his flock when he makes his rounds on the hill. There are few shepherds who accustom themselves to count sheep, who cannot, wherever they meet with them on a hill, count 100 going at large, or even 200, and it seldom happens that a greater number than 200 will be found together in an open hirsel. To know the number in the different lots is of great use in case of a hasty blast, as you can, in that event, know almost to a certainty whether or not any sheep are awanting, and from what part of the farm. A shepherd ought likewise to be able *to do any kind of work about a sheep farm,* such as cutting lambs, smearing, slaughtering, dressing for the market, repairing stone-dykes, cleaning out drains, mowing grass, making hay, casting and winning peat-turf for fuel, &c.; but he ought at no time to neglect the sheep for such work. Shepherds are generally accounted lazy; but those who really care for their sheep will not be so. Much walking unfits a man for hard labour, as much as hard labour unfits a man for much walking; but labourers will generally be found more lazy on a hill, or among sheep, than shepherds at field-work."*

2590. *Slipping of the lamb.*— Ewes in lamb are liable to abortion, or slipping of the lamb, as it is termed, as well as the cow, but not so much, nor is the complaint considered epidemical in the sheep. Various causes produce it, such as severe weather in winter, having to endure much fatigue in snow, leaping ditches, being frightened by dogs, over-driving. It is stated by Mr. Youatt, that too liberal use of salt will produce abortion. The wool is apt to come off in spring after abortion. It is scarcely possible to predicate abortion in sheep, on account of their woolly covering, but its immediate effects of dulness on the ewe, and of a redness under the tail, will be symptoms noticed by an observant shepherd. "The treatment after abortion," observes Mr Youatt, "will depend entirely on the circumstances of the case. If the fœtus had been long dead, proved by the fetid smell of it, and of the vaginal discharge, the parts should be washed with a weak solution in water (1 to 16) of the chloride of lime, some of which may also be injected into the uterus. If fever should supervene, a dose of Epsom salts, timeously administered, will remove the symptoms. If debility and want of appetite should remain, a little gentian and ginger, with small doses of Epsom salts, will speedily restore the animal. Care should be taken that the food shall not be too nutritive or too great in quantity."

2591. *Labour of ewes.*—In protracted labour, when the ewe is becoming weak, she will be much relieved by receiving a table-spoonful of brandy and sweet spirit of nitre in equal parts, with a drinking-horn. To produce pains in a ewe when she becomes apathetic in lambing, 2 table-spoonfuls of a strong infusion of the ergot of rye, repeated in a second dose in a quarter of an hour, will produce pains and ease the labour. In cases where it is impossible to extract the lamb, and the life of both lamb and ewe is in danger, the Cæsarian operation—that is, extracting the lamb from the womb by an incision made in the side and in the womb of the ewe—has been performed with success. "In some lambs that are born apparently dead, the vital principle is not extinct, but it would soon be so if the little animal were suffered to remain on the cold damp grass. Every lamb that is found in this situation should be carefully examined, and if there is the slightest degree of warmth remaining about it, the shepherd should blow into its mouth in order to inflate the lungs: many a little one has thus been saved. The shepherd need trouble himself very little about the expulsion of the placenta or *cleansing*, although a day or two may pass before it is detached. A couple of ounces of Epsom salts, with a little ginger, may be given if there should be a longer delay, or if symptoms of fever should be exhibited; but the farmer would do well to avoid the rough barley or the misletoe, or in fact any stimulant, for there is at this time sufficient disposition to fever, without its being artificially set up."

2592. *Inflammation.*—"The inflammation of the womb, after parturition, usually comes on between the first and the fourth day, and especially when any violence has been used in extracting the lamb. It is a most fatal disease, and speedily runs its course. The treatment should be bleedings and purgatives of Epsom salts. Connected with this disease are after-pains or heaving, to which ewes are subject, and which are frequently severe and destructive. They are apparently the same pains, but considerably stronger, which nature uses to expel the lamb. It is evidently produced by the ewes being too well kept during their pregnancy. It cannot be too often repeated, that it is a fatal error to overfeed the ewes at this period, with the view of giving them strength to support their approaching labour. It is a most unscientific and injurious practice, and severely does the farmer suffer for it. But there is some epidemic influence at work, or the constitution of the sheep is at that time irritable almost beyond belief."

2593. *Purging in lambs.*— Young lambs, as long as they are dependent on their mother for food, are subject to few diseases. A change to new luxuriant grass in damp weather may bring on the *skit* or diarrhœa, and exposure to cold may produce the same effect. As long as it feeds and plays, there is little danger; but should it appear dull, its eyes watery and heavy, and its joints somewhat stiff, remedial means should immediately be used. "A gentle aperient is first indicated in order to carry off any offensive matter that may have accumulated in and disturbed the bowels; half an ounce of Epsom salts, with half a drachm of ginger, will constitute the best aperient that can be administered. To that must be added a table-spoonful of sheeps' cordial, consisting of equal parts of brandy and sweet spirit of nitre, housing and nursing." But there is a species of apparent purging, which is a more dangerous disease than the skit. "In the natural and healthy state of the milk and the stomach, curd produced by the gastric juice gradually dissolves and is converted into chyme; but when the one takes on a morbid hardness, and the other may have lost a portion of its energy, the stomach is literally filled with curd, and all its functions suspended. The animal labours under seeming purging, from the quantity of whey discharged, but the actual disease is constipation. It is apt to occur about the time when the lamb begins to graze, and when

* Little's *Practical Observations on Mountain Sheep*, p. 79-86.

the function of the stomach is naturally somewhat deranged. Chemistry teaches us, that while a free acid produces coagulation of the milk, an alkali will dissolve that coagulum. Magnesia, therefore, should be administered, suspended in thin gruel, or ammonia largely diluted with water, and with them should be combined Epsom salts to hurry the dissolved mass along, and ginger to excite the stomach to more powerful contraction. Read's stomach-pump will be found a most valuable auxiliary here. A perseverance in the use of these means will sometimes be attended with success; and, the little patient being somewhat relieved, the lamb and the mother should be moved to somewhat better pasture."

2594. *Costiveness in lambs.* — Besides looseness, lambs are at times subject to costiveness in the bowels. In the first few days of its existence the fœces they void has a very viscid consistence, which, when it falls on the tail, has the effect of gluing it to the vent and of stopping up that passage. On the removal of the obstruction by scraping with a knife, the symptom will also be removed. A worse species of costiveness is, when a few drops of liquid fœces fall occasionally to the ground accompanied by straining, as it is generally accompanied with fever that may be dangerous. Half-ounce doses of Epsom salts should be administered every 6 hours until the bowels are evacuated, after which both ewe and lamb should be turned into more succulent pasture, as the cause of the complaint is to be found in bare pasture in dry weather.

2595. *Fever in lambs.*—In cases of fever, which may be observed from the dulness of the lamb and its quick breathing, the administration of tolerable doses of Epsom salts will generally avert the malady *at its commencement.*

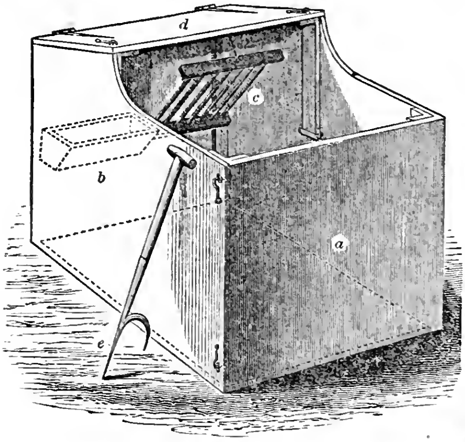
2596. *Udder-clap.*— After recovery from lambing, the only complaint the ewe is subject to is inflammation in the udder, or *udder-clap* or *garget.* Of this complaint Mr Youatt gives a good idea of its origin and of its treatment in these words:—"The shepherd, and especially in the early period of suckling, should observe whether any of the ewes are restless and exhibit symptoms of pain when the lambs are sucking, or will not permit them to suck at all. The ewe, like the cow, or oftener than that animal, is subject to inflammation of the udder during the time of suckling, caused either by the hardness or dryness of the soil on which she lies; or, on the other hand, by its too great moisture and filth, or by some tendency to general inflammation and determination to the udder by the bumps and bruises, sometimes not a little severe, from the head of the lamb. If there is any refusal on the part of the ewe, or even disinclination, to permit the young one to suck, she must be caught and examined. There will generally be found redness and enlargement and tenderness of one or both of the teats, or sometimes the whole of the udder, and several small distinct kernels or tumours on different parts of the bag. The udder should be cleared of the wool which surrounds it, and should be well fomented with warm water, a dose of Epsom salts administered, and then, if there are no large distinct knots or kernels, she should be returned to her lamb, whose sucking and knocking about of the udder will contribute, more than any other means, to the dispersion of the tumour and the regular flow of milk. It may occasionally be necessary to confine her in a pen with her little one, in order that he may have a fair chance to suck. A day, however, having passed, and she not permitting it to suck, the lamb must be taken away, the fomentation renewed, and an ointment, composed of 1 drachm of camphor rubbed down with a few drops of spirit of wine, 1 drachm of mercurial ointment, and 1 oz. of elder ointment, well incorporated together, must be rubbed into the affected part, or the whole of the udder, two or three times a day. She must also be bled, and the physic repeated. If the udder should continue to enlarge, and the heat and tenderness should increase, and the knots and kernels become more numerous and of greater size, and some of them should begin to soften or evidently to contain a fluid, no time must be lost, for this disease is abundantly more rapid in its progress in the sheep than in the cow. A deep incision must be made into that part of the udder where the swellings are ripest, the pus or other matter squeezed out, and the part well fomented again. To this should succeed a weak solution of the chloride of lime, with which the ulcer should be well bathed two or three times in the day. When all fetid smell ceases and the wound looks healthy, the friar's balsam may be substituted for the chloride of lime. The progress of disorganisation and the process of healing are almost incredibly rapid in these cases. and the lamb may sometimes be returned to the mother in the course of a few days. There are particular seasons, especially damp and warm ones, when there is a superfluity of grass, in which garget is peculiarly frequent and fatal. Without warning, the udder swells universally with hardened teats, which sometimes bring on great inflammation, and if that is not stopped in the course of 24 hours, part, if not the whole, of the udder mortifies, and the mortification rapidly spreads, and the sheep dies."*

2597. In case of an individual ewe, of a large flock of a pastoral farm, straying a considerable distance from the shed erected to afford shelter to ewes, or has suffered in hard labour, or has a weakly lamb, or has twins which are apt to stray from her or she from them, or has been overtaken by a rude blast immediately after lambing, a contrivance to afford such ewes temporary shelter, especially under night, having been used by Mr Nicholas Burnett, Blaik Hedley, near Gateshead, with success, seems to deserve attention. It consists of an enclosure of boards, or a box, as seen in fig. 226, whereof *a* is the front, which removes by hooks at the sides to admit the

* Youatt *On Sheep*, p. 497-515.

ewe and her lamb within, and where she is provided with a manger *b* to contain sliced turnips or oil-cake, and a rack *c* for hay, to fill both of which access is obtained by the lid *d*, movable on its hinges. I have been assured by Mr Bur-

Fig. 226.



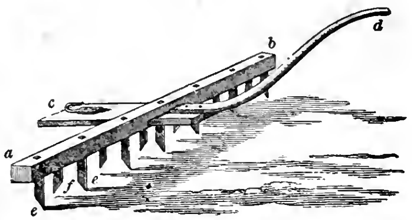
THE EWE-HOUSE.

nett, that in using this contrivance, which, being a light implement, can be easily carried to any spot, he has had the satisfaction of using it as a means of saving the lives both of ewes and lambs which would have otherwise perished from exposure. The size of the *ewe-house*, as it is called, may be made to suit that of the sheep bred on the farm, and as it is not costly, any number can be made to be used at a time; but a useful size will be found to be the following:—Length 5 feet 6 inches, breadth 3 feet, height 3 feet, breadth of the covered part *d*, 2 feet 7 inches, and rise of the slope at *d*, 7 inches. The fork *e* leaning against the side of the ewe-house may be used to grasp a ewe's neck, while lying on the ground, and to fasten it down, while the shepherd is lambing her without other assistance; but the method of holding a ewe between the heel and knee, which I have described above, (2547,) renders such an instrument of little use.

2598. One of the greatest sources of loss among lambs on hill farms is a fall of snow at the lambing season, or a continuance of snow to that period, Ground rendered wet by the melting of new-fallen snow is in a worse state for lambs than when made wet by rain, as in the latter case the temperature of the air is higher, though wet ground of every kind is inimical to the safety of new-dropped lambs. In such a case, the driest part of the farm, combined with shelter, should be chosen for the lambing ground, though it may be inconvenient in some other respects; but should the best lambing ground be covered with old snow, especially in sheltered spots, and the temperature of the air be generally above the freezing point, could the snow be stirred by any means, it would melt much faster than it would of itself.

2599. *A snow-harrow and* a *snow-plough* will be found useful implements for the purpose, and those recommended by Mr Hepburn of Culquhalzie seem to possess every requisite. The snow-harrow is represented by fig. 227. It consists of a single bull *a b*, $4\frac{1}{2}$ inches square, and 6 feet

Fig. 227.



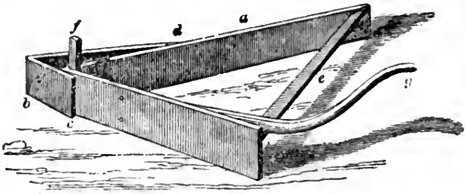
THE MOUNTAIN SNOW-HARROW.

long; and in the middle of which, on the under side, a piece of $1\frac{1}{4}$-inch plank *c*, 3 feet long, is sunk flush transversely, for the attachment of the draught-hook *c*, and the stilt *d* to steady the motion of the implement. In the bull are fixed, by screw-nuts at intervals of 10 inches, 7 cutters *e e*, &c., 9 inches long and $1\frac{3}{8}$ inch broad, sabre shaped, with their points turned backwards, so as to be less liable to be arrested by obstacles on the surface of the ground. Between these cutters are fixed 6 shorter ones *f*, &c., 3 inches long, having their points turned forwards. This implement, dragged by one horse ridden by a boy, and the stilt held by a man, cuts the frozen snow into stripes of 5 or 6 inches broad, which are easily pulverised by the feet of the sheep, or divided by the snow-plough. The severe snowstorm of 1823 lay on the hills from February to May; and the protracted snow-storms of 1837-8, with repeated falls and alternatioas of frost and thaw, caused the death of many a sheep before and at the lambing season. The snow became so compact in the latter year, that the common snow-plough was unable to penetrate it, and the common harrow to break its glazed surface.

2600. With the view of obviating both these inconveniences, Mr Hepburn contrived the snow-harrow described above, and also the snow-plough, of which the following is a description in Mr Hepburn's own words:—"The severity of the winter of 1837-8 in mountain sheep-pasture, led me to attempt the snow-plough, with or without the aid of the snow-harrow, for being applied in such situations. To enable the plough to clear tracks for the sheep along the hill sides, it is necessary it should be made to throw the snow wholly to the lower side. To effect this I caused to be fitted to the plough *a*, fig. 228—the body of which forms an isoceles triangle whose sides are $7\frac{1}{2}$ feet, and its base 6 feet in length, the depth of the sides being 15 inches—a shifting head *b c d*, with unequal sides; one, *b c*, being 18 inches, the other, *b d*, 30 inches long, fixed by iron pins passing through two pairs of eyes as seen at *c*, attached to the head and to the sides of the plough respectively, so as to bring the point of the attached head of the plough nearly into the line of its upper side, or next the hill.

The stilt *g* at the same time was made movable by a hinge-joint at its anterior extremity, fixed to the bottom of the head from the post *f*, so as to be capable of being fixed to the cross-bar or

Fig. 228.



THE MOUNTAIN TURN-WRIST SNOW-PLOUGH.

stretcher *e*, either in the line bisecting the angle, as at *e*, which is the position for level ground, or in the line, alternately, of either of the sides, *b a* or *b c*, when to be used on a declivity. The draught-chain is fixed, not to the shifting head, but to the upright frame-post *f*, in the nose of the plough, which rises 10 or 12 inches above the mould-boards. When the plough so constructed is to be worked along a declivity, with the left hand towards the hill, the shorter limb of the shifting head is fixed on the left side of the plough, near the point, and the longer limb on the right side, towards the middle; and the stilt being fixed in the left extremity of the cross-bar, nearly in a line with the temporary point, the plough is necessarily drawn in the direction of its left side, so as to throw the snow wholly to the right down the hill. When the plough is to return across the declivity, with its right side to the hill, the movable head is detached by drawing out the linch-pins, is turned upside down, and fixed in the reverse position; the shorter limb being attached to the right side, and the longer to the left side of the plough, while the stilt is brought to the right extremity of the cross-bar. The plough is then drawn in the direction of the right side, and the snow is thrown wholly to the left, near the lower side. Should the lower side of the plough show a tendency to rise, it may either be held down by a second movable stilt, fixed to the middle *e* of the cross-bar, or a block of wood, or other ballast weight may be placed on that side of the plough. The plough will be found to remove considerably more than its own depth of snow. When a plough of 1 foot high passes through snow 18 inches or 2 feet deep, very little of the snow falls back into the track, and what does so fall is easily cleared out by the plough in returning."*

2601. In lowland farms the snow remains around the fences long after the middle of the fields are clear. A speedy means of getting rid of the snow is to cut it with the common plough repeatedly. Had I not adopted this expedient in the spring of 1823, the oat-seed would not have been begun for a fortnight later than it did.

2602. In regard to the treatment of sheep on turnips in spring, they are managed in the same way as in winter, until removed to grass, which they are whenever the turnips fail, and are kept on for a short time until the weather becomes mild enough to have them shorn of their wool, and then sold to the butcher; but other farmers prefer selling them fat in the *rough* state off the turnips, that is, before the wool is clipped off them. The circumstances which regulate these different cases will be explained in Summer.

ON CROSS-PLOUGHING LAND.

2603. Immediately after the sowing of the oats is finished, preparations are made for sowing such of the turnip land with barley as has been made bare by the direct removal of the turnips, or the eating them off by the sheep, after the time for sowing the spring wheat has expired; and the first preparation of the soil for the barley seed is the ploughing it across, or at right angles to the future ridges. This operation I shall describe, not merely in reference to the preparation for the sowing of the barley, but to other operations.

2604. I have already stated in (768,) that the object of cross-ploughing is to cut the furrow-slices into small pieces, so that the land may be the more easily pulverised; and I have also shown that the land is feered and the horses directed for cross-ploughing, in the same manner as for ploughing two-out and two-in; and have indicated the state in which the land is left by that operation—a state in which it would be very improper to leave it all winter (2448.)

2605. The surface of the ground, as left by the sheep on eating the turnips growing on it, is in a smooth state, presenting no clods of earth but numbers of small round stones, when the soil is a dry gravally loam. The larger of these stones should be removed with carts filled by the field-workers before the cross-ploughing is even begun to be feered. These small stones are useful in filling any drain that may be near at hand, or they may be broken in a convenient place for metal to repair a farm road. A plough then starts and feers the ground for cross-ploughing, and the rest of the ploughs cross-plough the land as described in (768.)

* *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 191.

2606. The reason that the land is cross-ploughed for barley, and not for spring wheat, after turnips eaten off by sheep, is that wheat thrives best when the soil is somewhat firm, and not too much pulverised—whereas the land cannot be in too pulverised a state for barley; and, besides, if the turnip land were not cross-ploughed after the sheep have left it, their manure would not be sufficiently mingled with the soil, and the consequence would be that the barley would grow irregularly in small stripes, corresponding to the drills that had been manured for the turnip crop.

2607. During the time the land is gradually preparing for the barley seed, as the sheep clear the ground of the turnips, the stubble land, which had been ploughed early in winter, and which is to bear the green crops in the ensuing season, should now be cross-ploughed as opportunity offers, after the oat seed is completely finished upon ploughed lea-land; for in high districts, where barley is not sown, oats are sown on the turnip land after sheep; and, where this is done, the oats are treated in the same manner as barley. The portion of the stubble land first to be cross-ploughed is for the culture of the potato.

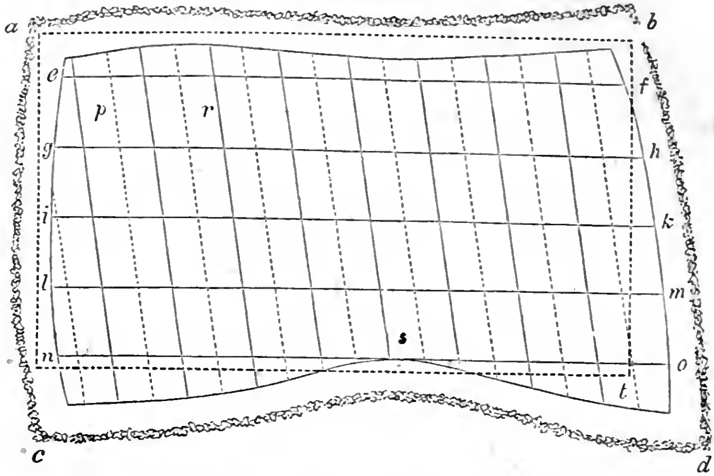
2608. The first thing to be done in preparing any winter-ploughed field for cross-ploughing is to render its surface as free of large clods as possible; and this is effected by *harrowing*. The winter's frost may have softened the clods of the most obdurate clay-soil, and the mouldboard of the plough may be able to pulverise them fine enough, and the lighter soils may have no clods on them at all; from all which circumstances, it may be regarded as a loss of time to harrow the ground before cross-ploughing it in spring, and, for these reasons, I believe, some farmers do not then practise harrowing; but it appears to me to be the most certain plan of pulverising the soil to harrow it before cross-ploughing the winter furrow; because you cannot be sure that, even in the strongest soil, all the clods have been softened to the heart by frost; and should any happen to be buried by the cross-furrow while still hard, they will not afterwards be so easily pulverised as when lying exposed upon the surface of the ground to the action of the harrow; and in the lightest soils, the harrows not only make a smoother surface, but assist in intermixing the dry frost-pulverised soil of the surface with the moister and firmer soil below, at least as far as the tines of the harrows can reach.

2609. There is not much time lost in harrowing before cross-ploughing; for although the harrowing should require a *double tine*, to pulverise the clods, or equalise the texture of the ground, the harrowing should be *across* instead of along the ridges, that the open furrows may be filled up with soil as much as possible, whether the land had been ploughed with gore-furrows, fig. 23, or not. The most obdurate state of ground can be harrowed in a short time.

2610. Two pairs of harrows should be set to cross-harrow together, as being the best method of harrowing effectually in all cases; and, when unconfined by ridges in cross-harrowing, will cover at least 16 feet in breadth, and proceeding at the rate of 2 miles per hour, for 9 working hours, will give 19 acres of ground a double tine, without interruptions; but, as much time is lost in turnings, as you have already seen (721,) and as time for taking breath must occasionally be given to the horses, that quantity of land cannot be cross-harrowed a double tine at that rate of travelling; but say that 16 acres are cross-harrowed in the course of a day, a half day's harrowing will make room for a number of ploughs.

2611. If time presses, the feerings for cross-ploughing may be commenced to be formed by one plough almost immediately after the harrows have started; and if the harrows cannot get away before the plough, it should take a bout or two in the first feering, till the harrows have reached the next feering, or the harrows may pass along the line of each feering, preparing each line for the plough, and then return and finish the harrowing of the ground between the lines of feerings. Thus, in fig. 229, after the line of feering *e f* across the ridges has been harrowed, the plough can either take a bout or two around *e f*, till the harrows have passed the next line of feering *g h*; or the harrows can go along each line of feering, first *e f*, then *g h*, then *i k*, and so along *l m* and *n o*, in succession, to prepare the ground for feering, and then return and harrow out the ground between *e* and *g*, *g* and *i*, *i* and *l*, and *l* and *n*. In this way the harrowing, and feering, and

Fig. 229.



A FIELD FEERED FOR BEING CROSS-PLOUGHED.

the ploughing of the different feerings, may be proceeded with at the same time. But if the time is not urgent, the systematic mode is to harrow the field across in a continuous manner, beginning along the fence *a b* from the gate at *b*, and proceeding by breadths of the harrows across the field till the other side of it *c d* is reached; or another equally effective mode is to step off feerings from *a b*, in breadths of 30 yards in succession, across the field towards *c d*, which has the advantage of giving a wider, and therefore easier turning to the horses at the landings.

2612. Suppose, then, that all or as much of the field to be cross-ploughed has been harrowed as will give room to a single plough to make the feerings without interruption. In choosing the side of the field at which the feerings should commence, it is a convenient rule to begin at the side farthest from the gate, and approach gradually towards it, and the convenience consists in not having to pass the ends of the finished feerings, and thus avoiding the trampling of the ploughed land to get at the unploughed. The convenience of this rule is felt not only in cross-ploughing, but in prosecuting every species of field-work; and besides avoiding the risk of damage to finished work, it is gratifying to the minds of labourers to think that, as their work proceeds, they approach the nearer home; while it conveys to others the idea of a well-laid plan, to witness the operations of a field which have commenced at its farthest end, and are finished at the gate, where all the implements employed meet, ready to be conveyed to another field. The gate is like home, and in most cases it is placed on that side or corner of the field nearest the steading. In the particular case, however, of the field represented in fig. 229, all these conveniences are not available, owing to the form of the field, which is a very common one; and peculiarities of form involve considerations in regard to conducting field operations of more importance than mere convenience; and one of these considerations is the important one of loss of time. It is always desirable to commence a feering at a *straight* side of a field, whence but little risk of error can arise in striking off the feerings to include parallel spaces of ground; and where this particular is not attended to, much time is needlessly spent in ploughing a number of irregular pieces of ground. It is better to leave all irregularities of ploughing to the last; and as an irregularity must occur, at all events, along the side of a crooked fence, it is a saving of time to throw the irregular ploughing to that side. In fig. 229 it so happens that the straighter side of the field is nearest the gate at *b*, and the crooked fence, *c* to *d*, farthest from it. In pursuance of the rule propounded, the feering should begin along the side of the straight fence *a b*, and terminate in an irregular space along the crooked fence *c d*. A straight feering could, no doubt, be made at first near *c d*, leaving irregularities between it and the fence; but the setting off that feering *exactly parallel* with the straight fence *a b*, to avoid making another irregularity there, would impose considerable trouble, and take up more time than the advantage would compensate for avoiding the inconvenience of having to pass the ends of the ploughed ground along the side-ridge from *d* to *b*.

2613. Let the first feering, then, be made about 7 or 8 yards from the fence *a b*, or from the ditch-lip of the fence where there is a ditch. Some farmers neglect the head-ridge in the cross-ploughing, and measure the feering from the open furrow between it and the ends of the ridges. I maintain that the head-ridges should be ploughed at this time, as well as the rest of the field, and if neglected now, the busy seasons of spring and of early summer will prevent attention being paid to them, till, what with the trampling of horses in working the land for green crop, and the probable drought of the weather, they will become so very hard, as to be found impracticable to plough them at all, and they will then be deprived of the ameliorating effects of the sun and air in the best part of the year. Let them, therefore, be included in the cross-ploughing of the field, though they cannot be *cross*-ploughed themselves.

2614. But if it be desired to plough them with the side-ridges, which form the head-ridges in the cross-ploughing, after the cross-ploughing of the field has been finished, and the side-ridges must be ploughed before the crop, whatever it may be, can be sown upon them, the first feering should then be struck at 7 or 8 yards down the ridges from the side of the head-ridge. Suppose that this line of feering is *f e;* and as it is executed in the same way as already described in feering-ridges in fig. 19, where the furrow-slices *m n* are shown to be thrown out right and left from the lines of feering *k l*, and *o n*, I refer you to (742.) The next line of feering is *h g*, fig. 229, at 30 yards' distance from *f e*, and so on a feering is made at every 30 yards' distance, to the last feering *o n*. As each feering is formed by the ploughman appointed to make them, the rest of the ploughmen begin the cross-ploughing at every feering in succession; and should all the feerings have been finished before the ploughs have entered the field, the ploughs can commence the ploughing at once.

2615. The ploughing of the ordinary feerings is all plain work; but a difficulty occurs at the last or irregular feering at *o n*—not that any intricacy is involved in the ploughing of irregular pieces of ground, but the loss of time incurred is considerable. This feering is ploughed like the rest, till the nearest point to the open-furrow of the head-ridge is attained; and if the head-ridges have been included in the feerings, the ploughing proceeds till the ditch-lip or fence is reached by the plough; but if left to be ploughed with the side-ridges, the last feering should be made across the lowest end of the ridges at the head-ridge open-furrow, as *o n*, and the ground included between the open-furrow and the feering should be ploughed out by *hieing* the horses, with the ordinary furrow above, *o n*, and an interrupted one below it, the plough passing along the head-ridge opposite to *s*, and leaving it unploughed. This feering will take longer time to plough than any of the rest, in proportion to the quantity of ground turned over.

2616. Had the field been a true rectangle, like the space included within the dotted lines *a n t b*, the feering might have been struck from either fence, and there would have been no loss of time in ploughing alternate long and short furrows. Scarcely a more instructive estimate can be made of the loss of time occasioned in ploughing land of the same extent than between a field of irregular and regular form.

2617. The distances between the black and dotted lines represent the single, and those between the black and between the dotted lines, double ridges.

2618. The furrow given at cross-ploughing is always deep, deeper than the one given at the commencement of winter; and this is easily accomplished, by the land not having had time to consolidate by the labour bestowed upon it, when the plough passes easily under the old furrow, and raises a portion of the soil below it. It is requisite to go deeper to keep the plough steady, otherwise the winter turned-over furrow having in it still much unrotted stubble, would affect its motion and prevent the maintaining of an equal depth of furrow. Cross-ploughing the first furrow in spring is always an unsteady work, the open-furrows presenting no resistance to the plough compared with the land in the centre of the ridge. Perhaps 9 inches may be considered a good average depth in cross-ploughing with a pair of horses.

2619. But means are frequently used at this season to cross-plough with a deeper furrow than can be done by a pair of horses, by employing 3 or 4 horses for the purpose. The *third* horse is very commonly yoked in front of the furrow horse of the plough, and harnessed in the cart-traces, as represented in the trace-horse of the cart in Plate III, the hooks of the trace-chain being passed into a link of the plough-chains, behind the haims, of the rear horse. A simpler plan is adopted by using the plough harness, and lengthening the plough-chains by *short-ends,* which are short pieces of chain hooked in a similar manner to the trace-chains just described. Neither of these methods, however, will bear a comparison, in point of draught, with the yoking of 3 horses, as represented in fig. 8. I have an objection, however, to this mode of yoking, which is founded, not on its principle, which is faultless, but on account of the inconvenience experienced by the middle horse, which becomes more heated in the work than either of the other two. The inconvenience may not be much felt in early spring work, but at the time the largest proportion of cross-ploughing is executed, or in summer, the middle horse must suffer considerably more than the others, and I have frequently witnessed this in places where 3 horses are still yoked abreast to the harrows. Three horses will take a depth of furrow of 11 or 12 inches, according to the texture and depth of the soil.

2620. A still greater depth may be attained, by yoking 4 horses to a plough, 2 leading and 2 following, the 2 off ones walking in the furrow, and the 2 near ones on the firm land. Two convenient and efficient modes of yoking 4 horses may be seen in figs. 9 and 10. Yoked as in fig. 9, the leading horses are best harnessed, as in the traces of the cart, Plate III; but, as in fig. 10, they are in their usual plough harness, with the exception of the chains, which are made for this particular mode of yoking. The depth reached by a 4-horse plough is, on an average of soils, 14 inches. I have used the 4-horse plough much, and *stout,* well-matched horses have never reached less than 14 inches in obdurate subsoils; while in freer soil and substratum, the plough went to 16 inches of perpendicular depth, and the work was most satisfactory.

2621. An ordinary stout plough will answer for 3 horses, and so it may for 4, where no boulder stones are in the land; but where a considerable quantity of 4-horse ploughing is desired to be executed, it is better to have a plough made for the purpose a little stronger than the ordinary 2-horse plough.

2622. In a 3-horse yoke, one man may drive all the horses by means of reins or by the voice, though a boy, to assist the turning of the leading horse, will save as much time as will compensate for his wages. Where 3 horses are yoked abreast, one man may as easily manage the three as two. In the case of 4 horses, one of the ploughmen drives the horses, and this with the whip instead of the reins, though the near leader should have reins, and the other ploughman holds the plough.

2623. Deep-ploughing is well executed by two 2-horse ploughs following one another in the same furrow; and when the substratum is free, this is a good way of stirring up the soil to the moderate depth of 10 or even 12 inches.

2624. The 3 and 4 horse ploughs should not be inconsiderately employed in cross-ploughing in spring, because either mode of ploughing occupying a considerably longer time with the same number of ploughs, and employing more horses than ordinary ploughing, cannot be prudently employed on land which is immediately to be occupied by an early spring crop, such as beans, though the time in which turnips and fallow, and perhaps potatoes, when cultivated to a limited extent, are respectively finished, will afford sufficient leisure to have the land for them deeply cross-ploughed in the best manner.

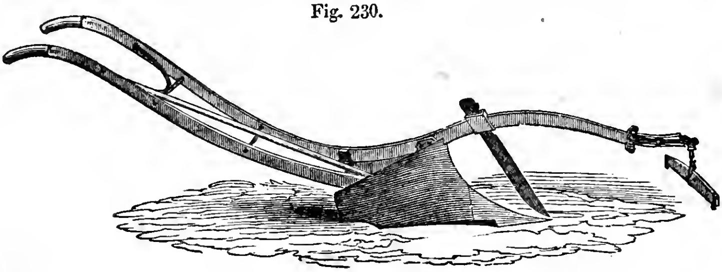
2625. Deep cross-ploughing with a 3 or 4 horse plough should not be confounded with trench-ploughing, which only deserves the name when a 2-horse plough goes before and turns over a furrow-slice, and in the bottom of which the 4 horse plough follows and goes as deep as it can. In deep-ploughing the 4 horse plough goes as deep as it can of itself; and it is rare that it meddles with the subsoil, but, on the contrary, it is the special object of trench-ploughing to disturb the subsoil.

ON RIBBING LAND FOR THE SEED FURROW.

2626. A species of ploughing executed with the small plough, in the same manner as drilling in the single method, (2388) and in form exactly resembling it on a diminished scale, is named *ribbing*.

2627. Fig. 230 is a view in perspective of an iron small plough, which, as is evident,

Fig. 230.



THE SMALL, OR RIBBING PLOUGH.

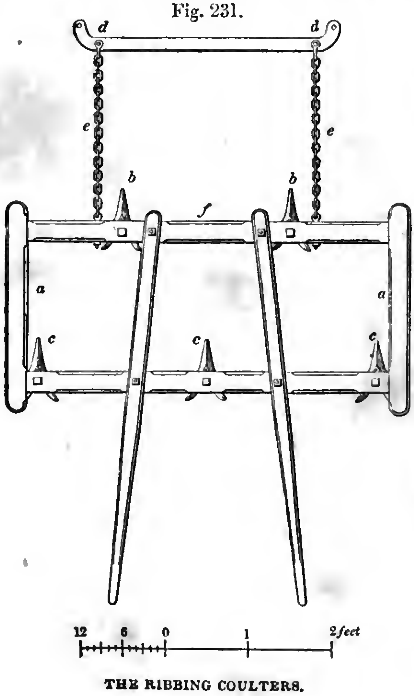
is exactly similar in construction to the common plough, fig. 2, but in such smaller dimensions and lightness as a single horse can work it with ease. A single swing-bar attached to the bridle is all the means of attachment required for the use of the horse. To afford the stilts the means of resisting any cross-strain upon them, an iron rod is fixed at one end to the inside of the land-side of the plough, and on being brought diagonally across the stilts, is fastened at the other end to the right hand or little stilt, a little below the handle. The other parts of the implement require no particular description.

2628. Of the two modes of making single drills, that made by this plough is necessarily restricted to the one which lays the furrow-slices towards the unploughed ground, (2388;) because the ribs being necessarily narrow, were clods and stones to fall into the hollows, which the other method would inevitably cause, the purpose of the ribs forming a kindly seed-bed would in a great measure be frustrated. The ribs with great pains can be formed as narrow as 9 inches, and by careless ploughmen they extend as wide as 14 inches, so that 12 inches may be considered a good medium width. They are always formed on the land after it has been ridged, being only used for the seed-furrowing. The best width of feering for making them is 2 ridges, beginning on the furrow-brow and laying the furrow slice into the middle of the open furrow between the two ridges, returning by the same furrow to the head-ridge whence the feering was begun; and by *hieing* the horses round this feering, the furrow-slices will be laid towards the firm land. By laying the furrow-slice into the open furrow, the seed is kept out of it, and retained upon the best parts of the ridges. Ribs are thus formed on the entire length of the ridges. Supposing the ribs 12 inches asunder, there will just be 30 ribs in every feering of 2 ridges of 15 feet each.

2629. The object of making these ribs is this; when heavy rain happens to fall between the ploughing of the seed-furrow and the sowing of the barley, the land may be so much wetted as to have become too consolidated for barley seed; and were it ploughed again in the ordinary way, a tough heavy clod might be brought up which would be difficult to reduce at that season, particularly if drought followed the recent ploughing immediately. Instead of disturbing this waxy ground, it is better to rib the land for the seed with the small plough, which, only stirring the upper surface to the depth of 3 inches or so, a sufficient mould is at once afforded to bury the seed, and that is all that is wanted at the time, the land having been sufficiently ploughed before. A couple of these ploughs will soon form a considerable extent of ground with ribs.

2630. As the small plough only makes one rib at a landing, and as only two small ploughs are to be found on most farms, and as it may be desirable, in some seasons, to rib a considerable extent of ground in a short time, an implement that will do more work in the same time, and in the same manner, should be preferable to the small plough. Such an implement may be found in the ribbing coulters, fig. 231, which is drawn by one horse, and makes 5 drills at a time, of a sufficient depth to cover the seed. It consists of a frame *a a*, bearing 5 coulters *b b c c c*, which operate on the surface soil exactly as the double mould-board plough, dividing it with small mould-boards, into a narrow furrow of mould on each side. Two coulters *b b*, are placed in the foremost part of the frame, and three *c c c*, in the hindmost part, at intermediate distances, and forming 5 drills, embracing four spaces of 12 inches each in width. The horse is attached by the hooks of the plough chains to the eyes at *d d*, in the bar *d d*, which is fastened to the frame *a a* by the chains *e e*, which are 2 feet long, and, by their weight, together with that of the bar *d d*, give steadiness to the draught. The implement might be rendered more important if requisite, by attaching two horses to it by a shackle at *f*, to the swing-trees of the common harrows; and the framing might also be mounted on an axle and wheels.

Fig. 231.



THE RIBBING COULTERS.

ON THE SOWING OF GRASS-SEEDS.

2631. Any time after the beginning of March, when the weather is dry, and is likely to continue so, grass-seeds may be sown.

2632. They are sown in company with another crop, never by themselves, except for a particular purpose, such as the laying down of a lawn to grass; and the crops they invariably accompany are cereal ones.

2633. The grass-seeds sown among one and all of these crops are the same, and they are few in number. They consist of red clover, *Trifolium pratense*, white clover, *Trifolium repens*, rye-grass, *Lolium perenne*, and sometimes, on light soils, the yellow clover, *Medicago lupulina*.

2634. These, in common parlance, are called the *artificial grasses*, because they are sown every year like any other crop of the farm, whereas the other grasses occur in a state of nature, and are permanent.

2635. The quantities of these sown vary but little over the country, and never vary on the same farm. It is considered that 12 lbs. per acre of clover-seeds are sufficient. The seeds are proportioned according as the grasses are to remain for one year or longer. When longer than one year, the proportion is from 6 lbs. to 8 lbs. of red clover, 4 lbs. of white clover, and 2 lbs. of yellow clover, when that is sown, per acre. One bushel of rye-grass per acre is sufficient for all purposes. When only one year, the proportion is 10 lbs. of red clover and 2 lbs. of white.

2636. The plants possess different properties. The red or English clover has a red flower, as its name indicates, the spikes of which are dense, globular, and slightly elongated, leaves three lobed—hence its generic name—habit of growth upright and branching, stem and leaves juicy, and root subfusiform. The plant flowers in June and July. It is an annual if sown by itself, but when sown with a cereal crop it is biennial, and comes into use in the second year of its existence. The plant grows to a height of 2 feet or more, affords a forage much relished by all sorts of stock; is generally cut twice, and, in favourable seasons, three times, and yields a heavy crop of hay, which is highly nourishing. The aftermath of the hay forms excellent pasturage in autumn. The plant only yields a crop for one year, and then dies.

2637. The white or Dutch clover is a name also derived from the colour of the flower, which is white, tinged with light pink. The flower is globular, surmounting an upright stalk, destitute of leaves. The leaves are small and three lobed, growing in creeping stems rooting at the joints, producing a thick close covering on the ground. The plant flowers from June to autumn. It makes but little appearance in the same year as the red clover, but is conspicuous the year after, makes a valuable pasture grass, and is perennial.

2638. The flower of the yellow clover, as its name also indicates, is yellow and small, and very prolific of seed, which is, consequently, sold much cheaper than the seeds of the plants mentioned above; and I suspect this circumstance, more than any other, induces farmers to cultivate it; for although the crop is rather bulky, its stems are so hard and wiry that both cattle and sheep are not fond of it, either in a green or dry state, and only eat it when mixed with better fare.

2639. The rye-grass may be divided into two varieties, which are chosen for sowing according to the nature of the husbandry. If the grass is to remain only one year in the ground, the common variety is sown, which can only be depended upon to exist one year after the cereal crop has been removed, and thereby becoming a biennial, as the red clover does. When the grasses remain for a longer period than one year, the perennial variety is chosen, of which there are many sub-varieties. The seed of all the varieties of rye-grasses is light in the hand, because it is coated with two-valved *paleæ*, which adhere firmly to it when ripe.

2640. The seed of the red clover, when grown in England, is large, full, glossy, and of bold purple colour; weighs 64 lbs. per bushel, affords 2000 grains to 1 drachm weight, and sells from 56s. to 75s. per cwt. The red clover seed of Holland is large, not well filled, with a yellow tinge along with the purple, indicative of humidity of climate. The seeds of French red clover are small, plump, and highly purple.

2641. The seeds of the white clover are very small, and of a rich golden yellow colour. They weigh 65 lbs. a bushel, sell at 56s. to 75s. per cwt. and afford 4000 grains to 1 drachm weight.

2642. The seeds of the yellow clover are large, and of dull greenish yellow colour. They weigh 64 lbs. a bushel, sell at from 18s. to 28s. per cwt, and afford 2600 grains to 1 drachm weight.

2643. Of the seed of the rye-grasses, that of the annual weighs 30 lbs. a bushel, sells for 20s. to 28s. a quarter, and affords 1712 grains to the drachm weight. The perennial rye-grass seed weighs 18 lbs. a bushel, sells from 24s. to 28s. a quarter, and affords 2000 grains to the drachm weight.

2644. Other seeds have been recommended to be sown alongst with these, to suit the purposes for which the future grass is intended. Among these is the Italian rye-grass, *Lolium Italicum*, which, possessing the valuable properties of celerity of growth and sweetness of taste, is well deserving of cultivation; but its remarkable quickness of growth renders it inconvenient to sow amongst grain. The great disparity between its period of growth and that of the grains, as also that of the other grass seeds usually sown, indicates that it should be cultivated by itself, although its growth is checked when sown with grain. It places itself rather among the forage plants, such as tares and rape, than the hay and pasture plants.

2645. In the case of grass of one year's duration, there is not much room for improvement in the proportions of the seeds given above; but as regards pastures of more than one year's standing, a greater variety of seeds might be introduced with advantage. On this subject Mr Lawson makes these suggestions. "For 3 years' pasture on good soils," he says, "the substitution of 2 lbs. of *Dactylis glomerata*, the common rough cock's-foot, for about 3 lbs. of the perennial rye-grass, will be found advantageous; while in sheep pastures the addition of 1 lb. per acre of parsley-seed, *Petroselinum sativum*, would also be attended with good results; and in certain upland districts, established practice will point out the introduction of 2 lbs. or 3 lbs. of rib-grass, *Plantago lanceolata*. In proportion to the retentiveness of heavy soils, as well as for those of a peaty nature, *Phleum pratense*, the meadow cat's-tail, should be added, to the extent of 2½ lbs. to 3½ lbs. per acre."* The improvement of pasture of 2 or 3 years' standing, not permanent pastures, has received less attention from farmers than it deserves. Had Italian rye-grass been a perennial, it would have formed a valuable ingredient in all such pastures, both for sheep and cattle. Sheep are remarkably fond of parsley, and will not allow it to run to seed, but I suspect it is only a biennial.

2646. The grass-seeds when sown amongst the cereal grains are not sown separately, but mixed together. Having weighed the respective quantities of seed required for the size of the particular field to be sown, they are mixed in this manner upon the floor of the corn-barn. The rye-grass seed is laid on the floor in a heap, which is made flat on the top to receive the clover seeds to be mixed with it. The red clover, being the larger sized seed, is put on first, and spread over the top of the rye-grass; and the white clover is poured over the red. The entire heap is then turned over in the manner described for pickling wheat (2309,) with 2 barn-shovels, fig. 166. The turning is repeated until the seeds, on being examined, appear well mixed. Although the clover-seeds are much heavier than the rye-grass, they do not fall through it to the bottom of the heap, on account of their smallness, which enables them to lie between the two valves of the *paleæ* of the rye-grass seed. The mixture is put into sacks, and taken to, and set down upon one of the head-ridges of the field to be sown.

2647. Grass-seeds are sown by hand and with machines. The hand sowing is now confined to small farms, while on the larger ones the grass-seed sowing-machine is universally used. The sowing of grass-seeds by the hand is a simple process, although it requires activity to do it well. The sower is equipped, as represented in fig. 202, and a carrier of the seed provided with a rusky, fig. 201, accompanies him, and he proceeds to sow, by grasping the mixed seeds between the fore and middle fingers and the thumb, instead of the whole hand, and makes the cast and steps exactly in the manner described for sowing corn in (2319.) Clover and rye-grass seeds being so very different in form and weight, it is not possible to cast them from the hand as that both shall alight on the same spot. The sower has little control over the rye-grass seed, the least breath of wind taking it wherever it may, and the heavy clover leaves it to its fate; and this is the case even in the calmest state of the air. His object is to cast the heavy clover seed equally over the surface, and, as its smallness prevents it being seen to alight on the ground, it is the more necessary for the sower to preserve the strictest regularity in his motions. In windy weather, the clover may be cast with pretty

* Lawson *On the Cultivated Grasses*, p. 53.

tolerable precision, and even more so than corn, but the rye-grass must just alight where it may. Most sowers attempt to sow a ridge with 2 casts, taking a larger grasp of the seeds; but the surer plan, for their equal distribution, is to take the smaller quantity between the two fingers and thumb, and give the ridge 3 casts, one along each furrow-brow, and the third along the crown. It is pleasant work to sow grass-seeds by the hand. The load is comparatively light, and the ground having been harrowed fine, and perhaps rolled smooth, the walking is easy; and although it may be tiresome to walk over the same ridge three times, the quick step in which the sowing is performed sustains the spirits; and particularly when 3 sowers are engaged together and arrange the work, so that two make the two casts along the furrow-brows of their respective ridges, while the third follows each alternately along the crown of every ridge. On making one of a party of 3, we sowed, in one day, 72 acres, 24 acres each, with 3 casts to every ridge of 15 feet in width. This was in Berwickshire in 1817, before the grass-seed sowing-machine was in use; and the work caused each of us to walk about 40 miles in 11 hours.

2648. But such feats cannot now be performed, as the grass-seed sowing-machine supersedes the necessity of doing it on large farms, where alone they could be done. This is a most perfect instrument for the sowing of grass-seeds, distributing the seeds with the utmost precision, and to any amount, and so near the ground that the wind affects them but little. The machine is represented in fig. 204. Its management is easy, when the ground is ploughed in individual ridges. The horse which draws it starts from one head-ridge and walks in the open furrow, as in *d*, fig. 210, when the machine sows to the crown of the ridge on each side, to *a* and *b*, the driver walking in the furrow behind the machine, using double reins. On reaching the other head-ridge, the gearing is put out of action till the horse, on being *hied*, enters the next open furrow from the head-ridge, when the gear is again put on, and the half of the former ridge is sown, completing the sowing of that ridge and the half of a new one, by the time the horse again reaches the head-ridge he started from. And thus 2 half-ridges after 2 half-ridges are sown until the field is all sown. The seed is supplied from one of the head-ridges, upon which the sacks containing it were set down when brought from the corn-barn. The head-ridges are sown by themselves. But the half of the ridge next the fence, on each side of the field, cannot be reached by the machine, and must be sown by hand.

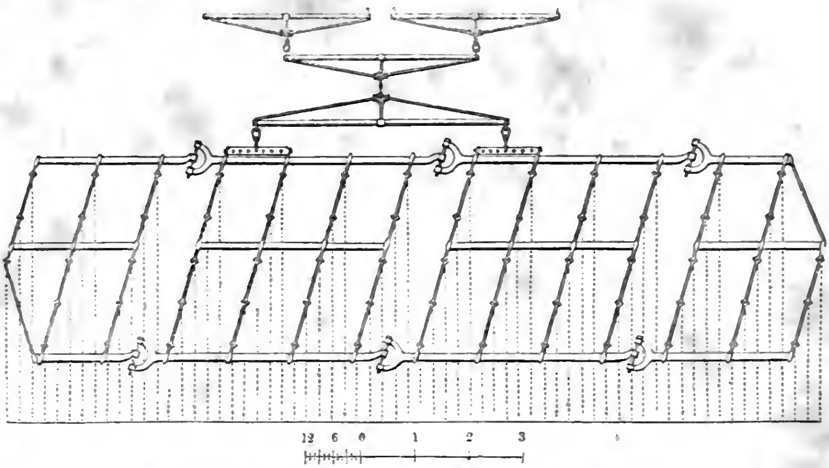
2649. When ridges are coupled together, fig. 22, the horse walks along the middle between the crown and the open furrow, the furrow-brow being the guide of the line for the end of the machine to keep, and 2 ridges are thus sown at every bout.

2650. Where ridges are ploughed in breaks of 4 ridges, as on two-out-and-two-in, fig. 25, the furrow-brow is the guide in going and the crown in returning, while sowing 2 of the ridges; and the crown in going and the furrow-brow in returning while sowing the other two ridges.

2651. Were this machine to proceed onwards, sowing without interruption for 10 hours, at the rate of $2\frac{1}{2}$ miles per hour, it would sow 45 acres of ground; but the turnings at the landings, and the time spent in filling the seed-box with seed, cause a large deduction from that quantity, perhaps nearly two-fifths.

2652. After the grass-seeds are sown, the ground is harrowed to cover them in; for which purpose lighter harrows are used than for ordinary harrowing, which would bury the clover seeds too deep in the ground; and being light, are provided with wings, to cover a whole ridge at a time, so that the sowing process may be quickly finished. Fig. 232 is a plan of grass-seed harrows, with wings, covering a ridge of 15 feet wide at one stretch, and differing only from fig. 208 in lightness. The harrows are represented with a complete set of iron swing-trees, as fig. 7, attached. Some dexterity is required to drive the winged grass-seed harrows. It is not convenient to move them from one ridge to the other immediately adjoining, as a part of the implement would then have to turn upon a pivot, which would injure them. Besides, it is inconvenient to *hup* the horses with these harrows. The way to avoid the inconvenience is to *hie* the horses at the end of the landings, round an intermediate unharrowed ridge.

Fig. 232.



THE GRASS-SEED IRON HARROWS, WITH WINGS AND SWING-TREES.

2653. The *iron-web harrow* is a late invention of the ingenious and indefatigable Mr Smith of Deanston, for the same purpose. It is formed of an assemblage of annular discs of cast-iron, of the shape of the common playing quoit, which are interweaved with iron wire in a certain regular form, until the whole forms a flexible web, in which the discs have liberty to play and roll about within small limits. The web may be 2 yards in length by 1 in breadth, and is simply dragged over the ground, when it is said to give the surface a finish superior to any thing hitherto introduced.

2654. The land may be rolled or not, according to circumstances, before the grass-seeds are sown. If it is dry, even strong land would be the better at this season to be rolled, to reduce the clods before they become very hard, and to form a kindlier bed for the small seeds. On this account the rolling should be performed before the sowing, and, of course, before the harrowing of the grass-seeds; because, were the land left with a smooth rolled surface after the harrowing, and rain to follow, succeeded by drought, which is a common state of the weather at this season, the smooth ground would soon become so battered and hardened, as to retard the growth of the germ of the new-sown crop; whereas, were it rolled before it was sown, the smoothed ground would offer a fine surface for the small grass-seeds to spread themselves upon, and when harrowed, a small round clod would be raised upon it, which would prevent the encrusting of the ground by the rain. On light hazel loams and turnip soils, it is better not to roll until the land has been sown and harrowed, because rain cannot encrust their smooth rolled surface, while the rolling assists in repelling the drought for a considerable time. When strong land is in a waxy state, between wet and dry, the rolling had better be deferred, while the sowing of the grass-seeds may proceed, if the season, or the state of the crop, amongst which the grass-seeds are to be sown, is already sufficiently far advanced.

2655. The cereal crops, amongst which the grass-seeds are sown, are winter wheat, spring wheat, barley, and oats, when the last are sown in lieu of barley.

2656. The wheat, when raised on bare fallow, grows generally so strong as to smother the young plants of the grasses as they come up before the wheat is reaped. Hence, in the Carse of Gowrie, wheat is seldom or never sown down with grass-seeds; but in other parts of the country, where it does not grow so strong, grass-seeds are sown amongst it.

2657. There is little danger of spring wheat attaining to so much rankness of growth as to injure the grasses growing amongst it. Spring wheat, therefore, is invariably sown down with grass-seeds, and these succeed very well.

2658. Barley is always the chosen and safest vehicle by which to introduce the grass-seeds to the ground. Remaining but a short time in the ground, it permits the young grass plants to grow to considerable strength before the approach of winter, and they are then the better able to withstand the vicissitudes of that season. Barley, however, does sometimes grow so rank and thick as to endanger the existence of the grasses, when they sometimes perish under the oppressive load of a heavy crop.

2659. Oats, when treated as barley, receive the grass-seeds in the same way; but, for some reason or another, the grasses do not thrive so well when sown with oats as with barley, or even with wheat.

2660. We shall now take a survey of the state of these respective cereal crops, at the time the grass-seeds are sown amongst them; and first, as to *winter wheat.* The state of this depends entirely on the sort of weather it had to encounter in winter and early spring. If the winter has been open and mild, the autumn wheat plant will have grown luxuriantly, and have even become *proud*—that is, in a precocious state of forwardness for the season. When in this state in spring—which is rarely the case in Scotland, though not unfrequent in England—should a heavy fall of late snow happen to lie upon it for some weeks, it will rot a great many of the plants; and the rest will have become blanched at the roots, pressed flat to the ground, and will probably die. Blanks, in consequence, are formed after such a catastrophe; but unless these are of large extent, or the season be too far advanced, the plants tiller out new runners from the roots, and fill up the blank spaces. When snow falls upon wheat in the early part of winter, and covers it for a considerable time, it protects the plants from atmospheric injury, and prevents the earth around them from cooling below 40° Fahr. In this state the young plants retain their healthy green colour, though they do not grow much; and whenever relieved from the snow, grow rapidly, unless encountered by black frost, which changes the green into brown, and kills many of the plants; but should no black frost ensue, the young wheat plant tillers closely, and afterwards grows equally, to a full crop. The most trying time for winter wheat is in March, when sharp frosts frequently occur at night, and bright sunshine in the day. The frost draws the moisture of the ground to the surface, and there freezes it; when the sun shines, the ice melts very rapidly, and the consequent evaporation produces such an intense degree of cold as to kill the plants suddenly; and if they escape this destruction, the damp ground, raised up by means of the expanded ice, suddenly contracts by the ice melting in the sun, and leaves the plants, with their roots half drawn out of the earth, ready to perish in the frost of the succeeding night. It must be owned, however, that this particular effect is produced on loamy soils, which rest on a wet impervious clay subsoil, and never on a dry subsoil, so that draining is the effectual remedy for this injury. Continued rains upon winter wheat make it change its colour to a bluish hue; and if the air is cold, the plant sets up with red-pointed leaves, as if determined to grow no more. Continued drought in spring gives to winter wheat a vivid green colour in fresh weather; but should an E. wind frost accompany the drought, and the sun also shine, the points of the leaves will become brown. Drought and heat combined, always promote rapid vegetation in the wheat plant.

2661. The April wheat forms a valuable assistant in filling the blanks occasioned in winter wheat by the snow and frost in spring. When sown as late as April, it will become ripe at the same time as the winter wheat. It may be harrowed in when the blanks are extensive; but, if practicable, an iron hand garden-rake may answer the purpose to cover it.

2662. In whatever state of forwardness

the winter wheat is found in the latter part of March, the grass-seeds should be sown amongst it—that is to say, if the ground is not actually covered with snow; and if the plant is strong, the common harrows, fig. 207, should be used in giving the grass-seeds a hold of the ground. If the plant is small and weak, and the ground tender, the grass-seed harrows, fig. 232, may suffice. Winter wheat will not be the worse, but all the better for a good harrowing in spring, even though some of the plants should be torn up by the tines, as the harrowing loosens the surface of the ground, compressed by the rains of winter, and admits the air nearer to the roots of the plants. After such a harrowing, rolling will press the weak plants into fresh earth, and induce an immediate tillering from the roots. When the plants have grown very rank before the grass-seeds have been sown, the harrowing should be given with the common harrow, but the rolling should be dispensed with, in case of breaking the stems of the plants. The difference in the effects produced by rolling, in breaking and bending the stems of plants, should be discriminated. Independently of other considerations, a cereal crop, on a rolled surface, affords great facility for being reaped at harvest.

2663. Many farmers used to sow grass-seeds without harrowing, trusting to the small seeds finding their way into the soil amongst the clods, and of being covered by their mouldering—and the omission, I believe, is still persevered in; but the safer and more correct practice is to cover every kind of seed, when it is sown.

2664. Although double harrowing across prepares the land on which *spring wheat* has been sown for the grass-seeds, it should not be imagined these are sown whenever the wheat is sown, because the latter may be sown at any time during winter or early spring when the state of the weather and soil will allow; but when sown at the latest period of the season, the grass-seeds should not only be sown, but also amongst the spring wheat previously sown; as also amongst the winter wheat, should there be any in the same field. It is worthy of consideration, in fields in which wheat has been sown at different times, that the latest sown should first be sown with grass-seeds, then the next latest, on to the winter wheat; because it is desirable first to finish the land which has been most recently worked, in case the weather should change, and prevent the finishing of the grass-seeds over the whole field.

2665. Frost injures clover seeds, and will even kill them when exposed to it, so they cannot safely be sown very early in spring; but they run little risk of frost being so powerful in March as to injure them when harrowed in.

2666. After *barley*, or oats when taken in lieu of barley, has been harrowed a double tine across, the ground is ready to be sown with the grass-seeds, and these are then best harrowed in with the grass-seed harrows, fig. 232. The ridges are then water-furrowed, fig. 209, and the land rolled across, fig. 222, when the barley-seed sowing is finished. If the land is rather strong, the water-furrowing had better be done after the rolling, if the rolling has been executed; but on light soils, the water-furrowing before the rolling always makes the most beautiful finish. If rolling cannot be executed when the grass-seeds have been sown amongst the barley, on account of the raw state of the land, it should be executed as soon, thereafter, as the state of the ground will allow,—it being of vast importance to have a smooth surface in reaping the crop.

2667. Should barley have still to be sown on the same field, it will be better to defer the sowing of the grass-seeds upon the wheat until the whole field is sown; and the new-sown spring wheat should be water-furrowed, and put past danger. If the winter-wheat in the same field is far advanced, it and the spring wheat should be sown with the grass-seeds at the same time, and the barley-land sown by itself, when the barley-seed is finishing.

2668. When the land, being strong, is suspected of being waxy when ploughed, it is better for the barley-seed, as also for the spring wheat-seed, that it be ribbed with the small plough, fig. 230, than ploughed with the common plough; and after the barley has been sown on the ribbed ground, a double tine along the ridges is sufficient to cover the seed, in the ribs; for cross-harrowing would derange the grains deposited in the drills into broadcast, and bring up a large proportion of the seed to the surface.

2669. The clovers belong to the class and order *Diadelphia Decandria* of Linnæus; to the family of *Leguminosæ* of Jussieu; and to the sub-class iii., *Perigynous Exogens;* alliance 42, *Rosales;* order 209, *Fabiaceæ;* tribe 2, *Loteæ*, sub-tribe 3, *Trifoliæ*, genus *Trifolium*, of the natural system of Lindley. The generic name is evidently derived from the triple leaves of the plants.

2670. This tribe includes the most valuable herbage plants adapted to European agriculture, the white and red clovers. Notwithstanding what has been said of the superiority of *lucerne*, and of the excellence of *sainfoin* in forage and hay, the red clover for mowing, and the white for pasturage, excel, and probably ever will, all other plants. The yellow clover, and the cow or meadow clover, are inferior to the white and red clover.

2671. The *soil* best adapted for red clover is deep sandy loam, which is favourable to its long tap-roots; but it will grow in any soil provided it be dry. Marl, lime, or chalk, promotes the growth of clover. The *climate* most congenial to it is one neither hot, dry, nor cold. Clover will be found to produce most seed in a dry soil and warm temperature; but as the production of seed is only in some situations an object of the farmer's attention, a season rather moist, provided it be warm, always affords the most bulky crop of herbage. Red clover-seed is imported into Britain from France and Holland, where it is raised as an article of commerce. What has been obtained from those countries has been found to die out in the season it has been cut or pastured, while the English seed produces plants which stand over the second, and many of them the third year; thus remaining, in the latter case, 4 years in the ground from the time of sowing.* Some prepare clover-seed for sowing by steeping it in water or in oil, as in Switzerland, and then mixing it with powdered gypsum, as a preventive to the attacks of insects.

2672. *Trifolium pratense perenne*, perennial red. This variety bears a great resemblance to the biennial sort in its general habits and appearance, and differs from it only in having rather more woolly leaves, in being more durable, and in coming later into flower. The seed is more costly than that of the red clover, and it is questionable that its permanency should counterbalance the greater cost of seed.

2673. *Trifolium medium*, meadow trefoil, or cow-clover. I suspect that this true cow-clover has been confounded with the perennial variety of red clover above, otherwise so worthless a weed would never have been recommended as a valuable constituent for our permanent pastures on light soils, where it never fails, by its obtrusive character, to destroy the more valuable pasture plants around it. Indeed, Mr Sinclair owns, that "the *Trifolium medium* is inadmissable in alternate husbandry, on account of its creeping roots, constituting what, in arable land, is termed *twitch*;" and the twitch is most abundant, and therefore most troublesome, in light soils, not only in arable fields, but in pasture, where it usurps the place of better plants; and yet Mr Sinclair says, that "for soils of drier nature and lighter texture, the *Trifolium medium* offers great advantages."†

2674. *Trifolium repens*, creeping trefoil, Dutch white, or sheep's clover, is the white clover cultivated in this country. It is a native of Europe, is plentiful in Britain, and is now cultivated in Jamaica. Mr Curtis affirms that a single seedling covered more than a square yard of ground in one summer. White trefoil is generally called Shamrock, but the *Oxalis acetosella* is supposed to be the true Irish shamrock.

2675. *Trifolium hybridum*, hybrid trefoil, Alsike clover, is a species possessing the properties of the red and white clovers, and on that account was considered by Linnæus a hybrid between them. It is a native of the south of Europe; but has been introduced into the agriculture of Germany and of Sweden, and, in the latter country, it is cultivated to considerable extent in the district of Alsike. The late Mr George Stephens, after seeing the success of Mr Lawson in raising some plants in 1834 and 1835,‡ procured about 2 bushels of it in Sweden the year following, which were somehow lost on the voyage. Farther experiments were thus checked in Scotland with this promising clover, which, from its dissimilarity to the red clover, by its fibrous roots and perennial existence, may very likely be found to thrive in such soils as are termed *clover-sick;* and if so, it would be a most valuable acquisition.

2676. *Trifolium incarnatum*, flesh-coloured-flowered trefoil, is a native of the south of Europe, and is not yet naturalised to the climate of Scotland. It may make good food for cattle, as Mr Miller thinks, but, being an annual plant, it will only suit as a forage one.

2677. *Trifolium Alexandrinum*, Alexandrian trefoil. Flowers pale yellow. Forksall says that this trefoil is universally cultivated in Egypt, being the best, and indeed the principal fodder for cattle in that country. It is sown only in the recess of the Nile, and, where the fields are too high to be inundated by that river, they are watered by means of hydraulic engines, the seeds being committed to the earth while it is wet. The produce is three separate crops, the plants growing each time about half an ell

* Sinclair's *General Report of the Agriculture of Scotland*, vol. i. p. 537.
† Sinclair's *Hortus Gramineus Woburnensis*, p. 222, edition of 1824.
‡ Lawson's *Agriculturist's Manual*, p. 153.

in height. After the last crop, the plant dies. When this trefoil is wanted for seed, it is sown along with the wheat. Both are gathered at once by the hand, not reaped or mown, and are thrashed out together, the trefoil seed being afterwards separated by a sieve. This species of clover being so important in its own country, may be worth the notice of British agriculturists, and may, perhaps, be naturalised in this country.

2678. *Trifolium procumbens*, procumbant trefoil, yellow clover, or hop trefoil. This species of clover seems to be confounded with the procumbent lucerne, *Medicago lupulina*. Its flowers are yellow. Its name of *hop*-trefoil is bestowed on it with much propriety, the heads being larger and more resembling the hop than any of the best of the species. It is common on the borders of fields in dry gravelly soils. In some meadows it forms a considerable part of the crop, and makes excellent fodder; and it is now very generally used for pasture, with or without white clover.

2679. These are all the species of clover that seem to deserve special notice, out of 166 described by botanists.*

2680. "Some years ago," says Mr Babbage, "a mode of preparing old clover and trefoil seeds, by a process called '*doctoring*,' became so prevalent as to excite the attention of the House of Commons. It appeared in evidence before a committee, that the old seed of the white clover was *doctored* by first wetting it slightly, and then drying it in the fumes of burning sulphur; and that the red clover-seed had its colour improved by shaking it in a sack with a small quantity of indigo; but this being detected after a time, the *doctors* then used a preparation of logwood, fixed by a little copperas, and sometimes of verdigris; thus at once improving the appearance of the old seed, and diminishing, if not destroying, its vegetative power already enfeebled by age. Supposing no injury had resulted to good seed so prepared, it was proved, from the improved appearance, its market-price would be enhanced by this process from 5s. to 25s. per cwt. But the greatest evil arose from the circumstance of these processes rendering old and worthless seed in appearance equal to the best. One witness tried some *doctored* seed, and found that not above 1 in 100 grains grew, and that those which did vegetate died away afterwards; whilst about 80 or 90 per cent of good seed usually grows. The seed so treated was sold to retail dealers in the country, who, of course, endeavoured to purchase at the cheapest rate, and from them it got into the hands of the farmers; neither of these classes being at all capable of distinguishing the fraudulent from the genuine seed. Many cultivators, in consequence, diminished their consumption of the article; and others were obliged to pay a higher price to those who had skill to distinguish the mixed seed, and who had integrity and character to prevent them from dealing in it." †

2681. Clover seeds are not imported into this country from France and Holland to any great extent. "The entries of foreign clover-seed for home consumption, at an average of the three years ending 1831," says M'Culloch, "were 99,046 cwt. a-year. But for the high duty of 20s. a cwt. there can be little doubt that the importation would be much more considerable." ‡

2682. Since then the duty has been much lowered. By the customs tariff of 1847, Victoria 9th and 10th, cap. 23, the duty on clover-seed imported from foreign countries was fixed at 5s. the cwt, and from a British possession, 2s. 6d. a cwt.

2683. As regards clover in the agriculture of Germany, Von Thäer observes that, "this plant is usually sown amongst corn; formerly it was always mixed with the spring grain, but at present it is commonly mixed with the autumn grain, and in most cases with equal success, provided the sowing be performed with proper attention. Clover is not sown at the same time as the autumn grain, but at such a time that it may germinate after the winter season. It is sometimes sown amongst pease, and certainly shoots forth with great vigour among the stubble of those plants. But if the pease are soon laid, and do not ripen quickly, the clover may be completely choked by them; its growth will then be very unequal, presenting large vacant spaces here and there. We are, however, acquainted with two plants which are altogether favourable to clover sown among them—these are flax and buck-wheat. These plants favour the germination and early growth of the clover, and allow it, much better than corn, to thicken and establish itself uniformly on the land. Flax is no longer sown, except in rich and well-prepared soils; it is cleared of weeds, an operation which is productive of benefit to the clover. The latter is not injured by the pulling of the flax, if this operation be performed with proper care. But amongst buck-wheat, I have seen clover growing thickly even on a soil which was not well suited to it. Close by its side, and on a somewhat better soil, there was a crop of oats growing, mixed with clover; and thus I had an opportunity of convincing myself, in the most positive manner, of the great difference between the two crops of clover, and the superiority of that which grew amongst the buck-wheat. This superiority was maintained during the whole of the following year. I would, therefore, recommend the cultivator who wishes to have a thick crop of clover, and does not think his land very well adapted to it, to sow his clover among the buck-wheat. It appears to be indifferent whether the buck-wheat be allowed to ripen, or mown to be consumed as green meat. Clover also thrives well among *colza*."

2684. "Harrowing in spring," observes Von Thäer, "when the clover begins to shoot forth, is

* Don's *General System of Gardening and Botany*, vol. ii.—*Leguminosæ*.
† Babbage *On the Economy of Machinery and Manufactures*, p. 102.
‡ M'Culloch's *Commercial Dictionary*—art. *Clover*.

a very useful operation, and well repays the expense which it occasions. The more forcibly this harrowing is performed, the greater is the benefit which it confers on the clover."* Here it would seem that the clover-seed had remained in a quiescent state in the ground all winter.

ON THE SOWING OF BARLEY.

2685. The ordinary sorts of spring wheat may be sown as late as the middle of March in ordinary seasons, and the new sort of spring wheat, named April or fern-wheat, may be sown until the first week of April; but after that it will be safer to sow barley.

2686. It may be laid down as an axiom, that land which has borne turnips that have been eaten off by sheep, should receive two ploughings of some sort before it is sown with *barley*. I have seen the experiment tried of sowing barley on a single furrow on land ranging from clay to gravelly, and the result was a manifest deficiency of crop compared to what had received two furrows; and such a result is not surprising, as barley requires a deep, well pulverised soil to grow to perfection; it is impossible to make any soil that has been trampled firm by sheep, after bearing a heavy crop of turnips, so with a single furrow. Strong land, with a single furrow, turns over with a tough waxy clod, ungenial to the growth of barley; and light turnip land, with a single furrow, exhibits the barley growing in drills corresponding with the drills in which the turnips had been manured. The least difference in the crop after one and two furrows is observed on fine hazel loam; still the superiority accompanies the two furrows. Let it therefore be laid down as a rule, that turnip land for barley shall receive two furrows; and the only question is, in what form these should be ploughed, bearing in mind that the land must be deep ploughed and well pulverised.

2687. On clay loam in good heart, it is not improbable that some of the turnip land that had been ploughed for spring wheat, had been, by the bad state of the weather, prevented from being sown with that grain, and, of course, it must now be sown with barley. Whether the land had been gathered up from the flat, fig. 20, or cast together, fig. 22, it should be seed-furrowed in the same manner, for the barley to retain the ridging of the whole field uniform; because the ploughing for the spring wheat being the seed furrow, and the ridges having been formed with a view to permanency, it would be impossible to replough them with one furrow only of the *common* plough, without disturbing their complete form in relation to the field, by making the two side-ridges only half the width of the rest. Such ridges, then, must either be ploughed *twice* with the common plough, to bring them back to their existing form, for which there may not be sufficient time, or they may be stirred with the grubber, fig. 215, or ribbed with the small plough, fig. 230, and retain their form.

2688. A choice from these various modes may be made according to circumstances. If the ridges have consolidated in consequence of being long ploughed, or of much rain having fallen upon them, and if the soil itself be naturally firm, two furrows with the common plough will put the land in the best state for receiving barley. If the ridges are somewhat soft, with perhaps too much moisture below, though capable of affording a fine surface with the harrows, the grubber is the most proper implement for making a deep bed for the barley-seed, and keeping the dry surface uppermost. If the soil is dry and loose on the surface, and tilly below, the surface would be best preserved by being ribbed with the small plough.

2689. Putting such particular ridges thus into the best state for the barley-seed, there will be no difficulty in ploughing the rest of the barley land. The first furrow, and in the best direction, should be to *cross-furrow* the barley land, as feered in fig. 229. Although the land may not all be so cleared of turnips as to allow the cross-ploughing to extend from side to side of the field, any portion should be ploughed and sown while the other is being cleared, and may be cleared by the time the sowing of the first part is completed. After the passage of the harrows a double

* Thäer's *Principles of Agriculture*, vol. ii. p. 623.—Shaw and Johnson's translation.

tine along the cross-ploughed land, the land should be feered and ploughed into ridges, and the usual form of the seed-furrow is either gathering-up from the flat, fig. 20, or yoking together, fig. 22. Every plough should be employed in ridging up the seed-furrow, and both the cross-ploughing and the ridging should be *deep* ploughed. The cross-ploughing should be turned up with a broad, stout furrow-slice, but the ridging should be ploughed with a deep narrow furrow slice, in order to subdivide the former furrow, to pulverise the soil as much as possible, and to make the crests of the furrow-slices numerous and narrow, so as to disseminate the seed among them equally, whether sown by the hand or with the machine.

2690. The sowing of barley on a fine pulverised surface requires strict attention, inasmuch as on whatever spot every seed falls, there it lies, the soft earth having no elasticity like the firm furrow-slice of lea, to cause the seed to rebound and settle itself on another spot than what it first struck. Hence, of all the sorts of grain, barley is the most likely to be *happergawed* in sowing by the hand, and on that account every handful should be cast with greater force, and more completely spread from the hand, than other sorts of grain. The walking on soft ground in sowing barley is attended with considerable fatigue, and as short steps are best suited for walking on soft ground, so by small handfuls you are best enabled to grasp plump slippery barley. The broadcast machine, fig. 204, is used for sowing barley as well as oats. The grain drills, figs. 205 and 206, are used to sow barley in drills, and this is best effected by sowing across the ridges after the surface has been harrowed.

2691. When the surface has been grubbed for the seed-furrow, the seed is best sown with one of the drill machines, as they afford the seed a hold of the ground, independent of ploughing.

2692. When the surface is ribbed with the small plough, the seed is best sown by the hand, or with the broadcast sowing-machine, and, on reaching the ground, it falls into the hollows of the ribs, out of which the young plants arise in drills almost as regular in line as if the seed had been sown with a drill machine, provided they have not been disturbed in the ribs; and the surest way of not disturbing them, is to harrow the ground a double tine only along the ribs, and not at all across them.

2693. Barley may be sown any time proper for spring wheat, and as late as the end of May; but the earlier it is sown the crop will be better in quality and more uniform, though the straw will be shorter.

2694. The average quantity of seed sown broadcast is three bushels to the acre; when sown early less will suffice, and when late, more is required; because there is then less time for so quick a growing grain as barley to tiller and cover the ground. When sown with the drill, two bushels suffice. Mr Brown makes some sensible remarks on this subject:—"Amongst the farmers," he says, "it seems a disputed point, whether the practice of giving so small a quantity of seed (three bushels per acre) to the best lands, is advantageous. That there is a saving of grain, there can be no doubt; and that the bulk may be as great as if more seed had been sown, there can be as little question. Little argument, however, is necessary to prove that thin sowing of barley must be attended with considerable disadvantage; for, if the early part of the season be dry, the plants will not only be stinted in their growth, but will not send out offsets; and if rain afterwards falls, an occurrence that must take place some time during the summer, often at a late period of it, the plants *then begin to stool*, and send out a number of young shoots. These young shoots, unless under very favourable circumstances, cannot be expected to arrive at maturity; or if their ripening is waited for, there will be great risk of losing the early part of the crop,—a circumstance that frequently happens. In almost every instance an unequal sample is produced, and the grain is for the most part of inferior quality. By good judges, it is thought preferable to sow a quantity of seed sufficient to insure a full crop without depending on its sending out offsets. Indeed, when that is done, few offsets are produced, the crop grows and ripens equally, and the grain is uniformly good."*

* Brown *On Rural Affairs*, vol. ii. p. 45.

2695. No grain is so easily affected by weather at seed-time as barley: a dash of rain on strong land will cause the crop to be thin, many of the seeds not germinating at all, whilst others burst and cannot germinate; and in moist, warm weather, the germination is certain and very rapid. Indeed it has been observed, that unless barley germinate quickly, the crop will always be thin. I have seen the germ of barley pierce the ground only 36 hours after I had sown it myself, when the ground was smoking by the evaporation of moisture, caused by a hot sun in a close atmosphere. I have also traced the germ of barley to its root to the depth of 9 inches below the surface; and this shows that land may be ploughed deep for barley.

2696. The harrowing which barley land receives after the seed has been sown broadcast is less than oat land, a double tine being given in breaking-in the seed, and a double tine across immediately after. When the seed is sown with the drill machine, the land is harrowed a double tine along, and another double tine across the ridges, before the seed is sown. When the seed is sown on ribbed land, the only harrowing given is a double tine along the ribs, just to cover the seed, as the ribs afford a sufficient hold of the ground.

2697. The grass seeds are then sown with the grass-seed sowing-machine, fig. 204: the land harrowed a single tine with the light grass-seed harrows, fig. 232; water-furrowed, fig. 209; and finished by immediate rolling, fig. 222. On strong soil, apt to be encrusted on the surface by drought after rain, the rolling *precedes the sowing of the grass-seeds*, and the work is finished with the grass-seed harrows; but on all kindly soils, the other plan is best for keeping out drought, and giving a smooth surface for harvest-work.

2698. The head-ridges are ploughed and sown by themselves.

2699. Barley is sown after potatoes and beans in the spring, but never when the weather will permit the sowing of wheat in the autumn. When intended for barley, the land is gathered up for the winter, water-furrowed, and gaw-cut, to prevent water standing upon it; and in spring it is cross-ploughed and ridged up for the seed-furrow.

2700. Barley is sown also at times after wheat or oats, and the sample in such a case is always fine coloured; but the practice is bad farming, and should never be pursued. It is practised in the Carse of Gowrie, because, as is alleged, the wheat grows too strong for the grass to be raised amongst it, and the succeeding barley is made to receive the grass-seeds. Such expedients are an excuse, but no justification of the practice.

2701. Barley is never sown in Scotland after lea, but might be after the land had received a partial fallowing in spring.

2702. When sown in autumn, barley does not stand the winter well in Scotland, though it does on the warm calcareous soils of the south of England. Winter barley is always early ripe, but is seldom a prolific crop; and when it tillers late in spring to cover the ground, the produce exhibits an unequal sample, and contains a large proportion of light grain.

2703. As an instance of sowing very late barley, I may relate what has fallen under my own observation. The late Mr Guthrie of Craigie, near Dundee, one season had early ploughed the greater part of a field of strong soil after turnips, and much rain had afterwards consolidated it. Being desirous of giving the land another furrow before sowing it with barley, he found the plough bring up large waxy clods, unfit to form a seed-bed for that grain. He consulted me, and I advised him to rib the land that had just been ploughed with the small plough, fig. 230, while the remainder of the field, about two acres, the old ploughed land, were ploughed in the ordinary way. His men never having seen land ribbed, I showed them the way, and saw the ground sown and harrowed with one double tine along. The sowing took place as late as the 26th May, in 1819, and the ribbed land produced 10 bushels the acre more barley than that ploughed with the common plough,—so essential it is to have mellowed soil for the reception of the barley seed.

2704. The spring treatment of barley in Germany is thus described by Thäer :—"All species of barley require a light, rich, loamy soil, which retains moisture, without, however, suffering from damp—a soil which contains from 50 to 65 parts in a hundred of sand, and the rest chiefly clay. If, having the former of these proportions, it is situated in a dry position, and having the latter, in a moist one, it will be rendered still more adapted for the production of barley. This kind of grain, however, thrives wonderfully well on more clayey or stiffer soils, where there is a sufficient quantity of humus to prevent the land from being too tenacious ; in short, in land which may be classed among good wheat lands. If the clayey soil contains a certain quantity of lime, and the proportion of clay in it is sufficiently diminished to render it light, without ceasing to be consistent, it will then be peculiarly adapted for barley ; and the more so, from the lime purging the soil of its acidity, which latter quality militates against the success of barley. On the other hand, in moist summers, barley will be found to succeed very well on land in which sand is the predominating ingredient, and where it is found in the proportion of from 70 to 75 parts in a hundred ; provided, however, that the soil is in tolerably good condition. But during dry summers, the crops of barley would fail on such lands ; consequently its produce can never be depended on. A poor, tenacious, moist, cold, acid soil, is by no means proper for barley, nor will that grain often succeed when sown upon it.

2705. "Land in which barley is to be sown must be thoroughly loosened and pulverised. When, as usually happens, it is sown on the stubble of autumnal grain, the land must be ploughed at least three times for its reception ; but where the soil has been thoroughly loosened during the preceding year by weeded crops, one ploughing will be quite sufficient.

2706. "If those crops by which the barley was preceded have not left a sufficient, or, indeed, a considerable quantity of nutriment behind, an ameliorative compound of manure, which has undergone fermentation. must be bestowed upon the soil. The tender nature of the grain renders it necessary that the nutrition intended for it should be easy of digestion, and properly prepared for and adapted to its organs.

2707. "All those kinds of barley which are usually sown in the spring, support and require a tolerably thick covering of earth ; they may be buried by a shallow ploughing of three or four inches deep ; and, in fact, when sown on a very light soil, must be placed at this depth beneath its surface. The land, however, must always first be allowed to get thoroughly dry, as nothing is more conducive to the success of this grain than a period of dry weather succeeding to the sowing.

2708. "Perfect ripe seeds, which have not become heated in the granary, will always produce healthy plants ; they must, however, be carefully sifted and washed, to separate them from those seeds of weeds which usually grow so fast among barley. When this has been done, and the seed sown early, 12 or 14 metzen per acre [1 metzen = 3⅓ lbs. or 14⅗ of a bushel] will answer as well as 20 or 22 would otherwise do, especially when large barley is sown.

2709. "Barley becomes very thick and bushy where it has sufficient space, but when crowded the plants are weakly. Small barley may be sown much more thickly, as the plants are never so full and bushy as those of large barley.

2710. "Should heavy rains, which harden the ground, come on after the seed has been sown, a harrow must be passed over the soil as soon as it becomes dry, and before the barley begins to spring up, in order to break the crust, which otherwise often impedes the growth of the plants, being too hard to admit of their piercing their way through.

2711. "After the barley has begun to appear above ground, it is often very dangerous to make use of the harrow, as the plants are as brittle as glass. This operation, if performed at all, must be very carefully managed, a light wooden harrow used, and the latter part of the day or the evening chosen for the purpose."* It would be better not to use the harrow at all in such circumstances.

ON THE TURNING OF DUNGHILLS.

2712. The ordinary treatment of dunghills of farm-yard manure is very simple,—the principle upon which it is founded is quite consonant to reason,—and the results of the application of their contents are quite satisfactory in the crops produced. The treatment is, to spread every kind of straw used in litter, and every kind of dung derived from the various sorts of animals domiciled in the steading, uniformly in layers, as supplied, over the area of the respective courts ; to take this compound of straw and dung from the courts at a proper period, and form it into large heaps in the fields where they shall be needed ; to prevent fermentation of the heaps by compression until the manure is wanted ; and to turn the heaps over in such a way, and at such a time, as the manure they contain shall be ready as a uniform compound, to be applied to the

* Thäer's *Principles of Agriculture*, vol. ii. p. 425-7.—Shaw and Johnson's translation.

soil when wanted. The result is, when the manure so treated is applied to the soil, that it is the most valuable of any known manure for every purpose of the farm.

2713. You have been told how the courts should be littered, and how it is best done in (1086) and (2005.) You have seen how those courts are emptied of their contents, and the proper time for emptying them (2006.) And you have witnessed how those contents are disposed of in heaps in the fields in which they shall be required, (2009,) and the reasons why they are formed in the manner recommended, (2010.) My purpose now is to inform you how those heaps should be turned to bring on them that degree of fermentation best suited for making them into good manure.

2714. Potatoes, as a crop, require a large quantity of farm dung. It is the practice of some farmers to drive the dung for potatoes direct out of the court, in its compressed state, and before it ferments at all. On strong soils, naturally unsuited to the growth of this plant, by reason of their heavy and tenacious character, long dung may be used, as it assists to relieve the pressure of the soil upon the young plant. Indeed, on such soil, I have seen a drill of potatoes manured with the dry twisted straw-ropes of the coverings of the stacks, and produce as good potatoes as good dung. So, also, potatoes may be raised on soils of that character with horse-dung in a state of *fire-fang*. In all other sorts of soils the use of long dung incurs imminent risk of a deficiency of crop, and therefore dung should be fermented for potatoes to be raised on true potato soils.

2715. There is one objection to unfermented dung for potatoes, which seems to me insuperable; and that is—it is impossible to have the straw thrashed by the mill absolutely so clean as that not a grain of corn shall be found in it, or the seeds of weeds which have been sifted from the corn when winnowed, and thrown upon the litter in the courts; and as it is impossible to destroy the vitality of those seeds without fermentation, it is as impossible to prevent them springing up with the crop when carried there among unfermented dung. They will spring up amongst the potatoes, not in the intervals between the drills, where they might easily be removed by the horse-hoe, but actually amongst the potato-plants, growing with them, and deriving as much nourishment from the dung as the potatoes themselves. I have frequently seen such an intermixture of potato-plants and weeds at various places, and very dirty and slovenly farming it makes. Having a piece of ground trenched from an old plantation, and being comparatively clean, I was desirous of raising potatoes upon it for the first crop; and having no dung ready prepared for this extra space of ground, what it required was taken from the court in which the corn-barn was situated, and the result was that a considerable number of stalks of corn grew amongst the potatoes. No doubt, the weeds that thus spring up amongst the potatoes may be removed by the field-workers with the draw-hoe; but the labour of removing large plants, and especially when forced in growth by powerful manure, is considerable, and the weeding cannot be accomplished without removing a considerable part of the useful soil around the young potato plants. It is certainly much better farming to have no plants to remove from such a position, than to have them to remove.

2716. A dunghill which has been placed on the field as formerly described (2009,) and which is intended to be applied to the potato crop, should be turned about a fortnight before it is to be used; and, before commencing to turn it, it should be considered from which end it will be most convenient to take the dung and lay it on the land. On the supposition that that end is nearest the headridge, and that the dung for potatoes requires only one turning, it should be begun to be turned at the end farthest from the headridge. The unturned dung-heap slopes a little at both ends, but the turned dunghill should be made of the same height throughout. A dunghill is turned over in a succession of breadths or *daces* as they are called. The usual width marked off on the dung-heap for the breadth of the dace to be turned is 3 feet, which affords sufficient room for people to work in; but the first few spaces upon which the first daces of the heap are laid, should be made narrower than 3 feet, until the desired height of the turned dunghill is attained at the end, which is done by throwing up the turned dung to a greater height than that of the end of the dunghill. The effect of this arrangement is, as the turning approaches the middle of the dung-heap, where it is of the greatest height, the space upon which the dung is *turned upon* will be more than 3 feet in width, and the additional width will be required at the middle, and on both sides of it, that the extra height of the dung-heap there may be reduced to the level of the new ends. After the middle has been passed, the spaces turned upon should be gradually lessened in width towards the end at which the turning is finished, where, as at the commencement, the turned dung will have to be thrown to a greater height than the dung-heap, to attain the medium height of the turned dunghill. There is more of good management in attending to these particulars of turning a dunghill than at first sight may seem necessary, because the turned dunghill will not ferment equally throughout, when it is of different heights. The greatest heat will be at the highest part, where the dung will become comparatively short and compact, whilst at the shallowest parts it will continue crude and unprepared; and those different states of manure will have of course very different effects upon the soil. In ordinary practice, miscalculations are continually made as to what will be the uniform height of the dunghills, and the consequence is, they are always lower at the ends than in the middle; and if an endeavour is afterwards made to equalise the height, it is done by throwing the dung off the middle towards the ends—the effect of which expedient is, that no union takes place between the dung which was turned over in the regular manner with what is thus afterwards thrown upon it; they remain in different states, and rise differently to the graip when removed into the cart; and the middle part having been trampled upon when the dung from it was placed on the ends, it becomes much harder than the ends, and consequently presents a different degree of fermentation.

2717. Laying down these rules by which dunghills should be turned, the mechanical part of the operation is executed in the following manner:—The people required to do this work are a man and a few field-workers, according to the size of the dung-hills; and of this latter class, women are by far the best hands at turning dung-hills, because, each taking a smaller quantity of dung at a time upon a smaller graip than the ordinary one fig. 82, the dung is more intimately mixed together than when men are employed at this work, who take large graipfuls, and merely lift them from one side of the trench they are working in to the other, without shaking each graip-ful to pieces.

2718. Turning dung is not a cleanly work for women, their petticoats being apt to be much soiled in the trench by the dung on both sides; but the plan which the Berwickshire women adopt of keeping this part of their dress clean, is to tie the bottom of the petticoat with the garters just below the knee.

2719. The man's duty is to cut the dung-heap into daces of 3 feet in width, across the breadth of the heap, with the dung-spade, fig. 191, in the manner described in (2012.)

2720. The drier portions of the dung are put into the interior of the dunghill, and, when different sorts of dung are met with, they are intermingled in small graip-fuls as intimately as possible. Each dace of the dung-heap is cut off, and turned over from the top to the bottom. When the bottom of the dace is reached, the scattered straws, and the earth which has been damped by the exudation from the dung-heap, are shovelled up with the square-mouthed shovel, fig. 83, or the frying-pan shovel, fig. 233, and thrown into the interior. When straw-ropes are met with, they should be cut into small pieces, and scattered amongst the dampest parts of the dung-heap. Though the dung-heap is cut into parallel trenches, the dung from the top of one trench is not thrown upon the bottom of the former one, but upon the breast of the turned dung, so that the turned dung slopes away from the work-people. The utility of this mode of turning is, that when the dung is carting away, it not only rises freely with the graip, but the dung is intimately mixed, and not in separate loose trenches. When a dung-heap is thus turned over, and its form preserved as it should be, it constitutes a parallelopipedon, and is a good-looking piece of work.

2721. Fig. 233 represents the frying-pan shovel, which is so named by its similarity to that culinary utensil. It is also called the lime shovel, as being well adapted for the spreading of lime, upon the land; the raised back protects the hand from the lime while the sharp point passes easily under the lime, making way for the sole to slip along the bottom of the cart. The use of this shovel is chiefly confined to the Border counties. When mounted with a helve, and of the medium size, it costs 3s. 10d.

Fig. 233.

THE FRYING-PAN OR LIME SHOVEL.

2722. Unless much rain has fallen from the time the dung was led out of the court until the heap is turned, the dung will not be very moist, and not at all wet, though in a free workable state, with a slight degree of heat in it, and evaporation would be observable from it, were the air cold at the time of turning. Very little moisture will have come from the heap. After this turning over, shaking up, and mixing together, which should be finished in the same heap as quickly as possible, that the whole mass may have the same time to ferment, a considerable degree of heat may be expected to show itself in the dung in the course of a few days. There is no danger of this first fermentation producing a great degree of heat, as the air is still cool at night, and the largest proportion of the heaps consists of the dung of cattle, which is slow of fermentation at all times, and particularly in the early part of the season. The first external symptom of fermentation is the subsidence in the bulk of the heap, which, in the course of a fortnight, at this season, may contract 1 foot of height. A perceptible smell will then arise from the dung, accompanied with a flickering of the air over it, which is occasioned by the escape of vapour and of gases. By inserting a few sticks into the heap here and there, a heat considerably above that of the hand will be felt on them, the relative heat of different parts ascertained, and the greatest heat may be expected at the side opposite from whence the wind comes. The substance of the dunghill becomes more consolidated in consequence of the fermentation, and also more uniform; and a black-coloured liquid will ooze from its sides, at the ground. If the soil upon which the dunghill stands was soft when the dunghill was formed, the oozing will be absorbed by it, and exhibit but little wetness at the surface; but if the soil was firm, the moisture will remain on the surface, and form small pools in the ruts of the cart-wheels or in the open furrows. All the leakage, if collected in even one pool, would afford but a trifling quantity; indeed much moisture cannot exude from a dung-heap derived from courts in which the cattle are supplied with as much litter as will keep them both dry and warm.

2723. The *turnip* dunghill receives a somewhat different treatment, but still conformable to the purpose for which it is destined. It is turned twice, and on this account is begun to be turned at the opposite end to that for potatoes, or at the end nearest the headridge; but the same mode is practised in turning it, as that just described for the potato dunghill. After the turning, it is allowed to ferment for about a fortnight. At the second turning, which is given about a fortnight or ten days before the dung is used, the operation is commenced at the end at which the former turning terminated, and is more easily performed than the first, inasmuch as the substance is more easily cut with the dung-spade, more easily separated and shaken with the graip, and less care is required to retain the rectangular figure formerly given to the dunghill.

2724. The weather at the second turning will be warm, and the fermentation, of course, rapid; so that apprehension may be excited that it will proceed to a degree injurious to the materials composing the dunghill. A spitful of earth thrown upon the top of the dunghill, will check rapid fermentation to a certain degree. For raising turnips, however, there is little dread of the fermentation proceeding too far, as it is matter of experience that the more effectually the fermentation has run its course, the dung becomes the more valuable for the nourishment of the turnip plant, as is well known to every turnip farmer. When in this valuable state, heat has almost entirely left it, it has become like soft soap, and rises in lumps with the graip, and would almost cut into pieces with the shovel. It is sappy, cohesive, greasy, heavy, and of a dark brownish-black colour. The larger the mass in this state, the more valuable it is for turnips.

2725. It is supposed by many farmers who grow Swedish turnips largely, that dung cannot be made into this state in time for Swedish turnips, which ought to be sown before the middle of May; and, in ordinary seasons in Scotland, the observation, I daresay, is correct. To obviate the want of so valuable an ingredient as old muck, it is the practice of some farmers to keep dung on purpose over the year. This would be impracticable on farms which depend entirely on their own produce for the manure applied on them; but let a sacrifice be made for one year, of collecting farm-yard dung from external sources, and forming it into a dunghill for the succeeding year, or of purchasing other manure to a large extent for one year, to raise the crop of turnips, and reserve the farm-yard dung for the Swedish turnips of the next year, and the object is gained. I have known farmers attain this object to a partial extent, but no one whom I have observed practised it to so great an extent as Mr Smith, when he was at Grindon in North Durham, where he possessed a fine stock of short-horns. The dung of the year was made fit for white turnips, which were not sown for a month or so after the swedes, and then heat and time combined to bring it to a proper state for use.

2726. This mode of preparing farm-yard manure is now decried as being wasteful of the most valuable part of the manure. No doubt some waste of the dung-heap takes place ere the dung is converted to the state just described; and, were means available to prevent the least waste, while the object of procuring the manure in the best state was secured, those means would be a desirable attainment. But the same necessity for having the dung in that state does not exist now as it did then. One infallible means has been put into the power of farmers to raise a good crop of turnips, and this is the sole object which the old plan had in view. It is now found that the use of a little guano secures the health and growth of the turnip plant at the early stage of its existence; and the farm-yard dung having been relieved from this necessary and essential care, and most onerous part of its duty, it may safely be consigned to the ground before reaching the state described above, and there, instead of in the fermenting dung-heap, become prepared for supporting the turnip plant at a more advanced period of its existence. This happy change serves to preserve some of the bulk of the farm-yard manure, and to extend it over a larger space of ground.

2727. This being the case, let us attend to the dung-heap, as proposed to be treated in the new or improved mode, and which is represented in fig. 192. In pursuance of the amended plan, the dung intended to be used for the potato crop should be allowed to remain in the court, until about a fortnight or three weeks before it is to be used, when it should be taken out to be fermented—for fermented it ought to be before it is used—and the place it should be taken to be fermented is the dung-pit in the field, fig. 192, into which it should be carefully shaken with the graips by the field-workers; and as the above mode is the most convenient for a dung-heap to be thrown by the graip into the cart when it is wanted for the field, so the dung, as it is brought from the court, in the carts, to the dung-pit, should be turned and shaken into regular daces, one after the other, in the dung-pit, beginning at a given point, and throwing up the dung upon the face of the dace with a slope, until the height is reached which the turned dung-heap should have in the dung-pit.

2728. The dung, which has been kept in an uncompressed state in a particular court at the steading, as formerly noticed in (2013,) becomes sufficiently fermented for potatoes, where it is, and may be driven directly to the potato-field when wanted, without further fermentation.

2729. The dung for the turnips was led out to the field at the proper season, (2019) and placed in heap in fig. 192 to await its further treatment, and that time will have arrived whenever the dung-pit has been cleared of the dung for the potato crop, on the supposition that the potatoes and the turnips are to be raised in the same field. In case the potato-planting should be delayed from some cause, it will be well to arrange to take the white turnips in the same field with the potatoes, when the dung for them will have plenty of time to be prepared; but the dung-pit for the dung intended for swedes, should be occupied by the beginning of May at latest.

2730. The turnip dung-heap, occupying its site *d*, in fig. 192, receives this treatment in preparation for the swedes: The dung-heap is begun at one end to be wheeled on barrows, fig. 87, into the dung-pit, where it should be thrown up with the graips by the field-workers in a regular manner, dace after dace, beginning at one end of the dung-pit and progressing backwards towards the other end. If the height of the turned heap is above the reach of the throw the field-workers can easily make, two or three planks should be laid down parallel to the dace they are working at, the dung wheeled upon them from the dung-heap, and they will afford a footing to those turning the dung, and from them the dung can be thrown to the requisite height. The dry straw around the ends, and sides, and top of the dung-heap should be carefully scattered in the dung-pit among the sappiest portions of the dung, and covered up by the same. In this way the entire dung-heap may be transformed from the stance in the outside to the inside of the dung-pit. The field-workers will wheel the barrows as well as men, one man only being required to cut the dung-heap into small pieces with the dung spade. The ground on which the dung-heap stood should be carefully shovelled clean as the dung is wheeled away, and the shovelling should be performed by the man, alternately with the cutting of the dung. After the entire dung-heap has been turned in the dung-pit, the shutters should be put on the open spaces serving in the meantime as doors, and the dung left to ferment until it is wanted.

2731. Long sticks should be stuck in all dung-heaps undergoing fermentation, that a knowledge may be gained of what is going on in the interior. The degrees of heat, and the consistency of the manure heap, will indicate whether the former is proceeding to too high a degree for safety to the heap, and the latter will exhibit unequal sinkings in its mass in those places which had been either insufficiently loosened, or its component parts irregularly mixed. On this account it is of great importance to exercise a constant superintendence over the turning of dung-heaps.

ON THE PLANTING OF POTATOES.

2732. The potato crop is cultivated on what is called the fallow division of the farm, being considered an ameliorating crop for the soil. Following a crop of grain, whose stubble is bare in autumn, the land for the potato crop is ploughed early, that it may receive all the treatment which winter can exercise, to make it tender; and as potatoes affect a dry and light soil, the land for them may be ploughed early in spring, and even then partially cleaned. The time for *cleaning* land is very limited in spring, and ought not to be depended on—so the cleanest portion of the fallow-break should be chosen for the potatoes to occupy.

2733. The stubble land will either have been cast, fig. 22, in autumn, or cloven down without a gore-furrow, fig. 27, according as the soil is strong or light; and having been particularly provided with gaw-cuts, to keep it as dry as possible all winter, it may probably be in a state to be cross-ploughed, fig. 229, soon after the spring wheat and beans have been sown, if either of these crops is cultivated on the farm; and if not, the cross-ploughing for potatoes constitutes the earliest work in spring after the ploughing of the lea.

2734. After the cross-ploughing, the land is thoroughly harrowed a double tine along the line of the furrow, and a double tine across it; and any weeds and stones, that may have been brought to the surface by the harrowing, are gathered off.

2735. If the land is clean, it will be ready for drilling, if not, it should receive another ploughing in the line of the ridges, across the cross-furrow, and ridged up by casting, fig. 22, and then again harrowed a double tine along and also across, and the weeds again gathered off. Should the surface be dry on harrowing after cross-ploughing, and the weather appear not likely to continue dry, the grubber, fig. 215, will be a better implement for stirring the soil, under the circumstances, than the plough, as it will still retain the dry surface uppermost, and bring to the surface the weeds that will entangle themselves about the tines. The time occupied in doing all this, as the weather may permit, may be about a month, from the middle of March to the middle of April, when the potato should be planted. As the land cannot receive more ploughing in early spring than it should, to make it still more tender, the drills for the manure should be set up in the double mode, (2397.)

2736. While the land is preparing for the potato crop—and it will not be possible to prepare it continuously, as the oat-seed, and the early part of the barley-seed will have to be attended to—the potato-seed should be prepared, which is the special duty of the field-workers. The potato-pit is opened by removing the thatch and earth, and the potatoes are taken into a barn.

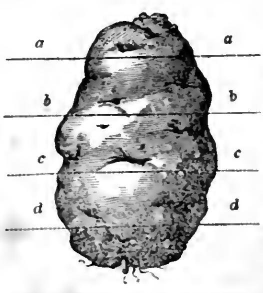
2737. The state of the potatoes, when taken out of the pit, will depend on the temperature of the weather in spring, and also on the state they were pitted in autumn. In cold weather, they will not be much sprouted in the pit by the time they should be planted; but should they have at all heated, in consequence of the wet state they were pitted, or the unripe state they were taken up, they will inevitably have heated and sprouted. When the sprouts are long, they should be removed, as it will be impossible to preserve them entire; but if the quickening of the tubers is evidenced only by mere buds, these should be preserved, as they will push above ground several days sooner than the sets which had not sprouted at all. It should be borne in mind, however, that sets with long sprouts, and sprouted sets that have been long kept after being taken out of the pit until planted in the field, are apt to set up puny plants. In selecting tubers, therefore, to cut into sets, the middle-sized, that have not sprouted at all, or have merely pushed out buds, will be found the soundest; and wherever the least softness or rottenness is felt, or any suspicious-looking mark as regards colour, or any other peculiarity is observed, the tuber should be entirely rejected, and even its firm portion should not be used for seed. The small potatoes should be picked out and put aside to boil for poultry and pigs.

2738. Potatoes are either planted whole, or cut in parts into *sets*. Large whole potatoes create waste of seed, and small sets give rise to puny plants.

2739. Small whole potatoes make good seed. One season, happening to have fewer sets cut than would plant the ground the dunghill allotted to the potato-land manured, some of the small potatoes, which had been picked out for the pigs when the sets were cut, were planted to finish the land with potatoes, and they actually yielded a better crop than the rest of the field.

2740. The usual practice is to cut a middle-sized potato into 2 or 3 sets, according to the number of eyes it may contain, and unless two eyes are left in every set, the chance of having a plant will not be great, as one of them may have lost its vitality. The sets should be cut with a sharp knife, be pretty large in size, and taken from the rose or crown end of the tubers; the other heel, or root end, may be kept for the pigs or poultry. When fresh, the tubers cut crisp, and exude a good deal of moisture, which soon evaporates, and leaves the incised parts dry. Fig. 234 represents a po-

Fig. 234.



HOW A POTATO MAY BE CUT INTO SETS.

tato divided into sets, having each at least two eyes: what is above the line *a a* is the crown, and what below the line *d d* is the root end, and should be rejected for seed. A potato may be cut in this manner, and in many parts, as through *b b* and *c c*, if large enough; and it may be cut through the middle between *b* and *c* horizontally or perpendicularly, provided always that at least two eyes are preserved.

2741. A very common practice prevailed to heap the cut sets in a corner of the barn until they were planted; and had they been prepared or exposed to drought prior to this treatment, they might have remained there uninjured, but if heaped up immediately after being cut, and while quite moist, the probability was that those in the heart, and near the bottom of the heap fermented, evolved a considerable degree of heat, and never vegetated. I believe much of the injudicious treatment which the sets of potatoes have received, arose from inconvenience of accommodation in the apartment in which they were prepared. The potato sets were locked up there. The straw-barn cannot be appropriated to them, as the cattle-man and ploughman must have daily access to it. The corn-barn is occupied at this particular period with a part of the barley-seed which had been thrashed in quantity. The implement-house is but a small apartment, and affords but little room—besides the many small articles which it contains. The only alternative is to heap them in a corner of the corn-barn. Hence the utility of such an outhouse as *g′*, Plate II., in every steading. The sets required to plant an acre of land will fill 24 bushels; so, to plant only from 5 to 10 acres of land, a large bulk of sets are required, and to give them room, by spreading them thin, would occupy a large floor; and all the sets should be prepared before the planting commences, there being no time for the tedious process of cutting them when the planting is in progress: extra hands would require to be engaged for the purpose, at a season when they would be obtained with difficulty.

2742. To insure the vitality of the sets in the ground, even when planted under adverse circumstances, it has been recommended to dust them with slaked lime with a riddle, immediately the potatoes are cut, and the sap, on exuding from the incised part, will be immediately absorbed by the lime, which, on forming a paste, encrusts itself on the incised surface.* Others recommend to dip the sets in a thick mixture of lime and water, which, on drying, envelops them in a coating of plaster. This latter plan would be attended with some trouble, and seems to offer no advantage over the former, which is easily done, and can do no harm. It has also been recommended to sprout the sets prior to planting them, in order to test their vitality, by spreading them on the ground 2 or 3 inches thick, covering them with a thin coating of earth, and watering the earth frequently until they are all sprouted; but the potatoes which have sprouted in the pit, if cut into sets and planted *immediately*, should be in as favourable a state to grow in the drill as when subjected to this process; and however easily it may be conducted on a small scale, I consider the suggestion as unfit to be practised on a large one on a farm; and especially when dry sets are planted, they are found to vegetate more equally, provided they have retained their vitality. It has also been recommended to dip the sets in diluted sulphuric acid.

2743. Since the prevalence of the disease among the potatoes in all soils and all situations, numerous expedients have been devised to prepare the seed, with the view of warding off another attack of the disease; but hitherto all expedients have proved unavailing. So the treatment of the seed, as given above, is perhaps just as likely to be good as any that has yet been devised.

2744. The potatoes not required for seed, firm and of good size, whether intended for sale or for use in the farm-house, should be placed in an outhouse, until disposed of or used, the apartment having an earthen floor, kept in the dark, with access to the air, and water thrown upon them occasionally, to keep them crisp, but not to make them moist, and they should be

* *Prize Essays of the Highland and Agricultural Society*, vol. xiv. p. 144.

carefully examined as to soundness when the sprouts are taken off.

2745. Having drilled up as much land as will allow the planting to proceed without interruption; having turned the dunghill in time to ferment the dung into a proper state for the crop; and having prepared the sets ready for planting, let us now proceed to the field, and see how operations should be conducted there, and in what manner they are best brought to a termination. The sets are shovelled either into sacks like corn, or into the body of close carts, and placed on a headridge or headridges or middle of the field, at convenient distances, according to the length of the ridges. When the drills are short, the most convenient way to get the sets in the field is from a cart; but when the drills are long, sacks are best suited for setting down here and there along the middle of the land.

2746. A small round willow basket, with a bow-handle, as fig. 235, should be provided for every person who is to plant the sets; and as a considerable number of hands are required for the operation, boys and girls may find employment at it, over and above the ordinary field-workers.

Fig. 235.

A POTATO HAND-BASKET.

2747. The frying-pan shovel, fig. 233, with its sharp point, is a convenient instrument for taking the sets out of the cart into the baskets. Single-horse carts take the dung from the dunghill to the drills. Graips, fig. 82, are required to fill the carts with dung; small dung-graips, three-pronged, fig. 218, are most convenient for spreading the dung in the drills, and a small common graip to divide the dung into each of the three drills, as it falls into the middle drill from the cart. The dung-hawk, fig. 217, is used by the steward for pulling the dung out of the carts. Boys, girls, or women, are required to lead the horses in each cart to and from the dunghill to the part of the field which is receiving the dung. The ploughmen, whose horses are employed in carting the dung, remain at the dunghill, and, assisted by a woman or two, fill the carts with dung as they return empty. The steward drags the dung out of the carts, and gives the land dung in such quantity as is determined on beforehand by the farmer. Three women spread the dung equally in the drills with the small dung-graips, while a fourth goes before and divides it with the common small graip into each drill as it falls in heaps from the carts. Women plant the sets of the potato out of the basket upon the dung. Ploughs follow, and split in the drills and cover in the dung and sets as fast as the planting is done, and they finish the operation of potato planting. It will be observed from this enumeration that potato planting requires a large number of people and implements to accomplish it effectually.

2748. If the drills have not all been set up previous to starting the subsequent work, a plough continues working them up in the double method, until as much land has been drilled as is desired to plant with potatoes. After he has finished drilling, he assists the other ploughmen in splitting in.

2749. The preparations for planting being thus ready, the first thing done is to back a cart to the dunghill *f*, fig. 236, to be filled with dung; and it is usually not quite filled, the dung being heaped as near the back-end of the cart as is convenient for the draught of the horse, that the man who drags it out may have the less labour. The carts are filled, and the bottom of the dunghill shovelled clean by the ploughmen whose horses are employed in carting the dung; the men are usually assisted by a field-worker or two, to detain the carts the shorter time at the dunghill. Whenever the load is ready, the driver *c* starts with the horse and cart *g*, and walks them along the headridge until they arrive at the undunged drills, down which they go until they come to the steward, who places the horse and cart into their proper place in the drills, removes the back-board of the cart, places it upon its edge on the nave between the body of the cart and the near wheel, as explained in (2433), and then tilts the body of the cart as far up as to get at the dung easily. When the carts are *whole*-bodied, the steward proceeds, after the back-board is removed, to drag out

Fig. 236.

POTATO PLANTING.

the dung. The wheels of the cart and the horse occupy 3 drills, as at *i*, the horse being in the middle drill between two. The steward *h*, with the drag in both hands, pulls out a heap of dung *i* upon the ground, and it invariably falls into the middle drill. The horse is then made to step forward a few paces and to halt again, by the voice of the steward, who then pulls out another heap of dung. An active man, accustomed to this sort of work, does not allow the horse to stand still at all, but to walk slowly on whilst he pulls out the dung. When the cart is emptied, the steward fastens down the body of the cart, if it is a coup one, puts on the back-board, and the cart again proceeds by its driver to the dunghill. When the distance to the dunghill is short, the carts are as slightly filled as to dispense with the back-board altogether; and when it can be wanted, the work is considerably expedited.

2750. After the cart has proceeded a few paces, and deposited a few heaps of dung, the foremost of the band of 4 women *k*, who spread the dung, divides the heaps, as at *m*, with her small common graip into other two heaps, *l* and *n*, one in each of the drills beside her; and from *m* she goes to the next heap *i*, and divides it into other two heaps, and so on with every heap of dung. The 3 field-workers, *n o p*, having each a small dung-graip, fig. 218, then takes each 1 of the 3 drills occupied by the horse and cart-wheels, and all spread the dung before them equally along the bottom of the drills *l m n*, each taking care to remain in her own drill from the one end of the field to the other, shaking to pieces every lump of dung, and teazing out any that may happen to be ranker than the rest, trampling upon the spread dung as she walks along and keeping it within the limits of the bottom of the drill. The spreading should always be kept close to the cart.

2751. Immediately that a part of 3 drills are dunged and the dung spread, the potato planters, after having plenished their baskets with sets from the cart *t* upon the headridge, proceed to deposit the sets upon the dung along the drills, at from 9 to 12 inches apart, according to the size of the sets. Some women prefer to carry the sets in coarse aprons instead of baskets, because they deem them more convenient. As setting requires longer time than dung spreading, there should be two bands of planters, as at *r* and *s*, to one of spreaders, which makes 6 planters to 4 spreaders. One band of planters, as *s*, go in advance of the other *r*, till the latter comes up to the place where the former began, and then the band *r* goes in advance, and so one band after another goes in advance alternately, each filling their baskets and aprons as they become empty, but all confining their labour to 3 drills at a time. This plan gives the advantage of planting the 3 drills quicker, thereby giving less time to the dung to become dry, and preparing the ground also more quickly to be split down by the ploughs.

2752. Whenever 3 drills are thus planted, the ploughman *u* commences to split the first, and cover in the dung and sets in the double way. The drills are split in the same way as they were set up; that is, as the ploughman *a* turns over the first furrow of each drill upon the firm ground, stretching from *a* to *e*, so the ploughman *u*, in splitting the drills, turns over the first furrow upon the dung towards the planters *r* and *s;* because the *first* furrow being the largest, it should have complete freedom to cover the dung and potato-sets.

2753. The ploughman *u* should not leave a single drill uncovered in the evening when he gives up work. If he cannot split all the drills in the double way, he should cover up the dung and sets of the few last drills in the single way; and he should receive assistance from the ploughman *a*, who is making up new drills, to split them completely, if the weather exhibits symptoms of rain or of frost. And, even at loosening from the forenoon yoking, every drill should be covered in, although the ploughman should work a little longer than the rest of the work-people; and for this he may be as long of yoking after them in the afternoon yoking. In dry hot weather he should make it a point to cover in the drills at the end of the forenoon yoking in a complete manner, as dung soon becomes scorched by the mid-day sun; and in such a state it is not so useful; not so much on account of the evaporation of any valuable material from it, that being chiefly water, but because dry dung does not incorporate with the soil for a long time, nor so well as moist; and when soil and dung together are rendered hot and dry by exposure, their incorporation becomes very difficult. If all the ploughs cannot cover in the drills within a reasonable time after the hour of loosening has arrived, especially at night, much rather give up the dunging of the land and the planting of the sets a little sooner than usual, than run the risk of leaving any dung and sets uncovered.

2754. Potatoes always receive a large quantity of dung, being a fallow crop, when the ground ought to be dunged, and they are considered to take more nourishment out of the soil than to return materials to it —yielding no straw but a few dry haulms, and the largest proportion of the crop being sold off the farm. A large dunging to potatoes always *seems* great, as time is wanting to make the dung short, and reduce its bulk. About 20 single-horse loads, or 15 tons the acre, of farm-yard dung, is as small a dunging as potatoes receive. In the neighbourhood of towns, street-manure, to the extent of 30 tons and upwards, is given; but there the crop is forced for an early market, and the street-manure has not the strength of farm-yard dung, and is not so well suited for them as for turnips.

2755. This is identically the same process of applying the dung as was explained in dunging the land for beans (2433;) and I have resumed the subject more particularly here, in order to show, by the graphic fig. 236, all the parts of the operation, which should be well understood, as reference will again be made to them when dunging the land for turnips as well as for bare fallow.

2756. You will observe that the process, as represented in fig. 236, is composed of a variety of actions, which, taken individually, are equally important, and none of which can be carried on without the assistance of the others, and all of which, if not proportioned to one another, would produce confusion. Thus, the ploughing of the drills, the dunging of the land, the spreading of the dung, the planting of the sets, and the splitting of the drills, are all equally important operations in potato-culture. Not one of them would be of any use without the others. There would be no use of making drills unless they were to be dunged, nor would the planting of the sets avail unless the dung were spread; nor would the planted sets be safe, even on the spread dung, unless the drills were split to cover the whole from the weather. But if these separate operations are not proportioned to one another, the whole process goes into confusion. Suppose the ploughman *a*, while making double drills, cannot move on as fast as the party who is spreading the dung, it is evident that, besides themselves, every party behind them would be detained by his tardiness, and made to lose time. Instead of the delay continuing, a remedy should be devised to remove it. The remedy obviously is, that the ploughman should have as many double drills made before the dunging commences, as never to be overtaken, or he should make single drills; or another ploughman should be sent to assist him to make double drills. The first is the best remedy, because the same man is kept at the same work until it is finished, and the second is the worst, because it does not sufficiently plough the land. Suppose, again, that more dung is conveyed from the dunghill than the steward *h* can possibly drag out, or the 4 women *k n o p* possibly spread—the result would be, that the steward and women would be overworked, while the horses in the carts, and the people at the dunghill, would be comparatively idle, and throw away time. The remedy is either to diminish the number of carts, or that of hands who fill the carts at the dunghill. Suppose there are fewer planters at *r* and *s* than can keep out before the ploughman *u*, time would not only be lost in covering up as many drills as might have been covered, but the dung spread would lie exposed to the desiccating action of the sun and air between the planters of the sets and the spreaders of the dung. Were the planters of sets too many for the spreaders of the dung to move on before them, the planters would be comparatively idle, and so would the ploughmen behind them. The remedy is, to increase or diminish the number of the planters of sets, for the number of the hands who spread the dung, cannot be altered. Suppose, lastly, that the ploughman *u* cannot keep up with the planters, who, nevertheless, do not go faster than the dung is spread, the effect is, that the spread and planted dung becomes dry before it can be covered up. The remedy is, either to employ another ploughman to split in drills, or to make the foremost ploughman cover the dung with one furrow, and let the others behind him finish the drills.

2757. I have dwelt the more fully on these particulars, because the dunging of land in this manner is one of those great operations which is made up of a variety of constituent labours that must all be performed simultaneously, and when so done, the result is obtained in the quickest and most complete manner, and with the greatest harmony. Wherever this harmony of parts is seen to exist, it is satisfactory proof that the person who has so arranged the working constituents possesses the talent of combining varieties of field-labour, and displays knowledge of his profession of a superior order.

2758. A very common mode of dunging potato-land, is to drag the dung from the cart for 5 drills instead of 3, and have three, or even fewer, women to spread it over them. In doing this, each woman's attention is not confined to a single drill, but extends over the whole 5, when she spreads the dung from the large heap she takes possession of; and it stands to reason that she cannot possibly spread dung *so* equally, nor *so* well, *over* 5 drills as *along* 1; and the work would not be done better, though faster, although all the 3 women were employed to spread from the same heap, as each would still have the 5 drills to attend to. Besides, when dung is dragged from the cart for 5 drills, it is laid in large heaps at considerable distances of from 5 to 10 paces apart, thereby increasing the difficulty of spreading. A larger space, too, is thus manured before the few women can spread the dung; and by the time it is spread, and the sets planted, the dung becomes dry. This plan is inexcusable on even a small farm, where labourers are few; because no advantage is gained by spreading the dung over 5 drills instead of 3, and it must be a very small concern that cannot afford to employ 3 spreaders; but even 2 women will spread dung over 3 drills better than 3 women over 5. On a large farm, the plan indicates slovenliness, encourages carelessness in work, and evinces a confusion of ideas in making so loose an arrangement. It removes the responsibility for bad work when 3 women have to spread the dung over 5 drills, whereas every woman is responsible for the drill she manures when confined to it.

2759. It is no uncommon sight, even on large farms, to see the dung carted out and spread in one yoking, and the sets planted and the dung covered in another, by the same people and horses—doing, no doubt, a great extent of work in each yoking and during the day; but the result would be far more satisfactory were the work finished as it proceeded.

2760. A large number of dunged drills are usually begun to be planted with sets at the same time, instead of confining the planters to setting a few drills at a time, and have them covered as soon as possible with the plough. In short, there is no end to the *many* ways in which field-work is actually done in a slovenly manner; but there is only *one* best way of doing it.

2761. Drills of potatoes are recommended to be made at 30 inches apart, instead of 27 inches, which is the usual width for turnips, because the large stems of the potato-plant growing vigorously require plenty of air. Even 3 feet apart is recommended by some cultivators, and in deep rich soils this width may not be too great; but I observe in the neighbourhood of large towns, where the greatest extent of ground is occupied by potatoes, that the drills seldom exceed 24 inches, owing partly to the great value of land, and partly because the early varieties of potatoes having small stems, and being most profitable, are cultivated in that locality. The drills for potatoes are not set up with the same exactness in width as for turnips, potato sets not being planted with a machine.

2762. As to the varieties of the potato which I would recommend to be cultivated, it would seem that different varieties affect different soils and situations; and it seems also not improbable, that the multiplication of varieties has arisen, in some measure, from the influence of soil and situation on the living plant, independently of the means purposely used for obtaining new varieties, such as the importation of tubers from other countries, or the raising of tubers from the seed. From whatever causes the varieties of the potato have increased, they are now extremely numerous; upwards of 100 varieties of field-potatoes alone having been described by Mr Lawson,* and as many experimented on by Mr Howden, Lawhead, East Lothian.† All I can do in regard to noticing any of the varieties in particular, is to mention those chiefly cultivated in the neighbourhood of Edinburgh, and elsewhere.

2763. The most common varieties cultivated in the fields are the Dons, very plentiful in the Edinburgh market. It is round, and an early variety; that is to say, the stems decay by the time the tubers are fit for use. It produces about 16-fold of the seed, and yields 576 grains Troy of starch from 1 lb. of tubers. The Dons are useable whenever taken out of the ground.

2764. The Buff is a mealy and superior flavoured potato, yielding about 15-fold, and 466 grains Troy of starch from 1 lb. of tubers. The Buffs are best to use in spring.

2765. The Perthshire Red, an oblong flat potato, is largely cultivated for the London market. It yields about 15-fold, and affords as much as 777 grains Troy of starch from 1 lb. of tubers. This variety is extensively cultivated in the neighbourhood of Perth, whence there used to be shipped for London not fewer than 300 cargoes every year.

2766. Of the late varieties, the foliage of which, in ordinary seasons, does not decay until destroyed by frost, and whose tubers require to be kept for some time before being used, the Staffald Hall, or

* Lawson's *Agriculturist's Manual*, p. 216-24, and *Supplement*, p. 52-5.
† *Prize Essays of the Highland and Agricultural Society*, vol. xi. p. 85 and 95.

Wellington, as it is sometimes called, is to be preferred. It is represented to yield 22-fold, and affords 813 grains Troy of starch from 1 lb. of tubers.

2767. The Scotch Black potato has long been cultivated in Scotland; and it seems to suit strong soil better than light, where it yields as high as 16-fold of increase, and affords 522 grains Troy of starch from 1 lb. of tubers. This variety has long been, and is still, cultivated in the Border counties, where it is used in spring. In those counties potatoes are not raised for the market.

2768. Of the late varieties for field-culture suited for cattle, the Irish Lumpers and Cups are prolific. The Lumper is a white oblong potato of very inferior flavour, but yields 421 bushels, and 3118 lbs. of starch per acre; and the Cups are an oblong light red, coarse potato, yielding 479 bushels, and 3539 lbs. of starch per acre.

2769. The small American white potato was extensively cultivated in the midland districts of Scotland more than 20 years ago, but has yielded to more prolific varieties. For the table, however, when raised in hazel loam—the true potato soil—there are few varieties cultivated superior to it in flavour, richness, and beauty as a dish. It is still raised in the garden.

2770. The finest flavoured and most beautiful potato I ever saw on the table was a light red, small, round variety, raised a few years ago in the sandy soil of the parish of Monifieth in Forfarshire. It had quite the *nutty* flavour of a *fresh* Spanish chestnut—a state of that fine fruit unknown in this country.

2771. A remark of Thäer's that "some potatoes put out long filaments into the soil; others press their tubers so closely together, that they show themselves above ground," suggests a consideration in the selection of the variety of the potato, for the particular soil in which it is desired to be raised, which I suspect is never attended to by farmers when in search of seed potatoes. On selecting seed, the tuber alone is regarded, without reference to the habits of the growth of the plant; and those who profess to describe those habits, seem to direct their attention solely to the characters of the plants exhibited above ground, in their stems, foliage, and flowers, while their habits under ground, in their roots and tubers, are deemed unworthy of notice, and are entirely neglected. Now, when it has been established that one variety "puts out long filaments into the soil," surely it would be improper to plant that variety in strong soils, which necessarily oppose the penetration of tender filaments through them, when a light soil would at once encourage that peculiarity of growth. The impropriety of the want of discrimination in this matter would be the more evident, when varieties exist which "press their tubers closely together,"—thereby indicating that they possess a property which renders them the most proper to be selected for planting in strong soil. It is therefore desirable that observers would take the trouble of investigating experimentally the nature of the growth under ground, of the several varieties of the potato plant which are most generally cultivated, since their entire value depends upon their enlarged increase under ground.

2772. There are other ways of cultivating the potato in the field besides the one I have described. When light soil, in which the potato thrives, is clean and in good heart, it is frequently dunged on the stubble in autumn, and ploughed with a deep square furrow by casting with or without a gore-furrow, figs. 22 and 23. Abundance of gaw-cuts are made to let off the superfluous surface-water in winter. It is then cross-ploughed in spring, harrowed a double tine, when it is ready to be drilled up in the single form, the sets planted, and the drills split in the double form, to complete the operation. In the neighbourhood of towns this is an expeditious mode of planting a large breadth of potatoes in spring on light soil, but it requires the land to have *long been in very good heart.* I have tried it at a distance from a town, on good potato land in middling condition, but could not succeed in raising much more than half the crop on dunging the same land in spring with the same quantity of dung.

2773. A modification of this plan may

be practised in very light soil, by cross-ploughing and harrowing in spring, and then ridging by casting without gore-furrows in the opposite way it was cast in autumn when the dung was ploughed in; and at this ploughing two women follow the plough, and plant the sets in the bottom of every *third* furrow. If the furrows are 9 inches broad, the distance between the rows of potatoes will be 27 inches; and if 10 inches, the rows will of course be 30 inches apart; so that this plan admits of the rows being made wide enough.

2774. A sub-modification of this method is to spread the dung over the smooth harrowed ground after the land has been cast into ridges in spring, instead of applying it on the stubble in autumn. The dung is raked in and spread evenly along the bottom of every *third* furrow by a woman with the small dung graip, fig. 218, following the plough, and immediately preceding the planters, and another plough follows the planters and covers up the sets. In both these modes the potato plants come up in *rows upon the flat ground* at the same distance as in drills, and after the stems are grown up in summer, the earth is either ploughed up towards them, which converts the flat ground into a drilled surface, or allowed to remain flat.

2775. Another mode of the field-culture of the potato is in *lazy-beds*, which is more generally practised in Ireland than in any other part of the kingdom. The system on arable land is becoming less general, though on lea-ground and undrained bogs there cannot perhaps be a better one pursued. "In bogs and mountains," says Martin Doyle, "where the plough cannot penetrate through strong soil, beds are the most convenient for the petty farmer, who digs the sod with his long narrow spade, and either lays the sets on the inverted sod—the manure being previously spread—covering them from the furrows by the shovel; or, as in parts of Connaught and Munster, he stabs the ground with his *loy*—a long narrow spade peculiar to the labourers of Connaught—jerks a cut set into the fissure when he draws out the tool, and afterwards closes the set with the back of the same instrument, covering the surface, as in the case of lazy-beds, from the furrows. The general Irish mode of culture on old rich arable lea (a practice very common in the county of Clare, and elsewhere among the peasantry who pay dearly for old grass land,) is to plough the fields in ridges, to level them perfectly with the spade, then to lay the potato sets upon the surface, and to cover them with or without manure by the inverted sods from the furrows. The potatoes are afterwards earthed once or twice with whatever mould can be obtained from the furrows by means of spade and shovel. And after these earthings, the furrows becoming deep trenches, form easy means for water to flow away, and leave the planted ground on each side of them comparatively dry." "The practice in the south of Ireland is to grow potatoes on grass land from 1 to 3 years old, and turnips afterwards, manuring each time moderately, as the best preparation for corn, and as a prevention of the disease called fingers and toes in turnips. In wet bog-land, ridges and furrows are the safest, as the furrow acts as a complete drain for surface water; but wherever drilling is practicable it is decidedly preferable, the produce being greater in drills than in what may be termed, comparatively, a broad-cast method."*

2776. The spade-culture of potatoes is appropriate for small farmers and cottars, but is far too expensive on a farm where horse-labour is employed.

2777. The potato plant is subject to a disease at a very early period of its existence, not only after it has developed its stem and leaves, but even before the germ has risen from the set. This disease is called the *curl*, from the curled or crumpled appearance which the leaves assume. The puny stem and stinted leaves indicate weakness in the constitution of the plant, and, like weak animals affected with constitutional disease, the small tubers produced by curled potatoes, when planted, propagate the disease to the future crop. The experiments of Mr T. Dickson show, that the disease arises from the vegetable powers of the sets planted having been exhausted by over-ripening; so that sets

* Doyle's *Cyclopædia of Practical Husbandry*—art. *Potato.*

from the waxy end of the potato produced healthy plants, whereas those from the best ripened end did not vegetate at all, or produced curled plants. It is the opinion of Mr Crichton, "that the curl in the potato may often be occasioned by the way the potatoes which are intended for seed are treated. I have observed," he says, "wherever the seed-stock is carefully pitted, and not exposed to the air, in the spring the crop has seldom any curl; but where the seed-stock is put into barns and outhouses for months together, such crop seldom escapes turning out in a great measure curled; and if but few curl the first year, if they are planted again, it is more than probable the half of them will curl next season." * The curl is so well known by its appearance, and the curled plant so generally shunned as seed, that the disease is never willingly propagated by the cultivator.

2778. But, of late years, a disease has affected the potato with so much virulence as almost to destroy the entire crop, and with so much subtlety as to baffle the ingenuity of the philosopher as well as of the farmer, to discover even its nature. It was first called the taint, then the failure, then the murrain, as its virulence increased; and now it is simply the potato disease, because no one can now venture to define its characteristics with any degree of accuracy. Its ultimate effect is to reduce the tuber to a complete state of putrefaction, and this is effected as well in the ground as in the pit. Its earliest appearance in the tuber is indicated by discoloured blotches in the substance on the removal of the skin; and so loathsome is the feeling attending the discovery of this state of the tuber, that hunger itself cannot tempt a human being to eat the tainted part of a potato.

2779. Conjectures have been formed as to its cause, and many remedies proposed for modifying the mode of cultivating the tuber. The former are accepted or rejected according to the predilections of the individual; the latter have been adopted in innumerable ways; and while one may have succeeded in one plan it has failed in another, and has failed in the same place in the succeeding season. Cut sets, large and small—whole potatoes, large and small—moist weather and dry weather—early planting and late planting—strong soil and light soil—high situation and low situation—northern exposure and southern exposure—shelter under trees and by hedges, and exposure in open fields—with manure and without manure—manure applied directly to the sets and indirectly to the sets—one kind of manure and another kind of manure—cutting and pulling off the stems, and letting the stems remain—picking off the blossoms, and encouraging their growth—pulling off the seed apples, and encouraging them to ripen—weeding the ground clean, and encouraging the growth of weeds around the potato plants—earthing up the rows, and allowing them to remain flat—ripening the tubers in the ground, and taking them up before they are ripe—taking them out of the ground, and allowing them to remain in the ground all winter—trying one variety and another variety—a late variety and an early variety—old varieties and new varieties, just raised from seed—smearing, dusting, and steeping the sets in various mixtures and ingredients, and potatoes brought from South America, the land of their origin: one and all of these expedients have been industriously and anxiously tried, not only in the British isles, but on the continents of Europe and America, and the greatest attention bestowed in applying them with the utmost care, and in the best way that ingenuity and skill could devise; and all have failed to produce a single conviction that we are acquainted with the nature of the disease better now than we were at its first outbreak. Perplexity has i reased every year; hope has urged the culture, year after year, until every expedient should be exhausted. A respite from disease in 1847 inspired a considerable degree of returning confidence; but the serious failure in 1848 has decided the fate of the potato culture.

2780. I do not say that the culture of the potato will be abandoned for the future, for that will never be; but the crop will not again be so extensively cultivated, nor confidence reposed in it, until there be entire immunity from disease for several

* *Memoirs of the Caledonian Horticultural Society*, vol. i. p. 55 and 440.

years in succession. Whether such experience awaits it I cannot foretell, but I do not expect it; for I take this disease to be somewhat analogous to every severe epidemic which overtakes the human frame for the first time in a country, that, after it has once run its course through the human constitution, it never fails to leave a testimony of its existence, more or less evident, ever after.

2781. One of the expedients resorted to for avoiding this direful disease in the potato is the raising of new varieties from the seed contained in the potato apple; and although the new produce has by no means escaped the disease, it may be worth while to describe a mode of raising new potatoes directly from the seed of a size fit to be used at table. I wish to remark, that the new varieties of potatoes, which have not been exempted from the disease, may have been produced from the seed of diseased plants. We have no evidence that the potato apples gathered for the purpose of raising new plants had been the produce of sound plants. The plants may not have exhibited symptoms of disease, nor the tubers from the same plants have indicated any disease, and yet the embryo of disease may have been in them, ready to be developed under favourable circumstances. We have no security now that we can select a single plant of the potato free of the germs of the disease; and if the probability is that it contains disease, whatever be the result of the experiment it can conduct to no safe practice.

2782. A successful mode of obtaining good-sized potatoes from seed seems to have been followed by Mr John D. Peters, Gastron. He says, — "I have divided my manner of proceeding into two parts:— 1. The manner of obtaining the seed 2. The manner of treating the sowing and planting. The seed apples must be carefully collected when the potatoes are dry, because those apples which fall off of their own accord produce the best seeds. The apples are then suffered to remain until they begin to rot. Then they must be pressed, and again allowed to remain in their jelly or slime, until the latter, by decomposition, be changed into water. And now the seeds, as in the case of cucumber seeds, may be washed out clean, but previous to this not a drop of water must be added.

2783. "From the middle to the end of March, according to the favourable state of the weather, a bed is to be prepared in the following manner, — Let a space be levelled, about 12 feet long and 4 feet broad—sufficient plants can be reared upon this space to plant out 80 square rods; put horse-dung upon it to the depth of 9 inches; then cover this dung with about 6 or 8 inches of mould, previously run through a sieve. The space is to be enclosed by common frames, with suitable glazed covering. After the mould has been thus laid over the dung, make it smooth and even, and then draw cross-furrows, of about half an inch in depth, with a fine rake, and sow the seed therein; after which, with the back of the rake, again smooth the small furrows, but without raking the ground again. The earth or mould is to be watered by means of a small watering-pot, and great care must be taken to keep the bed mould always of equal moisture. The slides may only be moved to admit air when the plants shall have made their appearance, which occurs after the space of 10 or 12 days. Care must likewise be taken not to let the plants be choked by weeds.

2784. "After the plants have attained a length of 6 inches, they are then to be planted out at the same distance that potatoes are usually planted. The plants must be put into the ground at such a depth that two-thirds of the plant be covered. They are then watered a little. The future treatment of the plant may now be conducted exactly in the manner of potatoes which have been planted out.

2785. "If this process be strictly attended to, the first year's crop will yield potatoes of the size of a hen's egg, and a much richer harvest may be expected than any crop from cuttings could yield. I have actually had plants which have yielded upwards of 100 potatoes, some of the size of a hen's egg, many as large as walnuts, and all the others sufficiently large for planting." *

* *Hamburg Correspondenten* of November 30, 1846.

2786. M. Zander, gardener to Count Arnim at Boitzenburg, near Berlin, raises potatoes from seed in a similar manner to that of Mr Peters, and with equally good success

2787. A good potato is neither large nor small, but of medium size; of round shape, or elongated spheroid; the skin of fine texture, and homogeneous; and the eyes neither numerous nor deep-seated. The habit of growth of its stem is strong and slightly spreading, and colour lightish green. I believe that the intensity of the colour of the flower is in some degree an indication of the depth of the colour of the tuber; and I believe also, that white potatoes are generally fit to be eaten when taken out of the ground, but that red ones are the better for being out of the ground for a shorter or longer time, according to the fineness of their texture, before being used.

2788. The *intrinsic* value of a potato, as an article of commerce, is estimated by the quantity of starch it yields on analysis; but, as an article of domestic consumption, the *flavour* of the starchy matter is of greater importance than its quantity. Almost every person prefers a mealy potato to a waxy one, and the more mealy it is usually the better flavoured. The mealiness consists of a layer of mucilage immediately under the skin, covering the starch or farina, which is held together by fibres. Light soil raises a potato more mealy than a strong; and I suppose every one is aware, that a light soil produces a potato of the same variety of better flavour than a clay soil. Thus soil has an influence on the flavour, and so has culture; as potatoes, whatever may be the variety, raised from soil which has been dunged for some time, are higher flavoured than those grown in immediate contact with dung.

2789. Mr Howden, Lawhead, discovered a curious effect which moist and dry soil comparatively had upon the sprouting of the potato, and on the constitution of the sets. He says: "On the 28th June I selected from a store which had been repeatedly turned and kept for family use, 70 potatoes of the old rough black variety. I divided this number into 5 lots, sizing them, so as each lot of 14 potatoes weighed exactly 4 lb. I made on that day one lot of 14 into starch, and obtained 9 oz. On the same day I put 14 potatoes whole, and 14 cut into 56 sets, into a deep box filled with *dry* mould. The remaining 14 whole and 14 cut I put into another box filled with *moist* earth, and which was watered from time to time. At the end of three weeks, with the exception of five sets, all the plants made their appearance. All this time the dry box had been kept from moisture. On the 21st July, however, I allowed it to be moistened with heavy rain, and on the 28th July, I took up and extracted starch from the whole. Before doing so, however, I weighed the several lots: and what seemed to me curious was, that each lot of the *whole* potatoes had *gained* 8 oz.; while each lot of the *cut* ones had *lost* 6 oz. of its weight, and of their number ten did not vegetate. The *sprouts* from the *whole* potatoes weighed 4 oz., and those from the *cut* only 2 oz., yet the *starch* from the 28 *cut* potatoes was only 2 oz., and that from the 28 *whole* potatoes 9 oz., being exactly the produce in starch of half that number, namely, 14, which was made into starch at the commencement of the experiment."

2790. I mentioned the effect which the unequal formation of the double-drill had in causing the plants of beans (2443,) germinating within it to grow out of the side instead of the top of the drill, and the drill has the same effect on potato plants. To evade the injury that would accrue to the plant from this cause, the drill is harrowed down flatter in eight or ten days after the potatoes have been planted, and the harrowing is best effected by the drill-harrow, fig. 220. Of the two forms of drill-harrows, the rectangular and triangular, the triangular is safest in its action after the germ of the potato has pierced through the ground, as its outmost tines work between the tops of the drills across their hollow, whereas the rectangular harrow rides upon the tops of the drills.

2791. The common harrows are passed either along or across the drills, according to the nature of the soil. Strong soil bears the harrows along the drills; and in very hard land, particularly in dry seasons, they may be pased along a double tine, but otherwise a single tine will suffice. Harrowing across, *with well-worn tines*, will have the least chance of disturbing long manure when used for dunging potatoes, as the coming drill which first receives the fore part of the harrow supports it and prevents the tines penetrating too deep; but the walking across drills is irksome both to man and beast, so that the harrowing is most easily performed along the drill. The common harrows are however a harsh implement for harrowing drills, compared to either of the drill harrows.

2792. A wooden roller of a form to embrace two drills, is recommended to be used to crush the clods, often found on strong land in dry weather after wet, upon the tops of the drills, or to push them down from the top to the bottom of the drills.

2793. The potato belongs to the class and order *Pentandria Monogynia* of Linnæus; the family *Solaneæ* of Jussieu; and to class iii. *Perigynous Exogens;* alliance 46 *Solanales;* order 238, *Solanaceæ;* tribe 2, *Curvembryæ;* genus *Solanum,* of the natural system of Lindley.

2794. On this remarkable family of plants Dr Lindley observes that they are "natives of most parts of the world without the arctic and antarctic circles, especially within the tropics, in which the mass of the order exists in the form of the genera *Solanum* and *Physalis.* The number of species of the former genus is very great in tropical America. At first sight this order seems to offer an exception to that general correspondence in structure and sensible qualities which is so characteristic of well defined natural orders, containing as it does the deadly nightshade and henbane, and the wholesome potato and tomato; but a little inquiry will explain this apparent anomaly. The leaves and berries of the potato are narcotic; it is only its tubers that are wholesome when cooked. This is the case with other succulent underground stems in equally dangerous families, as the cassava among spurgeworts; besides which, as De Candolle justly observes:—'Il ne faut pas perdre de vue que tous nos alimens renferment un petite dose d'un principe excitant, qui, s'il y etait en grande plus quantité pourrait être nuisible, mais qui y est necessaire pour leur servir de condiment naturel.' The leaves of all are, in fact, narcotic and exciting, but in different degrees, from Atropa Belladonna, which causes vertigo, convulsions, and vomiting, tobacco, which will frequently produce the first and last of these symptoms, henbane and stramonium, down to some Solanums, the leaves of which are used as kitchen herbs. . . . An extract of the leaves of the common potato, *Solanum tuberosum,* is a powerful narcotic, ranking between Belladonna and Conium; according to Mr Dyer, it is particularly serviceable in chronic rheumatism, and painful affections of the stomach and uterus. . . . . The common potato in a state of putrefaction is said to give out a most vivid light, sufficient to read by. This was particularly remarked by an officer on guard at Strasburg, who thought the barracks were on fire, in consequence of the light thus emitted from a cellar full of potatoes."*

2795. "The name is given by Pliny, but the derivation is uncertain; some derive it from *Sol,* the sun; others say it is *Sulanum,* from *Sus,* being serviceable in the disorders of swine; and others from *Solor,* to comfort, from its soothing narcotic effects. All these conjectures are, however, improbable. *Solanum tuberosum,* the common potato, has roots bearing tubers; stems herbaceous; leaves unequally pinnate; leaflets entire; pedicel articulated. It is a native of South America, on the west coast everywhere."†

2796. The Solanaceæ or Nightshades, comprise 900 species, of which we have only five in Britain. The genus *Solanum* has only two British representatives, *Solanum dulcamara,* a pretty climbing shrub, found occasionally in hedges, and *Solanum nigrum,* with an herbaceous stem. Both these plants, like the rest of the tribe, are strongly narcotic. The *Solanum dulcamara,* bitter-sweet, or woody nightshade, has a purple flower and bears red berries; the *Solanum nigrum,* or garden nightshade, bears white flowers and black berries. These plants can only be identified botanically by an examination of the leaves and berries. The active principle in both is an alkaloid, *Solania,* which is itself a poison, although not very energetic. Two grains of the sulphate killed a rabbit in a few hours. According to Liebig, this poisonous alkaloid is formed in and around the shoot of the common potato, when it germinates in darkness; but there is no evidence that the potatoes are thereby rendered injurious. Their noxious qualities are probably due to other causes.

2797. Having been so long familiar with the potato in a cultivated state, it is interesting to be acquainted with its appearance in its native localities and unaltered condition, the more especially as recent events have given us some reason to fear that we may have again to recruit our present varieties by having recourse to the original stock. "The wild potato," says Mr Darwin, "grows on these islands, the Chonos Archipelago, in great abundance in the sandy, shelly soil near the sea beach. The tallest plant was four feet in height. The tubers were generally small, but I found one, of an oval shape, two inches in diameter; they resembled in every respect, and had the same smell, as English potatoes; but when boiled they shrank much, and were watery and insipid, without any bitter taste. They are undoubtedly here indigenous; they grow as far south, according to Mr Low, as

* Lindley's *Vegetable Kingdom,* p. 619-21.

† Don's *General System of Botany and Gardening,* vol. iv. p. 400—*Solanaceæ.*

lat. 50°, and are called Aquinas by the wild Indians of that part : the Chilotan Indians have a different name for them." "Professor Henslow, who has examined the dried specimens which I brought home, says that they are the same as those described by Mr Sabine from Valparaiso, but that they form a variety which by some botanists has been considered as specifically distinct. It is remarkable that the same plant should be found on the sterile mountains of Central Chili, where a drop of rain does not fall for more than six months, and within the damp forests of these southern islands."*

2798. "The potato (*Solanum tuberosum*) was generally cultivated in America at the time of its discovery; but it is only a few years since its native country has been ascertained with certainty. Humboldt sought for it in vain in the mountains of Peru and New Granada, where it is cultivated in common with *Chenopodium Quinoa*. Before his time the Spanish botanists Ruiz and Pason were said to have discovered it in a wild state at Chancay on the coast of Peru. This fact was doubted after the journey of Humboldt and Bonpland, but it was re-asserted by Caldeleugh, who sent spontaneous plants from Chili to the Horticultural Society of London ; and latterly Mr Cruikshanks confirmed it in a letter to Sir William Hooker, in which he says, 'This wild potato is very common at Valparaiso; it grows chiefly on the hills near the sea. It is often found in mountainous districts far from habitations, and never in the immediate vicinity of fields and gardens.' There is little doubt, therefore, that Chili is the native country of the potato ; but Meyer affirms that he found it in a wild state, not only in the mountains of Chili, but also in the Cordillera of Peru.

2799. "It is asserted that Sir Francis Drake introduced the potato into Europe in 1573 ; but this is very doubtful, since it has also been ascribed to Sir John Hawkins in 1563 ; it is, however, certain that Raleigh brought it from Virginia to England in 1586 ; and it appears probable, from the learned researches of M. Dunal, that the Spaniards had established its cultivation in Europe before this time. It was first cultivated extensively in Belgium in 1590, in Ireland in 1610, and in Lancashire in 1684. It is not much more than a century since it was known in Germany. Between 1714 and 1724 it was introduced into Swabia, Alsace, and the Palatinate; in 1717 it was brought to Saxony ; it was first cultivated in Scotland in 1728 ; in Switzerland, in the canton of Berne in 1730 ; it reached Prussia in 1738, and Tuscany in 1767. It spread slowly in France till Parmentier, in the middle of the last century, gave it so great an impulse that it was contemplated to give his name to the plant ; the famine in 1793 did still more to extend its cultivation.

2800. "According to Humboldt, the potato is generally cultivated in the Andes, at an elevation from 9,800 to 13,000 feet ; which is nearly the same elevation to which barley attains, and about 9,800 feet higher than wheat. In the Swiss Alps of the canton of Berne, the potato reaches, according to Kastoffer, an elevation of 4,800 feet.

2801. "Towards the north of Europe, the potato extends beyond the limits of barley, and consequently that of all the cereals ; thus an early variety has been introduced into Iceland, where barley will not grow. The potato degenerates rapidly in warm countries ; yet the English have succeeded in cultivating it in the mountainous regions of India ; but it is doubtful if it will ever succeed in the intertropical plains of Africa and America, where the temperature varies less than in Bengal. An elevation of at least 4,000 feet seems to be necessary for the growth of the potato in tropical regions."†

2802. Phillips says that Gerarde in his Herbal, which was published in 1597, describes the true potato under the name of "*Batatta Virginiana sive Virginiarum et Pappus*, potatoes of Virginia." After an accurate description of the plant and flower, he adds, "The roote is thicke, fat, and tuborous ; not much differing either in shape, colour, or taste, from the common potatoes," meaning the sweet potato, which was common in his time, "saving that the rootes hereof are not so great nor long, some of them round as a ball, some ovall or egge fashion, some longer, others shorter." "This palladium against famine," continues Phillips, who, when he used this phrase, little thought that the object of his eulogy would itself be the cause of famine and consternation, "was not cultivated in Scotland until 1683, and was then confined to the gardens. In 1728, Thomas Prentice, a day-labourer, first planted potatoes in open fields at Kilsyth, and the success was such that every farmer and cottager followed his example. Potatoes were scarcely known in the East Indies 30 years ago, but they are now produced in such abundance that the natives in some places make considerable use of them. Bombay is chiefly supplied with this excellent root from Guzerat. And though the cultivation of this root is much increased in France within these last few years, the poor of that country cannot yet be prevailed on to eat it."‡

2803. It may prove interesting to those who possess farms in the neighbourhood of a large town, to know the reasons why the street-manure of towns is not so suitable for raising potatoes as stable or byre dung. A paper on the subject by Dr Madden gives the explanation; but to enable you to judge of the nature of street-manure, the table below will show the chemical difference between it and horse and cow dung. The sum of the *chemical* nature of the three substances used in raising potatoes is, that *stable dung* is the most heating, but not so durable—that *byre*-dung is *cooler*, and much more lasting —and that *street*-manure is very inferior to both

* *Voyage of H.M.S. Beagle round the World*, p. 285.
† Johnston's *Physical Atlas*,—Phytology, map No. 2.
‡ Phillips' *History of Cultivated Vegetables*, vol. ii. p. 81-104.

in every respect, and, in fact, would be little better than soil, were it not for the highly azotised nature of its organic matter, and probably also for the presence of a considerable quantity of lime:—

	MANURES.		
	Stable.	Byre.	Street.
Water, &c.,	13·5	45·7	26·4
Organic Matter—			
Soluble in Water,	11·5	9·0	1·4
Soluble in Potassa,	15·9	12·6	1·0
Destroyed by Heat,	13·33	21·8	11·2
Saline Matter,	45·77	10·9	60 0
	100·00	100·0	100·0

2804. The effect of applying this street-manure to the soil is: "When any quantity of it is ploughed into good soil, the following changes take place,—The ordure and carbonate of lime, which are evidently the most powerful ingredients of this manure, will react upon the less decomposable organic matter, both of the soil and of the manure itself, and thus bring the whole into a state of fermentation, the extent and intensity of which will be regulated by the quality of these active ingredients, especially the ordure. This action depends upon the fact that, when any organic substance in a state of fermentation is brought into contact, or mingled with any organic matter capable of fermenting, but not at present in that condition, the whole mass, after a time, undergoes the same series of changes, which are always accompanied with the escape of various gases, and the formation of certain soluble compounds, which latter constitute the chief food of plants. Moreover, it has long ago been proved, that substances rich in azote are always the most prone to decomposition, and likewise are capable of exciting fermentation to a far greater extent in others of a less putrescible nature. Again, it is well known to farmers that chalk or carbonate of lime possesses the power of increasing the putrescent tendency of many vegetable substances, so that, when applied to soils, it renders them *richer*. But what is curious enough, at the same time that it causes the production of soluble matter by promoting putrefaction, it renders less soluble those portions already in a state of solution, by entering into chemical combination with them. On these accounts, therefore, and especially from the ordure being a very highly azotised substance, street-manure will be capable of exciting putrefaction to a greater extent, considering the small quantity of organic matter which it contains, than one at first sight would be led to suppose. It must, however, be remembered, that as the putrescent effect will only be produced in the immediate neighbourhood of the active ingredients themselves, and as, moreover, these are mixed with a large quantity of other comparatively inert matters, their action is very liable to be confined to certain spots. Owing, likewise, to the presence of cinders, a certain portion of the soluble organic matter will be absorbed by them, and thus, for a time at least, removed beyond the reach of the plants. But, on the other hand, it will be observed, that, from the highly azotised nature of its organic contents, the fermentation will be *rapid at the first*, and, consequently, the manure will be hot in proportion to the quantity of real manure which it contains."

2805. As to the actual effect of this manure in raising potatoes being one-third inferior to stable and byre dung, the following explanation of its inferiority is offered by Dr Madden. "In the account of the culture of the potato, given in Professor Low's excellent Elements of Practical Agriculture, we find the following expressions,—'Dung will in all cases act most quickly upon young plants when it is well prepared, but extreme preparation of the dung is *not required* in the case of the potato. It is enough that it should be in *such a state of fermentation as that it may be readily covered by the plough*,'—thus proving that this plant does not require an instant supply of a considerable part of soluble matter. And, moreover, it is clear that, as the useful part of this plant is produced during the *later* periods of the growth of the crop, the greatest supply of food will be necessary at that time. But we have already shown that street-manure, from the nature of its constituents, ferments very *rapidly at first*, and, consequently, its *greatest effects* will be in the very *early* periods of the growth of the crop. The next sentence in Professor Low's work commences thus,—'The potato requires a *large supply* of manure.' But we have already shown that street-manure does not contain one-third as much *real manure* as either that derived from dairies or stables. And a little below the above quotation occurs the following sentence,—'*Lime* does *not* appear to act in a *beneficial* manner, and is *rarely* applied directly to this crop.' But our analysis has proved that lime exists in considerable quantities in the street-manure of Edinburgh; and as it has been exposed to great heat—for it is evidently derived from the ashes—it will, of course, be in the same state as *mild lime* when it is applied, and will, most probably therefore, have the same effect, which, according to Professor Low, is '*not beneficial*.' The potato possesses a spreading root, and, consequently, must require a *uniform manure*, in order that all its parts may be equally supplied with soluble organic matter. But we have before shown that street-manure is *partial*. The potato requires the greatest quantity of azote at the *later periods* of its growth, because the tubers contain considerably more of that substance than the leaves. But street-manure, from the nature of its organic constituents, will ferment rapidly, and allow most of its azote to escape during the *early* periods of the cultivation of the crop."

2086. As a general rule for the application of manure to potatoes, "We may hence argue," as Dr Madden remarks, "that a manure, to suit well for the potato-crop, should possess the following qualities,—It must be spread equally through the soil, so that the spongioles, at the termination of all the *spreading fibres* of its roots, may be supplied with nourishment." And surely there is no way of spreading dung so equally as along only three drills at a time, and by spreaders keeping to their own drills. "It must yield azote during the *whole* period of the growth of the plants; in fact, rather more is required during the *later* periods than prior to the development of the tubers; for, from M. Boussingault's analysis, it appears that they contain $\frac{5}{100}$ per cent more of this substance than the leaves. In an economical point of view, therefore, the best manure for potatoes would be one which contained plenty of azote, but still did not decompose very rapidly,—cow-dung, for example." *

2807. What inorganic substances ought a potato manure to contain, and in what proportions? is a question which "it will not be very difficult to answer," observes Dr Fromberg; "for, knowing the average composition of the ash of sound potatoes, (1257,) and proceeding upon the principle that, in manuring a crop, we do nothing more than mix up with the different proportions of those substances of which the crop itself consists, we need only to recalculate the table presenting this composition in a hundred parts. In how far the excess of one ingredient will do harm, when all the others are present in sufficient quantity, it is almost impossible to say, although it cannot certainly be great; but when there is a deficiency of any ingredient—potash for instance, and an excess of another, such as lime—then it is likely that the plant will assimilate the latter instead of the former, or rather, the acids that are in the plant requiring to be neutralised, will combine with lime in such proportion as there is a want of potash. It may be that the quantities of those inorganic ingredients appear trifling, considering that of them altogether there is only about one per cent present in potatoes, and therefore of little consequence; yet there are reasons to think that these small quantities, and their exact proportions, within certain limits, are of essential importance for the proper performance of the functions of the several organs of the plants. . . . . The substances that ought to be in a potato manure are the following, arranged according to their *several proportions in tons*:—

Bases.	Potash,	1180 lbs.
	Magnesia,	87 ...
	Soda,	87 ...
	Lime,	50 ...
Acids.	Sulphuric acid,	416 ...
	Phosphoric acid,	235 ...
	Chlorine,	195 ...

Oxide of iron and silica are present in every soil, and the organic acids are produced within the plant itself."†

2808. Thäer mentions a few particulars in the cultivation of the potato in Germany which seem to us peculiarities, and, I must add, are no improvement on our own mode. He says, "As early as possible in autumn, I break up the soil to the depth of two inches lower than before, and then pass the harrow over it. In winter the dung is carted and uniformly spread. At the beginning of spring, this dung is buried by a light ploughing; and the harrow passed over before the seed-time ploughing. I like to have a portion of the manure brought up to the surface by this operation, because a greater quantity is then collected around the roots of the potatoes. . . . The potatoes are set in furrows as follows:—by means of the *marking plough*, lines or small furrows are traced at right angles or obliquely to the direction which the plough is to take. Four persons are then stationed at equal distances on the line of the plough, each having assigned to him the space which he is to plant. One plough traces the first furrow, which is immediately set with potatoes. Two other ploughs then follow, and the potatoes are set in the furrow traced by the third. It will be understood that the persons who set them have to go from one side to the other, each one keeping within his allotted space. Each potato is set at the point of intersection of the line traced by the marker, with the furrow formed by the plough. It is of importance that the potatoes be set as close as possible to the perpendicular side of the furrow, and not on that where the slice has been turned over; for, in the former position, the potato is most likely to remain in its place, and not to be disturbed by the horses' feet. The best ploughmen must be employed to trace the furrow in which the potatoes are set: first, to insure that the furrow may be of a proper and uniform depth, three inches in a heavy, and four or five in a sandy soil; secondly, to enable him to correct any errors which the others may have made in the width of their furrows. The first ploughman always traces the first furrow in commencing a new bed. The width of the beds must be measured at the two extremities, and poles set up there, in order to preserve as much as possible the parallelism of the beds. If the labourers are well practised, three ploughs and five planters will finish eight acres per day, or six at the least. Each planter must have his sack of potatoes within his reach. A week after the setting the ground is harrowed, an operation by which a few weeds are destroyed. Great numbers of them afterwards spring up. Nothing more is, however, done to get rid of them till the potatoes are about to spring up, and some of them just beginning to show their leaves above ground,"‡

2809. Rooks are very destructive to the potato-crop just as the germs of the plants are penetrating the ground, and they seem to possess an exquisite sense of smelling to find out those sets which are most palatable to their taste. They steal very quietly into potato-fields, and are there pretty well hidden amongst the drills; and in this respect their tactics differ from what they pursue when in search of grubs in lea, when it is being ploughed, which they do openly; or even

* *Prize Essays of the Highland and Agricultural Society*, vol. xiii. p. 359–70.
† *Transactions of the Highland and Agricultural Society* for March, 1847, p. 685.
‡ Thäer's *Principles of Agriculture*, vol. ii. p. 577–8.—Shaw and Johnston's translation.

when alighting amongst growing corn, which they do in large numbers. Nothing but gunpowder will deter them from a potato-field; they soon find out the innocuous character of a scarecrow—that sorry semblance of humanity, a *tattie-doolie*, being despised by them. One cannot always be firing amongst crows with the gun, but an occasional shot does good, aided by that effectual check to their visitation of any field—the burning of gunpowder matches here and there, and now and then, along the windward side of the field, the fumes of which sweeping across the face of the ground being smelt by them, put them in constant trepidation, and at length to flight. Some people will tell you that the rooks are doing no harm in the potato-field, as they are in quest of insects, and these they will remove from among the potato sets. This may be true; still if they injure a single sound set, while in quest of insects feeding on unsound ones, they do harm. At all events, the devouring of an unsound set—one that will not grow—by insects can do no harm to the farmer; but how happens it that crows dig a hole by the side of the strongest germs to get at the sets! This act evidently proves that the carrying off one set which has sent up a shoot to the day destroys the existence of one entire young plant.

2810. Dr Fromberg analysed the sprouts or shoots of one kind of potato, a white variety from East Lothian, at four different periods of its growth from the 26th April to the 20th June, to ascertain the amount of protein compounds afforded by that part of the plant; and as the results were irregular, I only give the mean of the four kinds.

Nitrogen per cent, . . .	0·391
... calculated dry, . .	3·215
Equal to protein compounds per cent,	3·203
... calculated dry, . .	20·223

"The increase in the protein compounds is here not regular," observes Dr Fromberg, "which may partly be attributable to the shoots having been taken from various specimens, although of the same variety. But the large quantity of these compounds in potato shoots, compared with that in the tubers themselves, appears to be one cause why the vital powers of the latter are so much weakened by sprouting. This fact will cease to appear strange, if we bear in mind that the shoots derive both their nitrogenous and non-nitrogenous constituents from the tuber; and that, when they take a smaller proportion of the latter, the former must predominate in them."*

2811. "Vegetable matter," says Dr Taylor, "when eaten in a state of decay, is capable of exciting pain, vomiting, purging, and other symptoms of poisoning. Potatoes, carrots, turnips, and other esculent vegetables, in a state of decomposition, may thus excite serious symptoms, which might be referred to mineral poisons." Amongst other cases of poisoning from decayed vegetables having been eaten, which he quotes, I shall only select one: "In a series of cases recorded by Dr Peddie, where a family had subsisted six weeks on refuse potatoes, picked up on the surface of fields, the symptoms were severe, and in two instances death ensued. The potatoes were of a green, and of a deep purple colour, and had an exceedingly bitter and disagreeable taste; so much so that no mode of preparation rendered them palatable to the destitute family which suffered from their effects. In a very few days after using them, the whole family were seized with severe griping pains in the bowels, followed by diarrhœa of a green watery kind. These symptoms continued, with short intermissions, during the whole of the time that the potatoes were used for food. Two of the children died.

2812. "It has been supposed that *Salamine* exists in potatoes, and confers on them poisonous properties, but there is no direct proof that this is the case. According to Liebig, salamine is generated in the shoot of the potato when it is allowed to germinate in the dark."†

ON PARING AND BURNING THE SURFACE.

2813. As the term implies, paring is a removal of the surface of the ground, with what may be growing upon it at the time; and burning is the reduction by fire to a state of powder, of what has been pared off.

2814. The object of the process is to obtain possession of the soil pared for arable purposes, sooner than could be obtained by common ploughing and harrowing; and paring and burning will certainly insure a crop in advance for one season at least.

2815. The reason that common ploughing and harrowing cannot make the soil available at once, is, that the rough herbage and small ligneous plants which grow upon the surface, are of too obdurate a nature to be reduced into friable mould in the course of a short time, and these operations alone would never affect their reduction, which would require to be greatly assisted by the agency of the atmosphere through seasons of alternate rain, frost, thaw, and drought.

2816. There would be no use of employing extraordinary means of changing the state of the surface, could it be done by the common plough; and when the common plough cannot do it, the extraordinary means are chiefly manual labour, though horses may be employed to assist in many such cases.

* *Transactions of the Highland and Agricultural Society* for March, 1847, p. 667.
† Taylor, *On Poisons*, p. 531-3.

2817. The common No. 5 garden spade, fig. 237, with a sharp edge and its corners a little worn by work, removes the rough herbage of the surface very well, and the soil can be set up at the same time by the workmen to be dried; but the labour of paring and burning in this manner would be expensive, and is therefore seldom incurred, though the spade might be usefully employed in some cases in assisting the other means, and its work would then be economical.

Fig. 237.

THE COMMON SPADE.

2818. A more efficient and expeditious implement for this purpose is a spade of a different form, fig. 238; the face of which is angular and sharp, the blade 9 inches broad and 15 inches long; the right-hand and straight side of which is turned up 3 inches with a cutting edge in front; the helve is 5 feet long and flat, provided with a flat cross-handle 2 feet long, with its plane at right angle to that of the helve. The blade of the spade is set at such an angle with the handle, as to permit the latter to be elevated to the height of a man's haunches, when the blade rests on its sole, when at work, flat upon the ground.

Fig. 238.

THE FLAUCHTER-SPADE AT WORK.

2819. The mode of using this instrument is this: As its use is attended with considerable labour, the workman is provided with a sort of leather apron containing two pieces of board fastened into it, which are placed in front of the groin, and the apron is buckled round the waist and the upper part of the thighs. The blade of the instrument is laid flat on its sole, and its point is made to enter the ground by a push of the body upon the handle placed against the boards in front of the groins, and there held by both the hands. The body gives successive pushes, longer or shorter, as the nature of the ground admits; and the point is made to dip deeper, keep level, or move upwards, by the direction of the hands, according to the thickness of the surface to be removed. At each push the point cuts in front, while the cutting edge severs the removing turf from the solid surface, and after a turf has been cut of a foot or two in length, according to the nature of the surface, but never exceeding three feet in any case, it is turned upon its back or side as the case may happen, by a sudden jerk of the handle, given by both hands, upon the pared surface on the left hand of the worker. The edge of the spade is kept sharp with a scythe-stone.

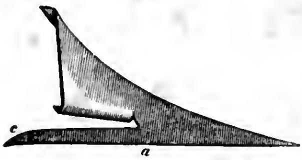
2820. This instrument is called in Scotland the flauchter-spade, from the Teutonic verb to flauch or take off the skin; and the mode of using it will at once show the impropriety of the English term of the breast-plough, the breast of the worker never touching it.

2821. The thickness of the turf removed with this spade depends much on the strength and skill of the workman, but it seldom exceeds 2 inches, even in the softest parts of the ground, and more often $1\frac{1}{2}$ inch on ordinary surfaces.

2822. It will take a man a week to turn over one acre of ground, and he will require 2s. 6d. or 3s. a-day for such hard work, or 15s. to 18s. an acre.

2823. A more expeditious mode still of removing the surface is with the horse and plough. The share of the common plough cuts a furrow-slice at most 10 inches broad, and its depth is 4 or 5 inches in lea. As the turf in paring requires to be no thicker than will remove the herbage, it need never exceed 3 inches in thickness, and the plough will scarcely be held steady at less depth; and as that depth would be easy work for the horses, a greater breadth of slice may be turned over than the share of the ordinary form can do. The only mode of causing the share to do more work is by extending the feather outwards to 12 or 15 inches, as desired for the breadth of the turf. Fig. 239 represents the share of the common plough, where at *a* the breadth of the common feather is 10 inches, but on welding a wing 3 inches in breadth, and having a sharp edge upon the outer point *a* of the feather, the paring face may be increased to 15 inches in breadth, from *c* to the land side of the share. When the paring has been accomplished the wing *c* can be cut off, and the share is again fit for ordinary use.

Fig. 239.



THE PARING SOCK.

2824. The mould board will not lay over so broad a furrow-slice in the same regular manner as it does an ordinary one in lea; the slice will be partly rolled over upon itself, which will be in its favour for drying. The most land that a plough is expected to turn over in ordinary circumstances is an acre, but in work of this nature, when many interruptions may occur from thaws and frosts, and irregularities of the ground, perhaps half that extent is as much as may be turned over even with the facility afforded by the broader share for going over a greater extent of ground. Even at half an acre a-day for each plough, its use is less than half as costly as the flauchter-spade.

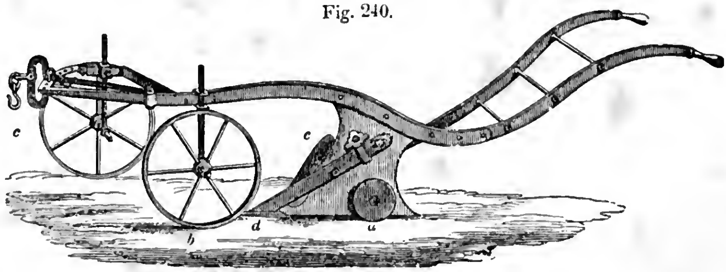
2825. When the ground is even, this share may be able to turn over the entire surface, but when uneven and much broken, and where stones abound, it cannot be used, and the flauchter-spade should be employed on such places; while the common spade may be used in small deep hollows, or among thick masses of herbage. Thus all these implements may co-operatively complete what one alone could not accomplish so well.

2826. When the turf is laid over by the spade, the workmen might slip them off and set them up one against the other, though not so effectually as by the hand. The flauchter-spade taking up a long thin turf, cannot get quit of it without either laying it flat or setting it partly on edge. The broad continued turf laid over by the share of the plough must fall flat upon the ground, and be set up by the hand to be dried.

2827. The paring-plough used in parts of England in the fens, pares the turf by means of two angular shares with the wings facing each other, and just crossing the centre line, one being a little before the other, and they are attached to shanks, placed in front of the mould board, upon which the turf is raised in a manner similar to the furrow-slice in ordinary ploughing, and is set on its edge upon the pared ground, ready to be dried, as neatly as if done by the hand.

2828. A better paring-plough fig. 240, has recently been manufactured by Mr Thomas Johnson, engineer, Leicester. Its peculiar parts consist of a small wheel *a*,

Fig. 240.



THE LEICESTER PARING PLOUGH.

attached to near the heel, to support the sole along the pared ground. The near wheel *b* moves in front of the coulter *d*, upon the unpared surface, while the off wheel *c* moves upon the pared surface. By the adjustment of these two large wheels, the thickness of the turf to be pared is determined. The coulter *d* cuts the turf, and the mould-board *e* sets it upon its edge, curled up to be dried. It cuts the turf 14 inches in breadth, and from 1 to 2 inches in thickness. On good lea a man and a boy, and a pair of horses, will pare, it is said, 2½ acres a-day. The cost of the implement at the work is £5, 10s

2829. Paring may be executed any time during the winter and spring, but perhaps it is best and most easily done from February to April. It is difficult to do when the ground becomes dry and hard, while in boggy land it is best executed in dry weather. While the land is very wet, it cannot be done in boggy ground, as the footing would be insecure, and the soil is then soaked in water; nor in clay land, as the upper surface would soon become poached.

2830. The sods are set up on edge or against one another in the best way, to expose the largest surface to the air, to be dried in the quickest time for the next process they have to undergo, which is the burning. The long continuous turfs turned over by the ploughs, before being dried, will require to be cut in convenient lengths with the spade. In dry weather they may be ready to be burned in about a fortnight.

2831. In burning, the fires must first be begun with some combustible materials, as wood, chips, shavings; and at first they must be well attended to, in order to have the first turfs well dried, and after these have begun to burn, to surround them with fresh sods, so as to keep the fire in a smouldering state, and never to get into flame or to burn fiercely. A number of fires should be lighted one after the other, and then the field-workers could be employed in carrying the turf a short distance, and supplying the fires with fresh sods, placing them thickest on the side the wind blows against, to keep down the force of the fire. This being the object, it is evident that the turfs should not be too dry before the burning begins. The heaps should be supplied with turfs until they attain a large size, capable of containing from 10 to 15 cart-loads of ashes, and the larger the heap is the less will the air affect its interior to consume the ashes. The dried and burning turfs of one heap will supply fire to begin the burning of other heaps. In case of the fire bursting into combustion through the night by reason of the wind, the heaps should be well covered with fresh sods in the evening, part of which may be removed in the morning. If the fire is dull, a hole opened in the windy side, or even a few holes punched into the heap with a stake, will set it agoing. In a large heap there is no fear of the fire going out, or that it is out, although the heap show but little symptoms of activity on the outside. A heavy rain will not put out the fire of a large heap. When a heap has attained a sufficient size, and it is inconvenient to carry the sods to it beyond a reasonable distance, it should get leave to smoulder and cool, and the unburnt sods on the outside should be carried to the heap nearest at hand.

2832. To obtain good results, the burning of the heaps should not be conducted in a thoughtless manner; but ought to be done according to a plan previously fixed upon. A good plan is to begin to burn one row of heaps after another, and to begin the first row at that side of the field on which it will be most convenient to plough the ground; and having gathered the turfs on both sides of the line of each heap as will serve their purpose, a considerable space of ground will thereby be cleared of turf; and as one line of heaps is constructed, let another be begun from the end the former one was finished at, and thus proceed until the field has all been heaped. In proceeding thus, the charred turfs of the previously formed heaps will be easily carried across the ground to those about to be formed. The time taken until the burnt heaps will be cold, will depend on the state of the weather, but it will take a considerable time if they are allowed to cool of themselves. The ashes may be spread abroad to cool, if they are required soon; but should wind arise after the heaps have been broken, the ashes will be scattered about in all directions, and those from the outside of the heaps may be blown off the ground altogether. Caution is thus requisite in conducting this operation.

2833. When a thick turf has been laid over by the plough, it will afford more ashes than the ground will require, or should receive at one time. To avoid such an occurrence, some persons, when they determine on paring with the plough, pare as much turf in stripes as will just supply the quantity of ashes wanted. To effect this, the ear of the feather of the share will require to be turned up with a cutting edge. But when the herbage is rough, the part thus left on is as difficult to reduce as it would have been without the burning of any proportion of it. What I think a better plan is, to pare and burn all the surface, and carry off the portion of the ashes not required to another field, which is to bear green crops; and as the carrying away of ashes implies robbery of the land which has supplied it, a substitute for them should be provided in the shape of farm-yard or other manure.

2834. The burning the heaps of ashes in line clears a large proportion of the soil for the plough, which may be employed between the heaps, to plough the land in any form of ridge desired; and, as the land is ploughed, the ashes should be spread upon it in the quantity determined upon, the breadth of space occupied by the heaps receiving the ashes before being ploughed. This is the simplest mode of applying the ashes; for if they are not applied until after the dung for the turnips has been laid on, as some writers recommend, the ashes will have first to be carried entirely off the field, and then brought on again when wanted.

2835. The ashes need not be immediately harrowed in, as exposure to the air will do them no harm, but the contrary. "There are two methods, one to spread and plough in immediately, the other to spread immediately, but to have them exposed to the atmosphere some months before turning in. Mr Wedge, on the thin sand soil on a chalk bottom of Newmarket-heath, had in one a treble experiment; part was pared and burnt in the spring, and the ashes spread and exposed till ploughing in the autumn for wheat; part pared and burnt late, the ashes left in heaps, and spread just before ploughing the wheat; the third pared and not burnt at all, by reason of bad weather. The first was by far the best, the second the next, and the third beyond all comparison inferior."*

2836. The land can thus be prepared for any future crop, and its cost has been estimated to amount in some cases to £2 per acre. We have seen that the cost of removing by the flauchter-spade is 18s., and the burning has been estimated at from 10s. to 15s. the acre, but in some cases the removal of the turf has cost 25s. the acre. Notwithstanding such a cost, paring and burning thin chalk soil in Kent, on chalk rock, worth 1s. an acre of rent, has realised good returns.

2837. I would prefer turnips to any other crop after paring and burning; and there is plenty of time to have the land prepared for them at the latter end of May or in June, if the paring begin as early in spring as it could. On strong land, which must be thoroughly drained before the paring and burning, swedes may be raised with dung along with the ashes. On light land, turnips of any kind will succeed, and especially the white varieties, to be eaten off by sheep. On heathy and boggy land, I would prefer rape to turnips, to be eaten on the ground by sheep; and the rape allows rather longer time for the preparation of the land, which the boggy land, though drained, may require the first season.

2838. Much diversity of opinion exists as to the propriety of paring and burning land at all. No doubt, benefit has been derived from it in many instances, as in chalk soils and deep and rather damp alluvial soils, where slugs and insects abound in the older pastures. I think it may be beneficially practised under two circumstances,—in the case of drained bog, and of heathy moorish soil on a clay subsoil; because the coarse and rough vegetation covering both these sorts of ground, is difficult to reduce by ordinary decomposing exposure to the air; and to think of reducing the whole of it in composts, mixed with fermentary ingredients, would involve such an amount of both manual and horse labour, and occupy such a length of time, as would exhaust the patience of any man. If paring and burning, therefore, would get rid of such troublesome

* Pott's *British Farmers' Cyclopedia*—art. *Paring and Burning*.

surfaces, and at the same time bestow the means of raising a crop of turnips in the same season, a great object will certainly be gained.

2839. The other case I would try paring and burning in, is that of coarse, rough, luxuriant old herbage, growing upon swampy clayey ground. After such land has been drained, it is very difficult to break up with the plough, whether with two or four horses, and much time is lost in waiting for such herbage to rot in the furrow, as I know from experience. To attempt to rot the sod with a crop of oats would be merely to throw away the seed, beside the risk of breaking the horses' legs between the furrow-slices in the harrowing of it. Now, since this herbage can be got rid of by paring and burning, and the land under it made arable the first year in such a state as to raise a crop of turnips, or even to have it for bare-fallow, is an advantage worth purchasing at some cost.

2840. Beyond these two cases, which can only happen in particular places, I would not sanction paring and burning; and in these cases only once, for as to treating land which is already in an arable state in that manner, I quite agree with Professor Low,—" when any kind of land is for the first time made arable, a reason may perhaps exist for this method of rendering it as soon as possible productive. But after land has been brought into a state of regular culture, it is difficult to believe, notwithstanding the authority of so many farmers in England, that paring and burning are good as a regular system. Great crops are doubtless raised in the fens, and other parts, where this system prevails; but greater crops still are raised in the north of England and in Scotland, on inferior soils, and with a less favourable climate, where the system of paring and burning is unknown."*

2841. As to the rationale of paring and burning, the best account of its probable effects upon the soil I have seen, is that given by the late Rev. W. L. Rham. " In burning vegetable matter in an open fire," he observes, " the whole of the carbon is converted into carbonic acid, and flies off, leaving only some light ashes containing the earthy matter and the salts which the fire could not dissipate. These are, no doubt, very powerful agents in promoting vegetation, when they are added to any soil; but they are obtained at a very great expense of vegetable matter, which, by its decomposition in the earth, might also have afforded food for vegetation. If the earth which is burnt with the sods is of a cold, clayey nature, the fire will change it into a kind of sand or brick-dust, which is insoluble in water, and corrects the too great tenacity of clays by converting them more or less into loams. This is so well known that clay is often dug out of the subsoil to be partially burnt. On stiff clay soils, therefore, there is a double advantage of paring and burning—that of the vegetable ashes, and of the burnt clay. When the fire is so managed that the vegetable matter is only partially burnt, the oily and inflammable portions being converted into vapour by the fire without being destroyed, and absorbed by the earth, the effect produced is only to impregnate the earth with minute particles of matter nearly converted into the constituent parts of vegetables. The earth is the mere recipient of these particles, which are held in its pores, as water in a sponge, ready to be let loose to any substance which has the power of attracting them. The moisture which the dry earth will also absorb from the atmosphere, if no rain should fall, is retained and increased by the effects of the salts with which it is impregnated. It is uniformly observed that turnip seed, which in most soils will not vegetate without heavy dews or rains, if sown in dry weather, scarcely ever fails to spring up in the ashes of a soil that has been pared and burnt. May not this be ascribed to those particles which have been taken up by the earth in the operation of slow combustion, absorbing moisture from the air, and giving it out to the seed which has been sown? It does this better than a heavy shower would: a heavy shower soaks the ground for a short time, and swells the seed; but if it is succeeded by a hot sun, the water evaporates so rapidly that the seed loses its moisture, and vegetation stops. The earth which attracts moisture from the air keeps it, its absorbent nature preventing the evaporation; and it furnishes it gradually to the seed as it is required. The wonderful effect of peat ashes on young clover may be explained on the same principle, and probably also that of gypsum. There can be no doubt, then, that considerable advantages may result from the paring and burning the surface of clays. But what is lost and destroyed in the operation? All that escapes in the shape of gas or vapour. The gas will probably be carbonic acid; for this is formed by the combustion of charcoal. We know that hot lime has a very strong attraction for this substance, which it fixes in a solid state, forming a carbonate of lime; and we have no reason to think that it parts with it to the roots of plants. But either earths may absorb carbonic acid, without having so great an attraction for it, and let it loose to water, which is known to contain it in certain proportions, and to be thus carried into the vessels of growing plants by the attraction of the roots. If this should prove to

* Low's *Elements of Practical Agriculture*, p. 181.

be the case, we may account for the great effect of burnt sods in promoting vegetation.

2842. "It is very easy to ascertain whether any soil will be improved or not by paring and burning. A few sods may be taken and exposed to heat in an iron pot closely covered over, or in a large crucible: the heat should not be so great as to produce light, but should be kept up for a considerable time, till the sods are consumed. If the ashes are red, and the whole is a fine powder, with particles of charcoal in it, the soil from which it was taken may be safely pared and burnt, especially if it forms a mud with water, and the earth is not rapidly deposited. But if it feel gritty, lets the water readily through, and is soon deposited when mixed with it, burning will be disadvantageous. This is the evident results of the principles laid down before."*

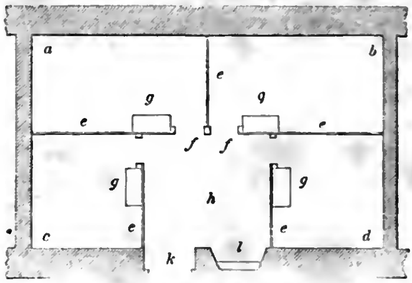
ON THE FARROWING OF SOWS.

2843. It should be so managed, where there are more than one brood-sow on a farm, to have one to bring forth pigs early in spring; but it should be borne in mind that young pigs are very susceptible of cold; and when exposed to it, though they may not die, their growth will be so stinted as to prevent them attaining to a large size, however fat they may become. Even the most comfortable housing will not protect them from the influence of the external air, any more than it does certain constitutional temperaments in spring, when the E. wind blows. From March to September may be regarded as the period of the year when young pigs thrive best.

2844. Whenever a brood-sow shows symptoms of approaching parturition—that is, when the vulva is observed to be enlarged and red—it is time to prepare the sty for her reception, for she will keep her reckoning not only to a day, but to an hour. The period for gestation of a sow is 112 days, or 16 weeks.

2845. The sties for the brood-sows in the steading are at *b′ b′*, Plate II. They consist of an outer-court 18 feet long by 8 feet broad, enclosed by a door, as in fig. 125, and an inner apartment 8 feet by 6, roofed in. The courts are provided with liquid manure gratings *x*, and troughs for food. This is the usual form of a sty for sows, but another more convenient for overlooking the state of the sow and her pigs is, when a number of single apartments are placed together, in a roofed house, shut in by a door, and built by itself, or constitutes one of the out-houses of the steading. Such an apartment, divided into sties, is represented by fig. 241, where *a b c d* are four apartments, two of which,

Fig. 241.



STIES FOR BROOD SOWS UNDER COVER.

a and *b*, are $7\frac{1}{2}$ feet by 12, and two, *c* and *d*, $7\frac{1}{2}$ feet by 8, divided from each other by wooden partitions *e*, 3 feet in height. The doors of the sties are all near *f f*; the feeding troughs are represented by *g g*, the area from which all the pigs can be overlooked and fed is *h*, the outer door is *k*, and window *l*. Drains may proceed from all the sties to the nearest liquid-manure drain; and such an apartment may be rendered perfectly comfortable by having the ceiling and walls plastered, a ventilator, such as fig. 81, placed on the roof in connexion with the ceiling, and the entire floor made of pavement.

2846 The litter allowed the brood-sow should be scanty and short, such as cut straw, or dried leaves of trees—young pigs being apt at first to creep among long straw, and get smothered or squeezed in it by the sow. When a sow has liberty before she is about to pig, she will carry straw in her mouth, and collect it in a heap in some retired corner of a shed, and bury herself amongst it before littering, and the chance will be, that some of the pigs will be smothered in it by herself; but when seen by her, she will carefully push them aside with her snout before lying down. Some sows have a habit of wandering away to litter in a quiet place, such as in a field of corn, in a plantation

* Rham's *Dictionary of the Farm,*—art. *Paring and Burning.*

amongst underwood, or in a dry ditch at the root of an old hedge or tree. I remember of a sow being missing for upwards of a fortnight, not a person having seen her go away, or been able to discover her retreat. At length she reappeared one day craving for food at the kitchen-door, bearing evident signs of having littered and suckled pigs. She was tracked to her hiding-place, though jealous of being discovered, which was in a secluded part of a dry ditch, at the root of an old thorn-hedge, about 300 yards from the steading, where she had formed a lair with the straw gathered from the adjoining field of wheat. She had subsisted some days upon the corn, but hunger at length drove her to the house in search of food. Had she been allowed, she would no doubt have come to the house every day for food; but means were used to have the pigs conveyed to the steading—and this was a work of some difficulty, as the sow herself was perfectly savage when any one approached her young ones; and these were so wild in their habits that they eluded capture for a long time among the standing corn. At length, by the assistance of the shepherd's dog, which seemed to enjoy the affair as a sport, they were all caught, a fine litter; and, on being put into a large basket, the sow followed her young ones to the steading. I remember of another sow taking up her abode in the bottom of a pea-stack, in which she left a small hole for an entrance, and had formed a large chamber in the interior. It was impracticable to dislodge her from her stronghold, she keeping every man, and even the shepherd's dog, at bay, and he was too knowing to fight with her; so she was let alone, and produced her young there, and kept them until they were able to run about, food having been set down for her. I mention these instances of the peculiar habits of some domesticated sows, merely to show you the propriety of securing the brood-sow that is about to farrow, in a proper sty, some time before the period of her reckoning, and particularly those which are given to wander abroad in quest of a lair.

2847. Knowing the day of her reckoning, she should be attended to in her sty pretty frequently; not that she will probably require assistance in the act of parturition, like a cow or a ewe, but to observe that all the pigs are safe, and to remove every one immediately that may be dead when farrowed, or may have died in the farrowing. I have known the case of a sow in high condition which died because the second pig, on coming by the breech presentation, had a hind-leg folded back, which could not be put right by the sow herself in straining, and, having been neglected, her parts swelled very much. Her life was attempted to be saved by the Cæsarian operation, and the pig was extracted and lived; but the others in her womb were dead, and she herself did not survive above an hour, having been completely exhausted before the operation was attempted. I do not know whether it is generally the case, but I have frequently noticed pigs born by the head and breech presentation alternately, not uniformly so, but most frequently.

2848. The first-born pigs are the strongest, and the last the smallest and weakest, in a large litter, though the difference is scarcely observable in small litters of 6 or 8. The small weak pigs are nicknamed *wrigs* or *pock-shakings*, and are scarcely worth bringing up; still, if there are spare teats for them, they should not be destroyed.

2849. Sometimes more pigs are littered than the sow has teats. I have seen as many as 19 pigs when there were only 12 teats; and I remember of a sow that never littered fewer than 17, though she had only 14 teats, which are two more than the usual number. Such a number of extra pigs may be brought up by hand on cow's milk, but, being very weak, they generally die off in the course of a day or two to the number of teats. Should there be only one pig more than there are teats, it must take its chance of obtaining a teat after the others are satisfied.

2850. A young pig soon gets to its feet after birth, and as soon finds its way to the teat; but it can find no sustenance from it until the sow pleases; so that until the parturition is accomplished, and the sow entirely recovered from it, there is no chance of the pigs getting a suck.

2851. Many sows are very sick during parturition, and for some time after; so much so that the skin of their mouth becomes bleached and parched, and the breathing quick. To those unaccustomed to see a sow in that state, it would seem that she must die; but a little rest recovers her, and she then betakes herself fondly to her young.

2852. It is necessary, as I have said, to remove the pigs as they die, when any die, as some sows have the abominable propensity of eating their own pigs when dead, whether the death takes place at the birth or immediately after, or whether it happens by smothering or squeezing the pigs by the sow herself. Mr Youatt advises the pigs to be removed as they are pigged, and to be returned after she has recovered; but there is no necessity for their removal if the sty is large enough, and the sow is attended to as long as she is a-pigging. I remember of a sow that was never sick at farrowing; and such was her propensity to eat every pig that died, or was smothered, that even during parturition she would get up as every pig was born, to ascertain whether it was dead or alive, and, if dead, would have eaten it instantly, had she been allowed.

2853. The afterbirth should be removed whenever it comes away, which it will do in a few minutes after parturition.

2854. A peculiarity is exhibited by young pigs, different from the young of other domesticated animals, in each always using the same teat in sucking.

2855. It is generally observed that the pigs supported at the foremost teats become the strongest.

2856. Sows require coaxing before they will give their milk. The pigs make loud entreaties, and rub the udder with their noses to induce her to lie down, which, when she does, every pig takes its own place, and nuzzles at the udder with the teat held in the mouth. After a good while of this sort of preparation, the milk begins to flow on the sow emitting a fond sleepy sound, during which the milk is drawn steadily and quietly till the pigs are all satisfied, and they then not unfrequently fall asleep with the teat in the mouth.

2857. Young pigs are lively happy creatures, and fond of play as long as they are awake, but are great sleepers. When a week old, their skins are clean, hair soft and silky, and with plump bodies and bright eyes, there are few more beautiful young animals to be seen in the farm-yard. Those of a white colour seem the most delicate and fine.

2858. The *food* given to the sow after she has recovered from parturition, which will be longer or shorter according to her constitutional temperament, is a warm drink, consisting of thinnish gruel of oatmeal and luke-warm water, which serves the double purpose of meat and drink. If she is thirsty, which she is likely to be on recovery from sickness, the gruel may be again offered in a thinner state in an hour or two afterwards. The ordinary food may consist of boiled potatoes, with a mixture of barleymeal and oatmeal amongst water, administered at a stated hour at morning, noon, and night, with such refuse as may be found in the farm-house. This food supports her well while nursing; and it should be borne in mind that, as long as she is nursing, she should receive abundance of food if it is desired she should rear *good* pigs. Should the weather be frosty, or otherwise cold, the water may be given a little warmed; but in fresh weather, or in summer, cold water is most acceptable to her. The mess should not be made so thin as to be sloppy, and take a long time to drink up; or so thick as to be cloggy in the mouth; but in a state of gruel—meat and drink at the same time. Whatever food is given to her should be *cooked*, and not in a raw state: the vegetables should be *boiled*, and the meal should first be made into brose with hot water, and then mixed with the vegetables; and the whole mess made thin as gruel with cold water. The trough out of which she receives her food should be washed every two or three days in cold, and every day in warm weather. I believe it is the common practice never to give pigs salt amongst their food, because it is said to encourage the *scab*. A large quantity of salt may have this effect, but I never saw a little salt produce any harm. When a sow leaves food in the trough, it should not be presented to *her* again, but given to the older young pigs. Bean meal is stated to bring a great flush of milk upon sows.

2859. Both male and female pigs are gelded, the few that are kept for breeding forming but a small exception. They should be gelded on the milk at from 10 to 14 days old. The males are castrated on being held between the knees, and the scrotum cut through to each testicle, which is removed by the pressure of the finger and thumb, and the spermatic chord separated by the knife. The she-pigs are treated in a different manner. Being laid on a chair bottom or table, on its far side, the pig is there held by an assistant; the operator cuts an upright incision into the flank, of about 2 inches in length, and introducing a finger, brings out the ovary of the womb, and separates it by the knife. He then closes the incision by a stitch or two with a needle and thread, and the operation is finished. There is very little danger attending the operation to either sex. In the case of rupture or hernia in the male—and some breeds of pigs are very liable to this disease when young — it is necessary to stitch up the incision of the scrotum, and the testicle at castration should, in such a case, be removed with care, in case of producing inflammation in the intestines. The incisions in both the male and female generally heal by the first intention. The gelder should use the precaution of cleaning his knife before every operation. The usual charge for gelding pigs is 2s. 6d. the litter, whatever number it may contain. Young pigs are not gelded when intended to be killed while on the milk.

2860. It is seldom that any complaint overtakes the sow on littering, though she may be carried off by puerperal fever, and I suspect there is no remedy for this disease in her case. The pigs which she leaves may be very well brought up by hand on cow's milk, as they will soon learn to drink out of a dish, in which the milk should be given to them warm from the cow, and as often, and even oftener, than the cows are milked. It is surprising how small a quantity of milk a pig will drink at a time, and on this account they should get it frequently; and the dish in which it is served should not be easily upset, as there will inevitably be a struggle which to get first at the milk, and one or more will be sure to jump into the dish. This practice should be checked.

2861. Pigs are very commonly weaned at 6 weeks old, but it is better to keep them on the sow for 2 months; though, in the latter case, she will require to be the better fed. Mr Youatt gives these instructions for weaning pigs:—"They should not be taken from the sow at once, but gradually weaned. At first, they should be removed from her for a few hours each day, and accustomed to be driven by hunger to eat from the trough; then they may be turned out for an hour without her, and afterwards shut up, while she is also turned out by herself. Subsequently, they must only be allowed to suck so often in the twenty-fours—perhaps six times at first, then four, then twice, and at last only once; and, meanwhile, they must be proportionally better and more plentifully fed, and the mother's diet in like manner diminished: thus will the weaning be accomplished without danger or evil consequences to either. Some persons have advised that the whole litter should not be weaned at once; we do not, however, agree with them, unless it should happen that one or two of the young ones are much weaker and smaller than the others. In such case, if the sow remains in tolerable condition, they might be allowed to suck for a week longer; but such a mode of proceeding should be an exception, not a general rule. But let it be understood that, while we would enforce the necessity of good and ample feeding, we highly deprecate all excess, and all stimulating, heating diet, such tending to vitiate the animal powers, often to lay the foundation of disease, and never to produce good, sound, well-flavoured flesh. A little sulphur mixed with the food, or a small quantity of Epsom or Glauber salts, dissolved in water, will frequently prove beneficial." *

2862. A sow is not allowed to take the boar until after the pigs are weaned, but as soon after as possible—in a week or two; and, to bring her into season the sooner, she

* Youatt *On the Pig*, p. 121.

should be fed with oats or oat-meal until she take the boar. The symptoms of season in a sow are a redness and enlargement of the vulva, which, when observed, the boar should have access to her; and should there be a boar on the spot, the meeting will be easily accomplished, and one embrace, which is usually a protracted one, is quite sufficient for securing a litter of pigs. When there is no boar on the farm, the sow is sent to him in a cart, not driven on foot, and she remains a few days with him to secure her impregnation.

2863. A sow that can bring up 10 pigs, and has 5 such litters in the course of 2 years, is a profitable animal. and deserves to be well maintained and taken care of. Even at 10s. a-piece, which is the lowest sum a farmer should take for a pig—for he should keep it until it is worth that sum rather than part with it at a lower price—such a sow will return £25 in the course of 2 years.

2864. As it is considered by farmers inconvenient to keep beyond a certain number of pigs in the farm-stead, it is necessary to determine what that number should be; and as it is difficult to fix its amount for every particular case, a few hints on different modes of managing litters, after they are weaned, may prove useful. Before investigating this point, a few particulars may be stated which you may regard in the light of *maxims* on this subject. A sow should always be either with young or giving suck. for if allowed to run about in season—that is, seeking the boar—she will loose flesh instead of gaining it. A sow should always be kept in good condition, whether with young or supporting young, because a lean sow never brings forth or can nourish strong pigs. Every breeder and feeder of pigs will find it his advantage never to allow them to go to bed with a hungry belly. A sow that brings forth the largest number of pigs of the best quality, proves the best nurse, and is most careful of her young, should always be preferred as a brood-sow. When a sow gets old, she is apt to become careless of her pigs, so that after 3 or 4 years may be a proper time to feed off a brood-sow. Pigs, though on grass during the day in summer, should nevertheless receive a drink of water, and meal or potatoes, or of whey, every morning and evening.

2865. There are just two ways of rearing pigs on a farm: one is to have a large number of sows, and sell the pigs as they are weaned, at 6 or 8 weeks old; the other is, to have fewer sows, and rear the pigs until they are fit for the pork-curers—and the adoption of either plan depends on the nature of the market in the locality. If there is a demand for young pigs just weaned, the larger number of sows will be the most profitable, because the pigs will not have to be maintained on food independently of their mothers; but it is one attended with much trouble, inasmuch as a large quantity of food will have to be daily cooked for the sows while supporting their young, and the market for pigs will be confined to those of one age.

2866. In the other plan, the sows are only supported on special food as long as they suckle the pigs, and there is choice not only of the market for weaned pigs, but for those of various ages, suited to the tastes of pork-curers. Suppose, then, that 2 sows are maintained, in pursuance of the latter plan, and that they bring forth 20 pigs twice a-year. Retaining 4 of these for ham, and other 2 for pickled pork, for the use of the farm-house, there will be 34 pigs to dispose of every year; and as these meet with a ready market when 4 or 5 stones each, at 6s. a-stone, will make them worth each from 24s. to 30s., or from L.40 to L.50 a-year for pigs. It should be borne in mind that these 34 pigs, when running about the courts in winter, eating a few turnips or potatoes, or grazing in the grass-field in summer, do not cost much to rear them to the weight most desiderated by the curers of pork, and in their ordinary state they should be fat enough for the purpose, and will make wholesome meat.

2867. On a farm of 500 acres, 2 brood-sows could thus be easily maintained; on a larger farm 3 might be kept, and on a smaller 1 may suffice: but circumstances must regulate the proper number. Where dairy-husbandry is practised, more sows may easily be kept. A remark of Mr Henderson's on this subject is worthy of attention, in regard to the timing of sows in bearing their litters of pigs. "Whenever," he says, "farmers have an opportunity of selling pork at all seasons, they do not think it necessary to make the sows bring their litters at a particular season, as they wish to have a lot of a certain age to go off regularly at least every month," in autumn, winter, and spring. "They make them ready for the market, with little expense, only giving them close feeding 2 or 3 weeks previous to their being sold." Pigs intended for pickled pork merely do not require even this feeding, though those sold for making hams are the better for a little extra and hardening feeding. "They have very little trouble in selling them," concludes Mr Henderson, "as there are jobbers continually travelling through the country, purchasing swine of all descriptions, who receive them and pay the money at the farms."

2868. The omnivorous disposition of swine is well known, and it is this property which makes them so easily maintained, and serviceable on a farm. "Swine, though exceedingly voracious," observes Mr Henderson, "will feed almost on anything. In miry and marshy ground they devour worms, frogs, fern, rush, and hedge-roots. In drier and woody countries they feed on haws, sloes, crabs, mast, chestnuts, acorns, &c., and on this food they will grow fleshy and fat. They are a kind of natural scavengers; will thrive on the trash of an orchard, the out-casts of the kitchen, the sweepings of barns and granaries, the offals of a market, and most richly on the refuse of a dairy. If near the sea, they will search the shores for shell-fish, in the fields they eat grass, and in great towns they are supported chiefly by grains. It is evident that the facility of feeding them everywhere at a small expense is a material benefit, more especially in a country where people are accustomed to eat flesh daily, or, on the other hand, where there is so ready a market for bacon and pork as we have. It is no less observable that, notwithstanding the facility of feeding, and the multitude of swine maintained, they seldom fail of coming to a good market. Swine ought to have hard feeding two or three weeks previous to their being killed, to give firmness to the flesh. This practice ought to be particularly attended to by those who feed at distilleries on burnt ale and grains, as the fat of pigs thus fed melts almost wholly away in boiling or roasting; peas and beans are excellent for the purpose, and acorns are still better. Where oak plantations are near, they will resort to them in autumn, and there remain until this their favourite food is exhausted. The late Sir James Colquhoun of Luss, I have been told, was in the habit of sending his pigs to one of the islands of Loch Lomond, where there is an oak plantation, that they might pick up the acorns, which is said to have given a surprising degree of delicacy to the flesh. Those who have woods of this kind, and orchards, ought to allow their pigs liberty to range among the trees, to pick up shaken fruit and seeds."* The hogs of Germany enjoy the droppings of the oak and chestnut forests, and it is supposed that it is this species of food that imparts the very superior flavour which the hams of Westphalia are known to possess. That all the hams sold in this country for Westphalian are genuine, I have doubts, after having become acquainted with their true flavour in their own country. I remember of passing through a forest of sweet chestnuts of about 3 miles in length, near Bellinzona, in the canton of Ticino, in Switzerland, in autumn, when the fruit was dropping from the trees; and into this forest the peasantry, I was informed, turned the pigs every year at that season to get fattened. Pigs are remarkably fond of the earth nut and the roots of the common and garden mint.

2869. *Ringing.*—Swine should not be allowed to enter a field of any kind without a ring in the nose. Their propensity to dig for worms and roots makes them turn up the soil with their noses, and when a grass-field is thus treated, it presents a scene of havoc. The best material for making the nose-jewels of swine is horse-shoe nails, they being both durable and ductile. As the heads of the nails are of no use, they are hammered into a point The nail is inserted into a hole, formed by an awl or other sharp-pointed instrument, through the supplemental or snout bone and the proper nasal, and its points are twisted firmly together. A new hole can be made and another nail substituted, when the old hole and nail have become worn. Mr Youatt says that it is a far better mode of proceeding, when the pig is young, to cut through the cartilaginous and ligamentous prolongations by which the supplementary bone is separated from the proper nasals. The divided edges of the cartilage will never unite again, and the snout always remains powerless.

2870. *Pulse.*—The beating of the heart of a pig may be felt on the left side, whence also the pulse may be taken; or from the femoral artery, which crosses the inside of the thigh in an oblique direction. In swine in good health, the pulsations are from 70 to 80 in a minute.

2871. *Bleeding.*—"The common and vulgar mode of getting blood from the pig," observes Mr Youatt, "is by cutting off a portion of the ears or tail; but these modes of proceeding should only be had recourse to when local and instant blood-letting is requisite. The jugular veins of swine lie too deep, and are too much embedded in fat, to admit of their being raised by any ligature abont the neck; it is therefore useless to attempt to puncture them—we would only be striking at random. Those veins, however, which run over the interior surface of the ear, and especially towards its outer edge, may be opened without much difficulty: if the ear is turned back on to the poll, one or more of them may easily be made sufficiently prominent to admit of its being punctured by pressing the fingers on the base of the ear near to the conch. When the necessary quantity of blood has been obtained, the finger may be raised, and it will cease to flow. The palate veins, which run on either side of the roof of the mouth, are also easily opened by making two incisions, one on each side of the palate, about half-way between the centre of the roof of the mouth and the teeth. The flow of blood may be easily stopped by means of a pledget of tow and a string, as in the horse." The plate vein, in the inside of the fore-leg, may be raised by a ligature tied firmly round the leg, just below the shoulder.

2872. *Catching or holding.*—Hurtel d'Arboval recommends the following means of getting hold of pigs: "Fasten a double cord to the end of a stick, and beneath the stick let there be a running nooze in this cord; tie a piece of bread to the cord and present it to the animal, and when he opens his mouth to seize the bait, catch the upper jaw in the noose, run it tight, and the animal is fast." Throw a sack or cloth over the head of the pig, and in his endeavours to get rid of it, seize him by the hind-leg. Mr Youatt says that, in the violent efforts usually employed to catch swine, their struggles to escape will often do them more mischief than the disease we seek to investigate or remedy would effect. Pigs in these struggles will rupture blood-vessels, which may cause instant death, or bring on inflammation and subsequent death.

2873. *Drenching.*—Whenever practicable, the medicine to be given to pigs should be mingled with a portion of their food, and thus cheat or coax them into taking it; but where this cannot

* Henderson's *Treatise on the Breeding of Swine*, p. 41-5.

be done, the following is the best method of administering a drink:—"Let a man get the head of the animal firmly between his knees—without, however, pinching it—while another secures the hinder parts. Then let the first take hold of the pig's head from below, raise it a little, and incline it slightly towards the right—at the same time separating the lips on the left side, so as to form a hole into which the fluid may be gradually poured, not more being introduced into the mouth at a time than can be swallowed at once. Should the pig snort or choke, the head must be released for a few minutes, as he will be in danger of being strangled."

2874. *Diarrhœa.*—"It consists in a frequent discharge of the fæcal matter in a thin or slimy state, but not actually altered, and arises from inflammation or congestion of the mucus lining of the intestine. What we conceive to be an attack of diarrhœa is often only an effect of nature to throw off some offensive matters, and will close of itself in the course of twenty-four hours; but where it goes on for any length of time, it must be taken seriously in hand, as it will otherwise weaken the animal, and impair its value. The best remedy for it is the compound commonly called calves' cordial, viz.,—

Prepared chalk, . . .	1 oz.
Powdered catechu, . . .	½
Powdered ginger, . . .	2 drachms.
Powdered opium, . . .	½

mixed and dissolved in half a pint of peppermint water. From half an ounce to an ounce of this mixture, according to the size of the animal, should be given twice in the day; and strict attention paid to the diet, which should consist as much as possible of dry farinaceous food."

2875. Mr Youatt mentions in a note that "our friend and fellow-practitioner, Mr Horsefield of Wentworth, informs us that sucking pigs kept in piggeries having stone pavements are apt to have the white flux, a bowel complaint very prejudicial to their growth. To prevent or ease them of this malady, let there be plenty of fresh earth strewn for them in the inner piggery, which they will eat with avidity, and thus be kept clean and in good condition." There must be something else than the stone pavement connected with the production of this disease, for my brood-sows brought up their young ones in sties of no other construction, and I never saw a single instance of the disease referred to for all the years I farmed.

2876. *Fecundity of Swine.*—"In one year two sows will breed ten each, of which we shall assume that one half are females, and so proceed on that assumed equality:—

The first year there will be males and females, ...	20
From which take the males, . . .	10
And we have the result as breeders, . .	10
At the second year then, we may fairly take the same ratio of time to each,	10
And it gives a hundred males and females,	2) 100
Leaving consequently for the Third year breeders, ...	50
	10
	2) 500
Fourth year breeders, . . .	250
	10
	2) 2,500
Fifth year breeders, . . .	1,250
	10
	2) 12,500
Sixth year breeders, . . .	6,250
	10
	2) 62,500
Seventh year breeders, . . .	31,250
	10
	2) 312,500
Eighth year breeders, . . .	156,250
	10
	2) 1,562,500
Ninth year breeders, . . .	781,250
	10
	2) 7,812,500
Tenth year breeders, . .	3,906,250
	10
Tenth year males and females,	39,062,500

I hope my friend has brought his pigs to a good market; but to equalise the supply, I shall for the present purpose take only the male half of the pig population for food, leaving the breeders to go on. In this way we can kill and eat 10 the first year—no bad increase from two sows recollect; the second year 50; the third year 250; the fourth year 1250; the fifth year 6,250; the sixth year 31,250, pork in abundance now; the seventh year 156,250—still more abundant; the eighth year 781,250; the ninth year 3,906,250; and the tenth year, also decided in like manner, the enormous number of 19,531,250 for food, without interfering with the breeders. . .

I shall close this paper with the sensible practical observations of my friend in reference to this subject, as, after all, it is in practice only that the benefits open to all are to be received by any. In the county of Kent he informs us there are 31,000 agricultural families or farmers. It is a very easy matter for each to keep two breeding sows, which in three years would produce, in round numbers, 15,000,000 of pigs. In the 52 counties of England, he also adds, the number of agricultural families is 760,000; so that, by the same mode of calculation as for Kent, of every farmer keeping two sows, the produce would be in the like period, 360,000,000 pigs. One good breeding sow to each would consequently produce 15,000,000. As I have said, and say again, is this all true? for if so, what prevents the immediate use of the same beneficial proceeding to every one, not even omitting the allotment tenant."*

2877. "The breeding of swine," says Arthur Young, "being one of the most profitable articles in the whole business of a farm, the husbandman cannot pay too much attention to it. I shall, in as few words as the subject will admit, give an account of the best system to be pursued in this branch of his business. The farmer who could make a considerable profit by hogs must determine to keep a proper number of sows, in order to breed many pigs; but this resolution ought to be preceded by the most careful determination to prepare crops proper for supporting this stock. The proper ones for that purpose are barley, buck-wheat, beans, pease, clover, potatoes, or carrots. In the common management, a farmer keeps only a sow or two, because his dairy will do no more; but in the system of planting crops properly for swine, a different conduct must necessarily be pursued. Potatoes, carrots, Swedish turnips, and cabbages must be provided for the sows and stores from October until the end of May, by which time clover, chicory, or lucerne should be ready to receive them, which will carry them till the stubbles are cleared; so that the whole year is filled up with these plants, and the common offal of the barn-door and of the corn-fields. When the sows pig, meal must be provided to make a wash, by the mixing it with water. This in summer will be good enough for their support; and in winter it must be mixed with boiled roots, oats, and pea-soup for the young pigs. If cows are kept, then the dairy wash is to be used in the above mixtures. Upon this system a farmer may apportion his swine to his crops, or his crops to his swine; and he will find that, for the whole year, he should have about an equal quantity of roots and grass, and half as much corn as potatoes. For carrying the profit to the highest advantage, the sows should pig but twice a-year—that is in April and August, by which means there will never be a long and expensive season for rearing pigs before they are put to the staple food of clover or potatoes, &c.: but this circumstance is much removed by the provision of crops raised expressly for the swine. Upon this plan the annual sale of lean hogs should be in October, the litters of April sold then as stores, and those of August kept till October twelvemonth to sell for breeders, if the farmer feeds them himself. The stock upon hand this month will therefore be the sows and the pigs littered in the preceding August, all which should have roots from the store, and even at the same time in the farm-yard, for shacking the straw at the barn-doors. In proportion to what they find in this, you must supply them with roots, giving enough to keep them in growth."†

ON THE HATCHING OF FOWLS.

2878. Spring is the busy season of the feathered inhabitants of the farm. I shall endeavour, in as few words as the clear elucidation of the subject will admit, to describe the mode of hatching and rearing every sort of fowl usually domesticated on a farm, to show you that it is not so difficult or troublesome an affair as the practice which generally prevails would seem to indicate. This I am enabled to do by observing and assisting in a system which was invariably attended with success, and which only observation of the habits of domesticated birds, and *punctual* attention to their wants, will enable any one to follow, and to produce and rear plenty of excellent poultry on a farm.

2879. In my observations on the management of *hens* in winter, I mentioned that the early-hatched chickens of the former spring were the best to treat as laying hens during winter (1708.) These same young hens, being in fine condition in spring, will prove good layers through the ensuing summer, and should therefore be kindly treated for that purpose, and discouraged from becoming sitters on eggs, which they will do, if allowed to wander in search of food, and find out nests of their own to lay in. I also mentioned, there was no difficulty of bringing up chickens in winter, if it were thought expedient to do so; and should any have been nursed in winter (1616,) they will now in spring be in good condition, and be valuable birds, fit to make a handsome dish of roast or boil.

2880. *Hens.*—As soon as the grass begins to grow in spring, so early will cared-for hens delight to wander into sheltered portions of pasture, in the sunshine, in the warm side of a thorn-hedge, and pick the tender blades, and devour the worms, which the genial air may have warmed into life and activity. With such morsels of spring food, and in pleasant temperature, their combs will begin to redden, and their feathers assume a glossy hue; and even by February they will begin to chant—and this is a sure harbinger of the commencement of the laying season.

2881. By March, a disposition to sit will be evinced by the early laying hens; but every hen should not be allowed to

* Youatt *On the Pig*, p. 83-124.

† Young's *Farmers' Calendar*, p. 20.

sit; nor can any hen sit at her own discretion, where the practice is, as should be, to gather the eggs every day as they are laid. It is in your option, then, to select the hens you wish to sit to bring out chickens. Those selected, if young, should be of a quiet social disposition, not easily frightened, nor disposed to wander afar; and they should be large and full feathered, to be able to cover their eggs well, and brood their young completely. Those which have proved themselves good sitters and brooders, neither carelesss, nor too solicitous of their broods, should be chosen in preference to others; but it is proper to make one young hen or so, every season, sit for the first time.

2882. The *eggs* intended to be set should be carefully selected. Every egg proposed to be hatched should have the date of its being laid written upon it. If those of a particular hen are desired to be hatched, they should, of course, be kept by themselves, well preserved, and set after her laying time is finished. In selecting eggs, they should be quite *fresh*—that is, laid within a few days—large, well-shaped, truly ovoidal, single, not seeming as if two small ones were joined together; neither too thin nor too thick, but smooth in the shell: their substance should almost entirely fill the shell, and be uniform and translucent when looked through at a candle, which is the best light for their examination.

2883. It is said that the position of the cell that contains the air in an egg determines the sex of the chick that will spring from that egg—that is, if the cell occupies the exact apex of the end, which is always the large end, the chick will be a male, and if on one side of the apex, it will be a female. I believe there is truth in this observation, but to what extent, and what experiments have been made to determine the point, I have not learned; but there is no doubt of this, that the longer an egg has been kept with access to the air, until it becomes addled or dead, this cell increases in size, by the absorption of air through the shell, and, of course, by absorption also of the substance of the egg, which makes room for the air. I have heard it remarked that this air cell is a positive indication that the hen which lays an egg with one must have been with the cock. This I do not believe, for I am sure I have seen such cells in eggs from hens that could not possibly have even seen a cock. The matter of the sex of the egg is of no importance on a farm, as a good chicken of one sex is as valuable, as an article of food, as a good one of the other.

2884. Either 11 or 13 eggs are placed under a hen; the former number, 11, is more likely to be successful in being entirely hatched than the latter, as few hens can cover as many as 13 large eggs sufficiently. A notion prevails even at the present day, of the propriety of setting an *odd* number of eggs under a hen. This may have arisen from the idea that, allowing 1 egg to be rotten, an *even* number, or so many *couples* of chickens, will still be obtained in the hatching; and, accordingly, it is considered a good hatching if 10 chickens are brought out of a setting of 11 eggs, or a dozen of one of 13 eggs.

2885. As essential a matter as selecting the hens and eggs, is the making a proper *nest* for the sitting hen. This should consist of a circular hassock of soft straw-ropes, or it may be a box, or a basket. The object of this foundation is to raise the nest sufficiently off the ground to keep it dry, and to give it such a hollow as none of the eggs shall roll out by any mischance. A box or basket is a convenient receptacle for a nest, but in using either it will be requisite to stuff the corners, as well as the bottom, firmly with straw, that the eggs may not drop into the corners, or the young chicks, as they are hatched, fall into them. The nest itself should be of soft short oat straw. It should be made as large as to afford the hen ample room, not only for her body, but also her tail. If the tail is bent while sitting, the hen will always feel uncomfortable. The nests are commonly made too small. The hollow directly occupied by the body of the bird should not be larger than she can fill; but the sides and base of the nest should spread out to give room around the hen, and elevation above the floor.

2886. Places should be chosen for the

sitting hens, for the hen-house, as G, Plate II., common to all the laying hens, will not answer, the perpetual commotion in it disturbing the sitting hens. Hatching-houses, such as c' d' e' f', Plate II., should contain one hen at a time; but as many may be accommodated in it as there are partitions to separate one hen completely from another, as hens are jealous of each other—and especially so when sitting, when she will sometimes endeavour to take possession of the nest and eggs of the other laying ones, or drive them away from their eggs. Other places may be selected for sitting in—such as an out-house, a loft, a spare room in the farm-house, or even the back-kitchen, when warmth is required for an early brood.

2887. The hen selected for sitting having been accustomed to lay in the hen-house, or elsewhere, will feel annoyed at first on being transferred to her new quarters; she will have to be coaxed to it, and even after all may prove obstreperous, though exhibiting strong symptoms of clucking, in which case she must be dismissed and another chosen, rather than run the risk of spoiling the entire hatching by her capricious conduct. A couple or so of old eggs should first be put into the nest, upon which she should be induced, by meat and water beside her, to sit for two or three days, to warm the nest thoroughly, before the eggs she is to hatch are placed under her. After she shows a disposition to sit, and the nest has become warm, the old nest-eggs are taken away, and the selected eggs are put into the nest—11, as I said before, being quite enough—and the hen allowed to go upon them in her own way, and to manage the eggs as she chooses; which she will do with her bill and body, and feet, spreading herself out fully to cover all the eggs completely. The time chosen for setting the hen should be in the evening, when a natural desire for roosting and rest is evinced; and by next morning it will be found that the hen has taken to the nest contentedly.

2888. It is not unusual, with some people, to set a hen at any time of the day, even in daylight, when she is almost certain to come off and desire to wander; and, to curb the disposition, a tub is placed over her to keep her in the dark. The consequent fright, upon such treatment, not only prevents her attending to the eggs, but some of them may be broken in her attempts to get out of confinement. In the desire to keep the creature in the dark, it might suggest itself to a considerate person, one should suppose, that darkness is more easily and naturally found at night than in the day, and that natural darkness is better than artificial.

2889. While sitting upon her nest, the hen should be looked at regularly every day, and supplied with fresh food, corn, and clean water. She will not consume much food during the time of incubation, which is 3 weeks. Every two or three days, the dung, feathers, &c. about the nest and on the floor should be swept and carried away, and the place kept clean and dry.

2890. In about 3 weeks a commotion among the eggs may be expected; and should the hen have proved a close sitter, and the weather mild, it is not unlikely that the heads of 2 or 3 chickens will be seen peeping out below her feathers before that period. The hen should not be disturbed during the time the chickens are leaving the eggs, or until they are all fairly out and dry. Any attempt to chip an egg infallibly kills the chick; and every attempt to remove pieces of a chipped egg causes the chick to bleed.

2891. Cock chicks, just out of the egg, may be distinguished from hen chicks by their larger heads and stronger legs.

2892. A good plan is to give the chickens, when fairly out, a drink, by taking them one by one and dipping their bills in clean water. Food is then set down to them on a flat plate, consisting of crumbled bread and oatmeal, and a flat dish of clean water. The hen's food consists of corn, or thick oatmeal porridge, boiled potatoes, and water. The chickens should be visited every 3 hours, and a variety of fresh food presented, so as to induce them to eat it the more frequently and heartily—such as picks of hard oatmeal porridge, crumbled boiled potatoes, rice, groats, pearl barley; taking care to have the food always fresh, and the water clean, however small the quantity may be taken. The hassock, or box, or basket, should now be removed, and the true nest set down on the floor, with a slope of straw from it, that the chickens may walk up to the nest to be brooded at night. In the course of 24 hours after all the chickens are on foot, the hen will express a desire to go out, which she should be indulged in, if the weather is dry, and especially when the sun is out; but if it rain, she had better be kept within doors, unless a convenient shed is near, in which she may remain with her brood for a short time. Visited every 3 hours during the day, and supplied with a change of food such as I have mentioned, and clean water, for about a fortnight, or rather until the feathers of the tails and the wings begin to sprout, chickens may then be considered out of danger, and, of course, become less of a charge.

2893. During the remainder of the season, the chickens should receive food 3 times a-day, consisting of porridge or boiled potatoes, as long as they last. When potatoes fail, hard-made oatmeal porridge is the best food for fowls at any time, when given in small bits at a time.

2894. It is not expedient to set a number of hens at one time, but in succession every 3 weeks or a month; for a few chickens, ready for the table in succession, are of greater value than a large number of the same age.

2895. As the season advances into summer, hens, as they become fat by picking up food in the fields, have a predilection to select places in them for nests to lay eggs, and bring out chickens. And it must be owned that this is a most natural predilection; but no dependence can be placed in it for a regular supply of young fowls. The weather may not suit hens sitting in the open air; and the hens have not the disposition to sit in the most desirable periods of the year, namely, at an early and a late period. It is impossible to obtain a regular supply of eggs or chickens, unless provision is made for collecting the one, and hatching the other, in a systematic manner.

2896. Chickens go 6 weeks with their mother. A good hen that has brought out an early brood will become so fat while rearing them, that she will soon begin again to drop eggs, and of course again become a clucker, and may then be employed to bring out a late brood.

2897. ***Turkeys.***—The hatching and rearing of *turkeys* is universally said to be a difficult matter to accomplish; an opinion I am not disposed to acquiesce in, and I maintain they are as easily reared as chickens. When a turkey-hen is seen disposed to lay, a nest should be made for her in the hatching-house. It may consist of the same materials as the hen's nest, but, of course, of a larger size to suit that of the bird. A box or basket is an excellent thing, with the corners filled up.

2898. When once the turkey-hen lays an egg, and a nest-egg is placed in the est, she will use it regularly every time she requires it, which will be once in about 30 hours. As the eggs are laid, they should be removed, and placed gently in a basket in the house, in a *dry* place, and turned with caution every day.

2899. When she has done laying, which may not be till she has laid 12 or 13 or even 15 eggs, she will be disposed to sit, when the eggs should be placed under her, to the number of 11 or 13, the former number being the most certain of succeeding, as a turkey cannot cover a greater number of her own eggs than a hen can of hers; and a brood of 10 poults is an excellent hatching. A turkey need not be confined within the apartment she occupies, as she is not disposed to wander, nor is she jealous, like a hen, of another one sitting in the same apartment with her. A turkey sits 4 weeks, and is proverbially a close sitter. During the incubation, corn and water should be supplied to her fresh and clean daily, and the dung and feathers removed from the nest every two or three days.

2900. When the poults are expected to make their appearance, the turkey should be frequently looked at, but not disturbed, until all the poults are fairly hatched.

2901. It is, I believe, a common practice to put a peppercorn down the throat of every poult a short time after it is hatched. How the practice originated, I cannot say; but as turkeys, when at liberty, have a great relish for ants, and seem to possess an instinctive faculty in discovering their hills, and so has the pheasant, it is possible that the peppercorn may operate as a substitute for the ant. It is known that ants yield a peculiar acid called *formic* acid; and it is not improbable that the pungency of the peppercorn may act as a stimulant on the stomach in the same manner as the acid in ants. Dr Thomson, in speaking of the nature of the formic acid, says, that "it is secreted by the *Formica rufa* or red ant, and is the liquid that renders the bites of these insects so painful. It was first publicly noticed by Mr Ray in the year 1670. . . . Mr Fisher had stated to Mr Ray, several years before, that 'if you stir a heap of ants so as to rouse them, they will let fall on the instrument you use a liquid which, if you presently smell, will twinge the nose like newly-distilled oil of vitriol.' Mr Fisher farther stated, that 'when ants are distilled by themselves or with water, they yield a spirit like spirit of vinegar, or rather like spirit of *viride æris*. It dissolves iron and lead. When you put the animals into water, you must stir them to make them angry, and then they will spit out their acid juice.' Margraaf obtained this acid in 1749, by distilling ants mixed with water, and rectifying the liquid that came over. The acid obtained had a sour taste and smell."*

2902. While referring to this acid, I can hardly fail, in the circumstances, noticing the constitution of pepper. "*Piper nigrum* is the name of the plant which produces common pepper. It is a shrub which grows in India. The seeds are berries, round, hard, having an aromatic smell and a *hot acrid taste*. These berries constitute pepper. The unripe berries are the common *black* pepper; while the ripe berries, deprived of their epidermis, constitute *white* pepper. . . In 1821 M. Pelletier published an elaborate examination of pepper. He showed that it contained the following constituents:—

Piperin.
A solid very acrid oil.
A balsamic volatile oil.
A gummy-coloured matter.
Extract similar to that obtained from leguminous seeds.
Malic and tartaric acids.
Starch.
Bassorin.
Lignin.
Earthy and alkaline salts in small quantities.

M. Pelletier showed that piperin did not possess alkaline characters, as Oestedt had supposed, but that it was a peculiar principle. He found, too, that pepper owed its peculiar *taste to a volatile oil*. This I had shown many years before," adds Dr Thomson.† From this account of it, it is not improbable that the solid and very acrid oil in the pepper may affect the stomachs of turkeys in a similar manner as does the formic acid in ants; and this may form an excuse for an old practice for which a satisfactory reason cannot be given by those who follow it.

2903. After the peppercorn is given—and it may be given or not as the person who has charge may choose, and I know it does no harm—the poults get a drink of water, and are returned into the warm nest, where the mother receives them with characteristic fondness. But before leaving the turkey for that night, the box or basket in which the nest is formed should be taken away, and the nest formed with a sloping face towards the floor, to enable the young poults to gain the nest. For 24 hours the poults will eat nothing, though the turkey herself should be provided with corn, firm oatmeal porridge or potatoes, and water. Next morning the young creatures will be quite astir and ready to eat food, which should now be given them. It should consist *solely of hard-boiled eggs, yolks and white shredded down very small*, and put on a flat plate or small board.

2904. In one respect turkey-poults differ in their nature from chickens, inasmuch as they are more apt to purge for the first fortnight of their existence, and when purging does overtake them, it is difficult of cure, and generally proves fatal; but hard-boiled eggs, forming an astringent and nourishing food, entirely *prevent* purging, better than some other things I have seen tried. For the sake of experiment, firm oatmeal porridge was

* Thomson's *Chemistry of Animal Bodies*, p. 7.

† Thomson's *Chemistry of Vegetables*, p. 895.

given instead of hard-boiled eggs, and in a short time two poults took the flux and died, the rest having been saved by a return to the egg. With egg not a single death has occurred among two hatchings every year for upwards of 20 years, and that is sufficient experience to justify the recommendation of any practice.

2905. Let the poults be visited every 3 or 4 hours, supplied with hard-boiled egg and clean water. Let this food be removed after the poults are served, otherwise the turkey will devour it; for she is a keen feeder, and not so disinterested a bird in regard to food as a hen. Let them remain two nights and a day in the house, and afterwards let them go into the open air and enjoy the sun and warmth, of which, it is hoped, there will be plenty in the month of May. In wet weather, they should be confined to the house, or allowed to go into a shed. When the birds become strong and active in the course of a few days, let the turkey be placed in a coop on the green to curb her wandering propensity, until the poults can follow her, which they will be able to do after they have been supported on hard-boiled eggs for a fortnight. This should be put upon a plate on the green beyond the reach of the coop, and where the poults can help themselves; whilst the food of the turkey is placed within reach of the coop, consisting of corn, porridge, boiled potatoes, and water. After the feathers in the tails and wings of the poults have fairly sprouted, the egg may be *gradually* withdrawn, and hard-boiled picks of porridge, with a little sweet-milk in the dish, to facilitate the swallowing of the porridge, should be given them at least 4 or 5 times a-day at stated hours; which wholesome food will support them until the mother can provide insects, and other natural food for them, as a variety along with it. They will now thrive apace, and grow amazingly fast as the weather becomes warm. Should the grass be damp, let the coop be placed on the gravelled walk or road, as dampness is injurious to all young birds of the gallinaceous tribe, especially in brooding. After the egg is withdrawn, the poults are fond of a little shredded cress and mustard, and, when at liberty, will pick the tender leaves of nettles with avidity. The predilections for ants, cress, and nettles, show that turkeys enjoy stimulating condiments with their food.

2906. Turkeys are sometimes extraordinary layers. One season a hen-turkey of my own, after bringing up 11 poults till they were 8 weeks old, made a nest in the middle of a large bush of nettles at the edge of a young plantation, which she visited by contriving to slip away unnoticed from her brood to lay an egg *every day*. The nest was soon discovered, the egg taken away every day as it was laid, and a nest-egg left in it, and thus she continued to visit it *daily* till she had laid the extraordinary number of 90 eggs. The consequence of this oviparous fecundity was, that the turkey did not moult till the depth of winter, and the moulting was so very bare that she had to be confined to the house; and whether the misfortune which befell her before spring was owing to the severity of the late moulting I do not know, but an inflammation and a consequent swelling seized one of her eyes, and she was deprived of its sight. By spring, however, she recovered from the moulting, was furnished with a completely new plumage, the wound on the eye healed, but she died a short time after.

2907. Turkey-hens are most watchful protectors of their young, and are particularly wary of birds of prey, which, whenever observed, even at the greatest height in the air, they will utter a peculiar cry, which the poults understand, and will hide themselves instantly amongst the longest grass and other plants within reach.

2908. Another peculiarity affects the turkey-hen; one impregnation from the cock fecundates all the eggs of the ovarium; and, on account of this property, I am told it is not uncommon in spring in Ireland for people to carry about turkey-cocks and offer their services at farm-steads, as those of a stallion are proffered. It is perhaps to this peculiar constitutional habit of the turkey that makes the cock so regardless of his own progeny, and which leads the hen voluntarily to shun his attentions as long as she has charge of the brood The brood goes with her for an indefinite length of time.

2909. *Geese*. Geese make early preparation for incubation. They, however, seldom lay eggs in Scotland till the end of February.

2910. The goose and gander cannot embrace but in water, and if the pond which they frequent be covered with ice, it should be broken to allow them to get to the water, as every egg requires a separate impregnation.

2911. An attentive observer will know when a goose is desirous of laying, by her sitting down amongst straw and picking up and placing one on this side and one on that side of her, as if making a nest. Whenever this is noticed, or an embrace on the water with the gander, a nest should be made for her to lay in in the hatching-house, and to which she should have easy access, for she cannot leap or fly up with the nimbleness of a hen or turkey, though her nest may also be made in a box or basket, of a size to suit the bird.

2912. It is improper to confine a goose a long time before laying her first egg; but when symptoms of laying are observed, she should be caught in the morning, when let out, and the lower portion of the soft part of the abdomen felt, where the egg may be easily ascertained to be in a position to be immediately laid; and if it feel hard, she should be put in her nest and confined until she lays the egg in the course of the day, after which she is let out, the egg taken away, kept dry in a basket, and turned every day, until the entire number laid are placed under her.

2913. Every other day after the first, the goose will visit her nest and lay an egg, and the number she may lay will seldom exceed 12, though 18 have been known to be laid; so, by the time she is done laying, it will be about the end of March. Considerable difference, however, in this respect, exists amongst geese, they laying on some farms considerably earlier than on others. This may arise from the nature of the soil, as it is probable that a dry, sharp, early soil for grass and grain, will promote the functions of poultry, as well as the vegetable economy, to an earlier development.

2914. After the goose has finished laying her eggs, she will incline to sit, and she should receive her eggs; and the best time for placing them in the nest, as I have said of the hen, is in the evening, that, by the arrival of the morning, the nest will be so warmed and made comfortable, as to induce her to keep possession of it. The number of eggs given to be hatched should be 11, which is as many as a goose can easily cover. The goose plucks the down off her body to furnish her nest with the means of increasing its heat; and one great use of the down is, that when she leaves her nest at any time she covers them with it, and thus effectually prevents the external air cooling them. A little clean water and a few oats are put beside her while she is sitting; but she will eat very little food all the time she sits.

2915. A feed of good oats, such as is given to a horse, will serve a sitting goose for a month; yet this little handful is actually grudged the poor patient goose, and, instead of good corn, the lightest corn blown from the fanners, only a degree better than chaff, is allowed her by many farmers who consider themselves good rearers of live stock.

2916. Some will not allow the goose to go abroad as long as she is sitting; but this is imposing an unnecessary constraint upon her. Let her go off whenever *she pleases*, and there is no fear but that she will return to her nest in time to maintain the heat preserved by the down. Most people will not then allow her to go to the water at all, alleging, that if she returns wet upon the eggs, they will become addled; but this is a mistake. Let her go to the pond if she wishes to wash herself, and depend upon it, she will not continue longer there than merely to refresh herself. The feathers will not become *wet*; it is not their nature to become so; and after the relaxation she evidently so much enjoys, she will sit the closer.

2917. Geese are liable to become costive while sitting and eating nothing but corn, and, to counteract which tendency, they should be supplied now and then with a little boiled potato in a dry state; and every fowl, while sitting, should receive a little of this useful ingredient.

2918. The gander usually takes up with one mate, but if there are only two geese, he will pay attention to both; and his regard for his mate is so strong, that he will remain at the door of the hatching-house like a watch-dog, guarding her from every danger, and ready to attack all and sundry that approach her sanctuary.

2919. At the end of a calendar month the eggs may be expected to be hatched; and during this process the goose should be left undisturbed, but not unobserved.

2920. After the goslings are all fairly out of the shell, and before they are even dry, they may be taken in a basket with straw to a sheltered dry spot in a grass field, the goose carried by the wings, and the gander will follow the goslings' soft whistling. Here they may remain for an hour or two, provided the sun shines, and in sunshine goslings pick up more strength in one hour than from the brooding they receive from their mother for a day. The goslings will endeavour to balance themselves on their feet and pluck the grass: the goose will rest beside them; and the gander will proudly protect them all. Water should be placed beside them to drink. Should the sky overcast, and rain likely to fall, the goslings should be immediately collected, and carried with the goose to the nest: for if they get their backs wetted with rain or snow in the first two or three days of their life, they will lose the use of their legs, never became strong, and will inevitably die. Should the weather be wet, a sod of good grass should be cut and placed within their house, beside a shallow plate of water. In setting down a common plate to goslings, it should be prevented from upsetting, as they will put their feet upon its edge, and spill the water. After two days' acquirement of strength, in sunny weather, the goslings may venture to the pond to swim; but the horse-pond being frequented by so many kinds of animals, is too dangerous a place for them as yet. A pond in a grass-field would be the best place for them. For the first few days after goslings go about, they should be particularly observed; for, should they fall upon their backs on the grass, or into a hardened hoof-print of a horse, or a wheel-rut in the ground, they cannot recover their legs, will be deserted by their dam and all the rest, and will certainly perish. After three or four days, however, in dry sunny weather, and on good grass, they will become so strong, grow so fast, as to be past all danger. It is surprising how rapidly a young gosling grows in the first month of its life.

2921. After that time they begin to tire of grass, and go in search of other food; and this is the time to supply them daily with good oats, if you wish to have a flock of fine birds by Michaelmas; any other grain will answer the purpose, as rice and Indian corn, let it be but corn, though oats are their favourite food. Even light corn will be better than none; and if they get corn until harvest, they will have passed their fastest growing period, and will then be able to shift for themselves, first in the stack-yard, and afterwards on the stubbles.

2922. The sex of the gosling may be easily ascertained after the feathers begin to sprout—the ganders being white, and strong in the leg, head, and neck; the geese gray, and having a gentler aspect.

2923. Goslings go with their parents for an indefinite length of time.

2924. Geese are in general close sitters; but sometimes they are capricious enough to forsake their eggs after a number of the goslings have been hatched. I have witnessed an instance of this sort of desertion. A goose after hatching five goslings, deserted her nest, and would no longer sit on the other six eggs to bring them out, though one of them was chipped. Fearing that the deserted eggs would perish from cold, my housekeeper—who took the charge of all the poultry, cows and calves, besides the house—brought the eggs into the house, put them in a basket amongst flannel and wool, caused the oven to be gently heated, placed the basket with the eggs in the oven, and continued the heat in it night and day until all the goslings were hatched, which they were one by one, excepting one in which the bird had died. They occupied some days in leaving their eggs, and longer than they would have done under the goose. They were carefully attended to, and were taken out to the grass in the best part of the day, kept warm in the house at night, and, when the weather was such that they could not get out, a grass sod was brought to them into the house. The goose refused to take this part of her own brood when offered to her, after they had gained sufficient strength to go about; which being the case, they were brought up without her aid, and became as strong birds as the rest of the brood. I consider this as a remarkable instance of the resources of a humane mind, and of a disregard of personal trouble; and it is an encouraging example of perseverance in the preservation of the lives of useful animals under unfavourable and even provoking circumstances.

2925. *Ducks*—Ducks begin to lay eggs early in the season, as early as January, so it is possible to obtain an early hatching of ducklings, if desired; but early ducklings are not desirable, as, during an unnatural period for them, they do not acquire much flesh, even with the utmost care; their bills and bones growing disproportionately large, and they never become fine birds. It is early enough to set duck eggs in Scotland by May, and by April in England. It is customary to place duck eggs under hens, owing, I believe, to the difficulty of making a duck take to a nest she has not herself made.

2926. Hens make tolerable foster-mothers to ducklings, though, in becoming so, the task is imposed upon them of a week's longer sitting than is in conformity with their own nature; and, after all, the natural plan is for ducks to bring out their own kind; and there is no doubt that, when a duck does choose a nest for herself, lines it with her own down, and brings out a brood, that the ducklings are better than any reared under the care of a hen; the instinct of the duck being more congenial to ducklings in leading them to places in search of food peculiar to their tastes, as well upon land as upon water. Still the entire production of ducklings on a farm should not be left to the chance of ducks setting themselves on eggs, for they are proverbially careless of where they deposit their eggs, and on that account hens must be employed to hatch at least a few broods of ducks.

2927. As in the case of her own eggs, a hen can only cover 11 duck eggs with ease; and she requires the same treatment as when sitting on her own eggs. A calendar month is required to bring out ducklings; and during the actual hatching, the hen should be left undisturbed until all the brood comes out.

2928. Ducklings should be kept from water for a couple of days, until their navel string is healed; and the food which they receive should be soft, quite the opposite of that given to turkey-poults—such as bits of oatmeal porridge, boiled potatoes, bread steeped in water, barley-meal brose, and clean water to drink in a flat dish in which they cannot swim. On this treatment, 3 or 4 times at least every day, they will thrive apace, and become soon fledged over the body, when they are fit for use; but their quill-feathers do not appear for some time after. In this state wild ducklings, under the name of *flaffers*, make excellent sport.

2929. A great number of ducklings are bred and reared every year in the Vale of Aylesbury in Buckinghamshire, for the London market, by people of the poorer class. The eggs are hatched by hens, and 3 or 4 broods are put together into one division; whilst other divisions contain them in a different state of growth, some half-grown, others full fledged, and all are fed alike. In this way one person has 300 or 400 ducklings feeding about the house, and perhaps under the same roof with the family. A great many are housed in little space, and never allowed to go at large; but permitted to wash themselves every day in a pond made on purpose near the house. They are fed three times a-day on potatoes, barley-meal, bran, greaves, &c., and receive as much as they can eat; and it is stated that they eat an incredible quantity of food while thus forcing for the market. When full-feathered they are sent to London, where they find a ready sale, at from 6s. 6d. to 8s. a pair. As the season advances, prices fall, till they reach 3s. a pair, when the breeding is given up for the season. Those people allege that they are not remunerated for their trouble even at the highest prices; and yet I have seen it lately stated on the testimony of a poulterer, that £30,000 are annually sent out of London for the purchase of Aylesbury ducks.

2930. *Pea-fowls.*—Pea-hens, in their hatching, will not be subjected to control. The hen selects a secluded spot for her nest, not unlikely in a garden, where she feels herself secure from the attentions of the cock, whom she avoids at this season with marked assiduity. She takes care that he shall not know, not only where her nest is, but when the pea-fowls come out; and it is alleged, that the cock destroys them. A pea-hen in this country seldom brings out more than three or four birds, though usually laying five eggs; and these she tends with great care, taking them to places where wild food can be found in greatest abundance, such as insects of various kinds and in different states; and, besides this, they are fed as young turkeys are. She continues her care for her young for the greater part of the year.

2931. *Pigeons.*—Pigeons, when their dove-cot is favourably situated for heat, begin to lay in February, and will continue to do so until December.

2932. They make their own nests, which are of the simplest materials and rudest construction, and the same nest will be used by the same pair season after season, if permitted, even after it has been much elevated by the dung of the young pigeons. A fine nest is not required by pigeons, which only laying two eggs at a time, one of each sex, the hen can easily cover them; and to afford to them still more heat, she pushes them below her with her bill, amongst the feathers.

2933. What I have said on the mode of hatching the different sorts of fowls usually reared, is suitable to every sort of farm, and may be acquired by any domestic of the farm-house; and that it is quite practicable, my own experience of it for years has proved. Other schemes are recommended in books, and large establishments, consisting of buildings and ponds, and spare ground, are erected and laid out in the parks and farm-courts of country gentlemen; but let any other plan be what it may, and its erections and appliances of whatever magnitude, there is no one, I feel confident, will afford poultry at all times in a higher degree of perfection and health than the simple one I have just described, and recommended for your adoption — and experience is the best test to which any plan can be subjected. I do not say that it is a very cheap plan, that it will supply *good* poultry for the table at *little or no cost*—the idea of cheapness entertained by farmers, when they condescend to cast a thought on the poultry of their farms. I do not believe that fowls can be reared upon the *refuse* of the products of a farm more than any other sort of stock; and when I see that the best oats, the best turnips, and the best grass that a farm can raise, are required to rear such horses, cattle, and sheep, as purchasers desire to have, I must also believe that poultry require the best food to make them as acceptable; but this I can say for the plan, that as a practicable one for an ordinary farm, it requires no costly buildings, and that it will assuredly yield poultry in good condition at all seasons, in return for the food and trouble bestowed upon them—and what more can a reasonable farmer desire?

2934. *Poultry in towns.*—Fowls are kept in towns in places quite unsuited to their habits; most frequently in a small court, surrounded by a high rail except on the side in which the hen-house is situated; and this consists of a flattish-roofed out-house, pervious to rain and redolent of moisture,—a condition the very worst for fowls. The floor of the court is generally covered with dirt, and the small vessel which is intended to contain water is as often dry as plenished with *clean* water, while the food is thrown upon the dirty court floor. Add to these sources of discomfort, the sun, probably, never shines upon the town hen-house, or only for a few minutes in the afternoon, when the fowls are about to retire to roost. Ducks are treated in even a less ceremonious manner than hens; having no water, their feathers become begrimed with dirt, and their food is given to them in a state little else than a dirty puddle. It is, of course, impossible that fowls can *thrive* in such circumstances; and, indeed, a sight of the poor creatures excites nothing but commiseration for their fate. What can induce people to keep animals in such a state of filth and discomfort, I cannot conceive.

2935. One cause of suffering to hens in such situations, is the want of sand or gravel to assist the trituration of food in the stomach. It is found that gallinaceous birds require a supply of quartzy substances—and these they find on any farm, as also calcareous matter, such as lime—to assist in the formation of the shell of the egg; without which, hens will lay what are called *wind* eggs, that is, eggs without a *hardened* shell. In the case of the fowls on board a certain East Indiaman getting unwell in their coops, notwithstanding the attention daily bestowed, and the good food allowed them, it was discovered by the surgeon, on dissection of some of the birds which had died, that the cause of death was the want of gravel to assist the digestion of food. A supply of stones to beat down small was obtained at a convenient port, and the fowls became healthy, and continued so afterwards. Another source of suffering of a similar nature to hens, is the want of dust to burrow in, and to scatter it amongst their feathers, in order to destroy the vermin which annoy their skin; and the ducks suffer equally much from the want of water to wash in and clean themselves.

2936. The Greeks exhibited much superstition and absurdity in the management of their poultry. "When we wish fowls to lay, we are to set clean straw under them, and to lay an iron nail in it, for this seems to be of service against every evil. Columella mentions the same thing. More than 23 eggs are not laid under a good hen, and fewer under one that is not a good one, according to the natural power of each bird. (Columella recommends 21 eggs—Varro went so far as to mention 25—which might not seem so extraordinary in a warm climate, and when we know that, even in this country, hens will bring out as many as 20 chickens, in nests provided by themselves in the fields.) The number must always be uneven; and you must set them under the hen when the moon is increasing, that is, after the new moon, to the fourteenth day of its age. Those, indeed, that are set before the new moon become abortive. It is also necessary to set the eggs chiefly that were laid from the blowing of Favonius to the autumnal equinox, that is, from the 7th of February to the 22d of September; wherefore you are to set them apart in the breeding season, that a young brood may be raised. But you are not to set the eggs laid before this season or afterwards; and all the first-laid eggs are not to be set, for they are stale and imperfect. Let the keeper turn the eggs every day, that they may be equally cherished on every side. It is also proper not to set one hen only the same day, but three or four, and you are immediately to take the chickens that are hatched from every hen, and to set them under one that has few: and you are to divide the eggs that are not hatched between the hens that are still sitting, that being cherished by them they may come to life; but you are not to set under a hen that has a small brood more than 30 chickens. Cold is inimical to the race of fowls.

2937. "You will thus prove if eggs are good: put them in water, for one that is faulty swims, as being useless, but that which is fully perfect will sink to the bottom; nor is it proper to shake the eggs in proving them, that the vital principle in them may not be destroyed; and as some persons set heterogeneous eggs under domestic fowls, you are to know that a hen hatches the eggs of a pheasant in the same manner as its own in 21 days, but the eggs of a pea-fowl and of a goose in 29 days. (Varro says in 27 days, and Pliny from the twenty-seventh to the thirtieth day.) Calculate, then, and set these according to those already mentioned, that they may be hatched 7 or 8 days afterwards. But there are in Alexandria, belonging to Egypt, hens called *monosyri*, from which game cocks may be raised, which sit on two or three sets of eggs successively, so that chickens that are hatched are taken away and bred apart, and the bird sits 42 or 63 days.

2938. "The chickens being indeed first put in a basket, are suspended over a little smoke, but they take no nourishment during two days. Secure the vessel from which food is given them with cow-dung. . . . The house is also fumigated with one of the things that drive away reptiles. . . . There have indeed been found certain antidotes which preserve hens. If rue is tied under the hen's wings, neither a cat nor a fox, nor any other noxious animal, will touch them; and especially if you give them food with which the gall of a fox or of a cat has been mixed, as Democritus positively affirms."*

2939. Few eggs are worth the trial of hatching if more than a month old; their condition, however, is greatly influenced by the season and the state of the weather. An egg retains its freshness longest in moderately cool weather; very hot weather destroys vitality in a few days; and an egg having been frozen is also useless for hatching. Failures in hatching arise from want of impregnation in the egg—from age, commonly called staleness, whereby life has become extinct—from weakness of the vital energy of the eggs, produced by age, lowness of keep, or ill health of the parent, in which cases the chick partially develops itself, but dies before the full period of incubation. Eggs may be brought to life, but unless the process of incubation be properly executed, the birds will be weakly, ill-conditioned, and die in a short time afterwards. To prevent the yolk of weak eggs from settling by its specific gravity, and adhering to the shell, it is useful to pass the hand over them, so as to change their position every 24 hours. The egg of a strong healthy bird, at the time of its protrusion from the body, is completely filled with yolk and albumen. If examined a few days after, by holding it toward the light, a small cell of air will be discoverable at the larger end, which increases with the age of the egg. This waste of its internal substance is occasioned by absorption of the atmosphere, through the pores of the shell, of the more volatile parts of its contents. When the cell is large in any egg, it is unfit for incubation; nevertheless, in a good egg, as incubation proceeds, this cell becomes considerable, produced probably both from evaporation by heat, and the vital action going on within the shell. It also serves an important purpose in the economy of this mysterious process. An egg will not hatch in vacuo.

* Owen's *Geoponika*, vol. ii. p. 167-72.

2940. The progressive series of phenomena, daily observable during the process of incubation in the egg of a common fowl, are curious and instructive. In an impregnated egg, previous to the commencement of incubation, a small spot is discernible upon the yolk, composed of a membranous sac containing fluid matter, in which the embryo of the future chick swims.

1st day.—At the expiration of 12 or 14 hours after incubation has commenced, the matter within the embryo evidently bears a resemblance to a head—vesicles assume the shape of the vertebral bones of the back.

2d day.—In 39 hours the eyes make their appearance—vessels join together indicate the navel—the brain, spinal marrow, rudiments of the wings, and principal muscles—the heart is evidently proceeding.

3d day.—At its commencement the beating of the heart is visible—some hours after, two vesicles containing blood appear, one forming the left ventricle and the other the great artery—the auricle of the heart is next seen, and pulsation is evident.

4th day.—Wings assume a defined form—the brain, the beak, the front and hind parts of the head visible.

5th day.—Liver seen—circulation of the blood evident.

6th day.—Lungs and stomach distinguishable—full gush of blood from the heart distinct.

7th day.—Intestines, veins, and upper mandible visible—brain becomes consistent.

8th day.—Beak opens—formation of flesh on the breast.

9th day.—Ribs formed—gall bladder perceptible.

10th day.—Bill formed—first voluntary motion of the chick seen.

11th day.—Skull becomes cartilaginous—protrusion of feathers evident.

12th day.—Orbits of sight appear—ribs perfected.

13th day.—Spleen in its proper position in the abdomen.

14th day.—Lungs enclosed within the breast.

15th day. 16th day. 17th day. } Mature state approached—yolk of the egg still outside of the body.

18th day.—Audible sign of life outside the skull—piping of the chick heard.

19th day. 20th day. 21st day. } Increase of size and strength—yolk enclosed within the body—chick liberates itself by repeated efforts made by the bill, seconded by muscular exertion of the limbs.

2941. The embryo of the chick is not in every egg placed precisely in the same situation, but varies considerably. Generally it develops itself within the circumference of the broadest part of the egg; sometimes it is found higher, sometimes lower; and when held before a strong light, has an appearance, when a few days old, somewhat resembling the meshes of a spider's web, with the spider in the centre. As it increases in size, the bulk of the contents of the egg decrease, so that when the bird is completely matured, it has ample space to move, and to use its limbs with sufficient effect to insure its liberation. The position of the chick in the shell is such as to occupy the least space. The head, which is large and heavy in proportion to the rest of the body, is placed in front of the belly, with its beak under the right wing; the feet are gathered up like a bird trussed for the spit, yet, in this singular manner, and apparently uncomfortable position, the bird is by no means cramped or confined, but performs all the necessary motions and efforts required for its liberation with the most perfect ease, and with that consummate skill which instinct renders almost infallible. The chicken, when it breaks the shell, is heavier than the whole egg was at first.

2942. In regard to the original formation of feathers in the chick of a bird, M. Raspail has the following observations:—"If we examine," he says, "the epidermis of a *sparrow*, as it comes from the egg, we shall find that we can isolate each of the small bottles, which the vesicles that form the rudiments of hairs assume the shape of, as well as the nerve of which it seems to be the terminal development. It might almost be supposed that the object viewed was the eye of a *mollusca*, with its long optic nerve. The summit of this vesicle is open, even at its early period, to afford a passage for a cylindrical bundle of small fibres, which are also cylindrical, and which are nothing else than the barbs, as yet single, of the feather. If, afterwards, we examine a feather at a more advanced period, we may, by a little address, satisfy ourselves that its tube is formed and grows by means of spathæ, one within another, of which the external ones project over the inner ones, so that the tube seems as if divided by so many diaphragms. The interstices of these diaphragms are filled with a fatty liquid, which condenses in them gradually, as the summits of the spathæ approximate and adhere to each other."*

2943. The hatching of fowls naturally leads the mind to the curious artificial system of hatching which the ancient Egyptians practised, and which afforded them an immense supply of poultry every year. It is unnecessary to detail the ancient mode of hatching, as it is unsuited to this country, our climate being much too unsteady for the purpose; but particular accounts of it may be found detailed by authors.† The modern Egyptians still practise the system, and as the results exhibit some extraordinary facts, I am tempted to give the following account of it from Mr Mowbray:—"Sicard," he says, "gives an idea of the immense quantities of chickens hatched in his time in Egypt. The number of ovens for hatching the eggs, dispersed in the several cantons of the country, was no less than 386. The

* Raspail's *Organic Chemistry*, p. 283.

† Wilkinson's *Manners and Fashions of the Ancient Egyptians*, vol. i. p. 134.

business seems to be monopolised by the Agas or government, and therefore cannot be varied in extent but by their permission. Each *mamal* or oven has one managing Bermean, a native of the village of Bermé in the Delta, by whom the art of managing it has been retained, and is taught to his children. These managers cannot absent themselves from duty but with leave obtained from the Aga of Bermé, never obtained but at the expense of 6 to 10 crowns. The Aga constantly keeps a register of these fees, which to him is a sort of rent-roll. The above number of ovens is kept at work in Egypt annually during 4 to 6 months, allowing more time than is necessary to hatch 8 successive broods of chickens, ducks, and turkeys, making in the whole, yearly, 3088 broods. The number in each hatching is not always equal, from the occasional difficulty of obtaining a sufficient number of eggs, which may be stated at a medium between the two extremes of 40,000 and 80,000 to each oven. The Bermean contracts to return in a living brood to his employer, two-thirds of the number of eggs set in the oven; all above being his own perquisite, in addition to his salary for the season, which is 30 to 40 crowns, exclusive of his board. According to report, the crop of poultry thus artificially raised in Egypt was seldom or never below that ratio, making the enormous annual amount of 92,640,000. It is obvious that the apparent grand difficulty of obtaining a sufficient number of eggs must subsist chiefly or entirely in the infancy of such an undertaking, and that its progress must infinitely extend that supply, as has been the case in Egypt, where the breeding stock has been so multiplied, and where, in consequence, the commodity is so cheap from its superabundance, that, in the time of Sicard, 1000 eggs were sold for 30 or 40 medims, making 3s. or 4s. English money. Indeed, the chickens were not sold from the stores by tale but by measure; according to Raumeur, by the bushel! And it appears, from travellers of the present day, to be the custom in Egypt to purchase chickens by the basketful."*

2944. M. Raumeur, under the French Academy, instituted experiments to prove that eggs could be hatched in France as well as in Egypt; but it was soon discovered that the two countries were placed in different circumstances in regard to climate, and the project was abandoned as being impracticable. Plans of artificial hatching were tried with better success by M. Bonnemain, by a system of supplying heat from hot water in pipes; but the French Revolution put an end to the experiment. It is worth observing, in passing, how strange it is to hear of the circulation of hot water in pipes, as a steady source of heat, recommended at the present day as a *novelty*. "The theory and practice of hot water circulation," observes Dr Ure, "were as perfectly understood by M. Bonnemain fifty years ago, as they are by any of our stove-doctors at the present day. They were then publicly exhibited at his residence at Paris, and were afterwards communicated to the world at large in the interesting article of the *Dictionnaire Technologique*, entitled *Incubation Artificielle*."

2945. M. Felgeris, proprietor of the baths at Chaudes-Aigues, (Cantal,) followed the plan of hatching eggs by means of hot mineral waters, as recommended by M. d'Arcet. "This consists of putting the eggs into a small basket, suspending it in one of the stove-rooms heated by the hot mineral water, and turning round the eggs every day. The very first trial was attended with success, and no failure was experienced in four repetitions of it."†

2946. To supply the inhabitants of Great Britain and Ireland with fowls as the Egyptians are—namely, at the rate of 46½ fowls to each person every year—the number required to be hatched would be 1,109,000,000 of fowls!

2947. Some years ago a machine for hatching eggs, called the Eccaleobion, was in operation in London where I saw it. It was the contrivance of Mr William Bucknell, who published an interesting statement of his experience on the condition of the eggs, and his observations on the habits of young chickens. The machine I saw was capable of containing 2000 eggs, open to sight through glazed doors, in different states of incubation, from the first hour in which the egg was deposited in the machine, until the last when the bird left the shell. The sight was highly interesting, and I could have spent hours in observing the gradual mutation assumed by the egg. I presume the cost of supporting the heat in the machine had not been repaid by the sale of birds, as I have heard nothing of its existence for several years.

2948. At present, in 1848, is a machine in operation in London, named the Hydro-Incubator, belonging to Mr Cantelo. I do not know the particular construction of the apparatus, but presume from its name, that the heat required by it is generated by warm water. Mr E. Hulme of Clapham, says, in regard to this machine—"the first thing I saw in July last, was a four-tray incubator in operation. One of the trays was taken out, and I could hear numbers pecking at their prison-walls. Next was the drying nest, with numbers of chicks hatched that day. I felt the degree of heat on the under side of the waterproof cloth, and thought it admirably adapted. I next saw the different broods with their hydro-mothers, from a day old until they ranked as roosters. Next were the out-door runs, where there were hundreds of full-grown fowls, and the whole, from the smallest, looked in perfect condition. Yet it struck me, that the place out-doors was altogether unsuitable for the full development of the system."‡

2949. I lately saw an advertisement from Norfolk, offering for sale an *incubator* of so small

* Mowbray's *Practical Treatise on Domestic Poultry*, p. 81-90.

† Ure's *Dictionary of the Arts and Manufactures*—art. *Incubation, Artificial.*

‡ *Gardener's Chronicle* for 21st October 1848.

dimensions that it could stand in any room, and not only there hatch eggs, but brood and rear chickens. Such a machine bids fair to outdo the feats of hatching actually accomplished by James Sandy, the bedridden cripple of Alyth, by the heat of his own person.*

2950. Mr Fortune says, in reference to the hatching of ducks in China, "One of the greatest lions in Chusan is an old Chinaman, who every spring hatches thousands of ducks' eggs by artificial heat. His establishment is situated in the valley on the north side of the city of Tinghae, and is much resorted to by the officers of the troops, and strangers who visit the island. The first question put to a sight-seer who comes here, is, whether he has seen the hatching process; and if he has not, he is always recommended to pay a visit to the old Chinaman and his ducks. . . . The Chinese cottages, generally, are wretched buildings of mud and stone, with damp earthen floors, scarcely fit for cattle to sleep in, and remind one of what Scottish cottages were a few years ago, but which now, happily, are among the things that were. My own friend's cottage was no exception to the general rule; bad fitting, loose, creaking doors; paper windows, dirty and torn; ducks, geese, fowls, dogs, and pigs, in the house and at the doors, and apparently having equal rights with their masters. Then there were children, grand-children, and, for aught I know, great grand-children, all together, forming a most motley group; which, with their shaved heads, long tails, and strange costume, would have made a capital subject for the pencil of Cruikshank.

2951. "The hatching-house was built at the side of the cottage, and was a kind of long shed, with mud walls, and thickly thatched with straw. Along the ends, and down the sides of the building, are a number of round straw baskets, well plastered with mud, to prevent them from taking fire. In the bottom of each basket there is a tile placed, or rather the tile forms the bottom of the basket; upon this the fire acts—a small fireplace being below each basket. Upon the top of the basket there is a straw cover, which fits closely, and which is kept shut while the process is going on. In the centre of the shed are a number of large shelves, placed one above another, upon which the eggs are laid at a certain stage of the process. When the eggs are brought, they are put into the baskets, the fire is lighted below them, and a uniform heat kept up, ranging, as nearly as I could ascertain by some observations which I made with a thermometer, from 95° to 102°; but the Chinamen regulate the heat by their own feelings, and, therefore, it will of course vary considerably. In four or five days after the eggs have been subject to this temperature, they are taken carefully out, one by one, to a door, in which a number of holes have been bored nearly the size of the eggs; they are then held against these holes, and the Chinamen look through them, and are able to tell whether they are good or not. If good, they are taken back and replaced in their former quarters; if bad, they are of course excluded. In nine or ten days after this, that is, about fourteen days from the commencement, the eggs are taken from the baskets, and spread out in the shelves. Here no fire heat is applied, but they are covered over with cotton, and a kind of blanket, under which they remain about fourteen days more, when the young ducks burst their shells, and the shed teems with life. These shelves are large, and capable of holding many thousands of eggs: and when the hatching takes place, the sight is not a little curious. The natives who rear the young ducks in the surrounding country, know exactly the day when they will be ready for removal, and in two days after the shell is burst, the whole of the little creatures are sold, and conveyed to their new quarters."†

2952. "If chickens about 2 months old and upwards," says Mr Bucknell, "are turned in among a brood of young birds that have no mother, they will sometimes take to brooding and tending them with the delight of natural parents. The gratification being quite mutual, the young chicks run after and strive with each other for their favours with the most untiring perseverance. Although, probably, it is simply the pleasurable sensation derived from the genial warmth communicated by the young birds nestling under them which induces them to do it, it is nevertheless a striking and highly interesting picture to witness these mimic mothers acting the part of foster parents with so much apparent satisfaction, yet with the awkwardness with which a girl, in similar circumstances, fondles her doll." I never witnessed such an instance of affectionate regard, possibly because I never saw a brood of chickens deprived of their mother, but the sentiments conveyed in the following sentence I have frequently seen realised, and can testify to the accuracy of observation and the correctness of the conclusions of Mr Bucknell:—"There is no difficulty," he says, "in teaching the young of the various tribes of gallinaceous fowl to eat and drink; they perform these operations spontaneously, or from observation, as appetite prompts them. Are not the facts of the extraordinary fecundity of these tribes, their requiring no assistance in hatching, and their being self-instructed in the manner of taking their food, abundant evidence that an All-wise Providence ordained these peculiarities expressly for man's advantage; as in all those families of birds not so fitted for his use they do not exist, and consequently cannot be rendered by artificial means available for his benefit! Food is not necessary for the chick until 12 or 24 hours after leaving the shell. Sickly and badly hatched birds seldom can be induced to eat, and die from inanition. Birds but a few hours old recognise the person who feeds them; and in a few days evince so many and such pleasing traits of confidence in her as their protector and friend, following her steps, and clamorously repining at her absence, as must

* Mention is made of this extraordinary mechanical genius in the *New Statistical Account of Scotland.—Perthshire*, p. 1117.

† Fortune's *Wanderings in China*, p. 80.

induce in the most callous breast a delightful sensation of regard for their welfare."

2953. It is of some importance to farmers to have the question answered in a practical sense, Whether the hatching and rearing of *chickens* is profitable? Mr Bucknell's answer to this question, in reference to artificial hatching is this—"Mr Mowbray, in his standard work, gives the consumption of food by birds in the highest state of condition as follows:—'By an experiment made in July 1806, a measured peck of good barley kept in a high style of condition the following stock, confined, and having no other provision: 1 cock, 3 hens, 3 March chickens, 6 April, and 6 May chickens, during 8 clear days, and one feed left.' Here, then, are 19 birds, varying in age from 2 months to their full size, consuming 1 peck of corn in 8 days, which, at 1s. per peck, gives a cost of 1⅛ halfpenny per head, which, however, is considerably above the cost of *chickens* for the first 8 weeks of their existence. But, taking it at this high average, it gives an expense of each bird of 9d. all but a fraction for 14 weeks' keep, at which age they are in the highest perfection, being the most delicate and easy to digest of all other animal food. Where they can enjoy the advantage of a good run, the expense would still be lessened perhaps one-third. Now, what is the price at a poulterer's, or in the London markets, of a fine fat chicken 14 weeks old of nearly its full size? Never less than 2s., and for 6 months in the year, or during the dear season, 4s. or 5s.; which, adding to 9d. an additional 3d. for the value of the egg and extras, gives the enormous profit of from 400 to 500 per cent, divided between the trader, the middleman, and the retailer. It need not be wondered at that such is the case, nor can it be otherwise while the present system continues. A poulterer whose sale is not more than 10 dozen per week, must keep a man and a horse and cart, and attend the different markets for his purchases. All these things, with incidental expenses, will amount at least to 2 guineas per week, which 2 guineas must be spread over the 10 dozen birds before he derives any profit for himself. Upon any artificial system, these expenses would be saved, and the 2 guineas thus thrown away would keep 1000 birds, averaging all ages, 1 whole week. Buildings and machinery, and other necessary apparatus being provided, no objection exists as to the expenses of hatching. An eccaleobion machine might be constructed, only requiring regulation once in 24 hours, capable of hatching throughout the year 10,000 eggs per month, (a week being allowed for removing and refitting,) while the cost for hatching during the month would probably be a half chaldron of coke at £1 per chaldron, which would be the one-twentieth part of one farthing per bird. The expense for artificial warmth during the time the birds might require it, would be somewhat more—perhaps 1 farthing per bird."

2954. *Diseases of Poultry.*—With the diseases of chickens or other young fowls, such as the *pip* or *chip*, I am not acquainted, not having seen any such disease after an experience of many years in rearing every species of fowl on a farm; and am therefore inclined to maintain, that were others to follow a similar course to the one I have described above, they would be equally unacquainted with diseases amongst their poultry. I am corroborated by a writer on the rearing of domestic poultry, whose experience I know is considerable,—whose attention I am sure is unremitting,—and whose good sense is evident. "Of the diseases of which poultry are liable, we are practically ignorant," says the writer, a lady of my acquaintance, "having been for many years here so fortunate as to experience few or no instances of disease among our stock; and we attribute the health of our various animals in the farm-yard *entirely to strict attention to cleanliness, diet, and rational treatment.* Those who listen to the advice of the ignorant and the prejudiced, nay, they who seek from books remedies for disorders which may appear among their live-stock, will have to contend with monstrous absurdities, excessive ignorance, and barbarous cruelty, in the quackeries recommended. Nature will generally effect a cure, if her efforts are seconded by simple means on our own part. Calomel, sulphur, rue, pepper, and gin, are all absurdities, though all recommended for the ailments of poultry." Another writer thus expresses himself on the same subject: "With regard to medical treatment applied to the diseases of poultry, but little regarding its efficacy is known. The nostrums and mode of treatment adopted throughout the country, together with the greater part that has been written upon the subject, is a farrago of nonsense and absurdity. *If shelter, warmth, food, and cleanliness, congenial to their habits, will not preserve them in health, but little reliance can be placed upon medicine.* Most good wives, however, possess an insatiable itching to be considered skilful doctors. From among some thousand birds that have come under my observation, *I never could discover that common and universal disease* called the '*pip.*' Yet show any farmer's wife a sickly chicken, and she immediately opens its mouth, and with her needle tears off the cartilage from the under part of the bird's tongue, to show it is afflicted with it! When will the light of knowledge banish these absurdities?"*

2955. The former writer, however, alludes to an ailment among chickens which I have never seen, arising, it would appear, from their being hatched at a particular period of the year. After adverting to the tender state of chickens superinduced by both early and late hatching, the writer particularises the period of the year when the disease alluded to makes its appearance.—"There is yet another time, during which it is *absolutely indispensable that hens be prevented from sitting, and that is the month of June.* Close observation (after having suffered at that season numerous failures most unaccountably) enabled

* Bucknell's *Eccaleobion*, p. 1-17.

us to discover the cause, and thereby verify the truth of an old saying, which we have since met with—

Between the sickle and the scythe,
What you rear will seldom thrive.

We had noticed that chickens which were hatched during the month of July, were almost all attacked about the time of their first moulting (a period always attended with much suffering to them) with a fatal disorder, the symptoms of which are unvarying. The chickens appeared to collapse, and moved about with difficulty, as if their joints were stiffened, or rather as if the skin had become tight and tender; their feathers became rough and stood out; their wings drooped and dragged on the ground; they refused sustenance; and becoming more and more weak and torpid, they, in a day or two, died off in great numbers. Every rational means were resorted to in order to arrest, or even account for the disorder; at length it was discovered that they were in a high state of fever, and that the extreme redness of the skin was caused by the irritation of hundreds of that minute pest, the harvest-bug. Some—very few—were recovered by anointing them all over with oil and vinegar (which is also the best, nay, the only remedy for the annoyance which human beings experience from the same source;) but the receipt is too rough for little delicate creatures already enduring the pain attendant on the season of moulting. It became obvious that the period during which harvest-bugs are most numerous and tormenting, must be inimical to the rearing of chickens; and that if hens were not allowed to sit in June, or rather, if the chickens were either strong enough to cope with the evil, or were not hatched until the season for the pest had passed by, the destruction might be prevented; and so it has proved."*

2956. *Harvest-bug.*—This is a short account of the harvest-bug. "You have already, perhaps, been satiated with the account given of our enemies of the *Acarus* or *mite* tribe," says Mr Kirby or Mr Spence; "there are a few, however, which I could not with propriety introduce here, as they do not take up their abode and breed in us, which nevertheless annoy us considerably. One of these is a hexapod so minute, that, were it not for the uncommon brilliancy of its colour, which is the most vivid crimson that can be conceived, it would be quite invisible. It is known by the name of the harvest-bug (*Acarus autumnalis*, Shaw,) and is so called, I imagine, from its attacking the legs of labourers employed in the harvest, in the flesh of which it buries itself at the roots of the hairs, producing intolerable itching, attended by inflammation and considerable tumours, and sometimes even occasioning fevers."†

2957. *Capons.*—Capons of the common fowl are formed both of the cock and hen chickens, when they are fit to leave the hen, at about 6 weeks old. Chickens are transmuted into capons by destroying the testicles of the male and the ovaries of the female. The testicles are attached by a membrane to what is called the *back bone* of the carved fowl. They are destroyed by laying the bird on its near side, keeping it down, removing a few feathers, and making an incision through the skin of the abdomen, and, on introducing the fore-finger through the incision, first the one and then the other testicle is obliterated or removed altogether by it. In the case of the hen, the ovary is nipped off by the thumb-nail, or cut off by a knife. The incision is stitched up with thread, and little danger is apprehended of the result. The effect of castration is enlargement of the body of the fowl, an increased delicacy of its flesh, but its flavour is in no way improved, at least in none of the capons I have tasted. Time was when capons were more plentiful at the table than chickens, so that even kain-rent was paid in them; but the conversion of fowls into capons is now abandoned in Scotland, as an unnecessary and troublesome operation, and will not probably be resumed as long as a well-fed delicate chicken can be procured with little trouble, although the London market is always well supplied with them.

2958. *Poullards.*—Turkey poults are converted into poullards by the same operation as described above, to convert the common fowl into a capon, and it produces similar effects upon the turkey.

* *Quarterly Journal of Agriculture*, vol. viii. p. 515-23.
† Kirby and Spence's *Introduction to Entomology*, vol. i. p. 103.

END OF VOLUME I.

APPENDIX TO SPRING.

BY JOHN P. NORTON, M.A.

PROFESSOR OF SCIENTIFIC AGRICULTURE IN YALE COLLEGE, NEW HAVEN.

THE first weeks of this season, in the climate of the New England and other Northern States, are not ordinarily of such a nature as will permit the farmer to pursue his various avocations in the open air. In these latitudes on our continent, although they correspond nearly with the South of France, where the climate is almost tropical, winter continues its reign far into the spring months. Snow often lies on the ground until April, and in some seasons much later. Even when the severity of the season relaxes in March, it is but for a brief period; frowns and dark storms soon obscure the smiling face of nature, which seems to have treacherously allured birds from their southern winter residence, and caused little early plants to show their budding flowers, only to overwhelm them by the severity of a second winter. A warm, open March, in the Northern States, generally indicates a backward, stormy April.

Still these are interesting months; for it is delightful to watch the struggles of the coming summer with the reluctant departing winter. It is pleasant to see, that amid all its apparent reverses, spring makes a steady and sure advance: now it is proclaimed by the charming song of the first bluebird, breaking forth when some hour of sunshine lights up the yet wintry landscape, with a warmer glow than the pale beams which have before seemed to harmonize with snow and ice: now by the mezereon and the crocus showing their blossoms hardily from beneath a sudden dash of snow, as if they felt that its reign was almost over, and its power to freeze their vitals gone.

When the final triumph of spring does come, it is sudden and beautiful, even glorious, in the quick development of luxuriant verdure. Often within the space of a single fortnight, the great majority of the trees burst forth into full leaf; flowers bloom on every side; and it is difficult to recall the wintry aspect of a few days before, when, looking at nature under the influence of a gloomy day, scarcely any progress seemed to have been made. But, in reality, the preparations for this seemingly almost instantaneous change have been long maturing: for weeks before the final time of opening, careful observers might have discerned a gradual increase in the size of the leaf buds, and a loosening of their outer envelopes; for weeks before this even, an incision into the trunk would have shown that the bosom of mother earth was beginning to throb again, to send the life-blood—the sap—once more through the limbs of her children; thus commencing anew a series of mysterious changes, to result as always before, in the fulfilment of the promise, "that while this world lasts, seed-time and harvest, summer and winter, shall not fail."

It is at this early period, when the sap first begins to ascend, that the making of maple sugar commences in the Northern States. Twelve or more species of the maple are indigenous to the North American continent, but of these only the *Acer Saccharinum* (common sugar maple), and the *Acer Nigrum* (black sugar maple), yield a sap sufficiently saccharine for manufacturing purposes. This sap varies in strength, but is generally considered to contain about half as much sugar as the sap of the sugar cane. The sap begins its upward flow in the latter part of February, or early in March, while the frost is still severe, and snow on the ground. It runs most freely when the days are bright and sunny, with sharp, clear, frosty nights.

The trees are not usually tapped regularly until they are at least thirty years old. Many are accustomed to do this by cutting out a kind of box with an axe, but, as ordinarily managed, this puts an end to the life of the tree much more quickly than any other way. The plan generally recommended is, to bore, according to the size of the tree, one, two, three, or four small auger holes, and into these insert tubes, which conduct the sap into wooden buckets or troughs placed beneath. These small auger holes soon fill up in the natural growth of the tree, and many instances are known of such tapping during a period of thirty years without perceptible injurious effects. It is, however, supposed that the trees last longer, and yield better, for an occasional year of rest.

When the trees stand closely together, as in the forest, about 4 lbs. of sugar per tree is considered the average yearly product; but where they are more widely separated, as in pastures, the average is often as high as 6 or 7 lbs. When a large tree is tapped in many places, a much greater product is often obtained. An instance is recorded of 22 lbs. from a single tree, and another of 136 lbs. from twelve trees. Such a draught as this is too much, and no tree can endure a repetition of it for many years in succession.

The process of manufacture is not unlike that pursued with the juice of the sugar cane, and with proper care a sugar may be obtained fully equal in every respect to the finest cane sugar. There are some farmers in Vermont who make three or four tons annually. The Patent Office Report for 1848 estimates the maple sugar crop of the Union at 30,000,000 pounds. There is scarcely any branch of agriculture more worthy of attention than this, in many portions of our Northern States. When the trees are once planted, and growing, very little further attention is required. They may be grown on rough, otherwise unprofitable, land, and with proper management will last a century.

If we allow one tree to each square rod, or 160 to an acre, and 4 lbs. of sugar from each tree, we have 640 lbs.,—worth, when well made, $64:—$20 would fully cover the expense of manufacture, leaving $44 as profit. This, too, is from land that as unimproved pasture, would do little more than pay for fencing. The labor comes at a season when the farmer has little else to do.

Old maple orchards, well cared for, usually produce more than 4 lbs. to the tree. The Patent Office Report for 1845 mentions a product of 1500 lbs. from 250 trees, or 6 lbs. per tree. During the first ten or fifteen years the value of the land for pasture would scarcely be diminished; indeed, if very poor previously, it might improve by the annual top-dressing of leaves.

2137 to 2141. The phenomena of easterly winds are as well known on the eastern portions of this continent as in Scotland. The character of this wind is, however, different here. To Scotland the east wind comes over the continent of Europe, and consequently is a dryer wind than any that they have, for in all other directions the winds come off from the broad Atlantic—charged, of course, with vapor and moisture.

Here our west winds proverbially bring fine weather, and are dry. With us also the easterly winds, in spring, seem for a time to diminish the force of the westerly currents which prevail at other seasons of the year. In par. 2140 is mentioned the fact that the north-east and south-west are the two leading currents of the globe. In the region of the Northern States then, if this be true, we are in a minor current, for our prevailing wind is north-west.

A Report of the Regents of the University of the State of New York for 1843 mentions, as the result of a table compiled from observations during seven years, in fifty towns, that the prevailing wind of the State, during each of those years, was north-west.

The southerly and easterly winds are, on the eastern side of the North American continent, the only winds that bring rain, with the exception of passing showers from other directions. The fact then, that the north-west wind is a land wind, and that it is the prevalent one, seems to explain satisfactorily the great number of clear days which we enjoy in every season.

In consequence of the general clearness of our atmosphere, we are accustomed to consider our climate dry in comparison with that of Great Britain, and without doubt we are correct; yet it is a singular fact that the mean amount of water which falls here as rain, snow, or hail, considerably exceeds the mean estimated for England and Wales, by Dr. Dalton. He gives 34 inches per annum, and Dr. Kane mentions the same depth as the mean for Ireland.

Observations during a period of sixteen years at Yale College, Newhaven, Ct., indicate the total amount of water that has fallen during that time as $712\frac{26}{100}$ inches. This gives the very high average of $44\frac{52}{100}$ inches. The largest quantity in any one year was 51 inches. The depth of snow varied still more than that of rain water. In the winter of 1846–7 the quantity measured was 61 inches, in that of 1847–8 but 20 inches. The depth of water obtained by melting the snow seldom exceeds 6 or 7 inches.

In the State of New York an average is found a trifle lower than that of Great Britain. This is shown by a mean of the observations made during a period of ten years, at fifty different points. The mean thus obtained is $35\frac{10}{100}$ The lowest mean of any single year was $30\frac{75}{100}$ in 1833, and the highest $44\frac{40}{100}$ in 1827. At one place the fall for a single year was as high as $55\frac{66}{100}$ inches; at another, as low as $17\frac{30}{100}$.

The State of New York may be considered an example of the inland or middle States, its extent of territory being about the same as that of the island of Great Britain. The annual fall in Newhaven probably does not vary greatly from that in most parts of the New England States that border on the sea. In some sections of Ohio the annual fall of rain is more than 40 inches; the mean of the State, however, for a series of years, is considered to be about the same as that of New York.

But though our mean amount of rain is thus shown not to be in any case materially less, and often much more than that of Great Britain and Ireland, our climate and soils are really much dryer, for the reason that our rains fall in a different manner. The same amount of rain which falls in the United States in the space of two or three hours, or at most in half a day, in England spreads itself leisurely over perhaps a fortnight. Our rains are usually heavy, but not of long continuance. Excepting the periods of the equinoctial storms, and in some particular localities, rain storms seldom continue more than from twelve to twenty-four hours—rarely so long as the latter period. The meteorological reports of New York for 1842, from forty-four points, show, in about half of the reports, a decisive preponderance of the clear days over the cloudy; ordinarily not much more than half of these cloudy days were rainy. On an average, snow or rain would seem to have fallen in greater or less quantities during from 80 to 100 days of the year. It is to be remembered, also, that the rain on very many of these days was merely in the form of passing showers.

If we compare this statement with the number of days in England that are rainy during the year, as mentioned by Mr. Stephens—178—it becomes quite plain that the popular opinion as to the superior dryness of our climate is correct. The rain falls heavily, but then the sun comes out and dries it up, so that the soil is in most cases soon freed from its surplus water. Early in spring, and usually till July, showers and rains are frequent; but at or about that period we generally have some weeks of fine clear weather, frequently almost uninterrupted.

2170 and 2171. The recommendations as to cottage gardens are well worthy of attention. Whenever a laboring man can procure a small plot of ground for his own cultivation, no labor that he expends will afford him so much gratification. It is not to be expected, however, that a taste for gardening should become very widely diffused, until the farmers themselves, as a class, show more interest in the subject than they do at present. In travelling through our country villages, we here and there see a neatly-kept garden, with a fine show of fruit and flowers, and bearing evidence of care. But the great majority of the so-called gardens are neglected looking places, where, in the early part of the season, are planted a few potatoes, squashes, and beets, some hills of sweet corn, and perhaps a root or two of dill and fennel. Here and there may perhaps be seen a few common lilies or poppies, memorials of some transitory visitor, or of some passing hour of floral enthusiasm. Towards the close of summer, the weeds, which were at first partially kept down, obtain the advantage, and finally become the prominent feature of these *gardens.* It is actually the case, that the inhabitants of many country villages can scarcely be said to enjoy the luxuries of the country. Their strawberries, raspberries, peaches, plums, grapes, &c., are neither so fine, so abundant, nor so cheap, as in the large cities. There are hundreds of farmers' families where fruit, excepting apples, and perhaps wild berries, is almost unknown.

This is simply because they will not devote the small amount of time that is required for the cultivation of good fruit. It is astonishing how little exertion is necessary: three or four hours during each week, early in the morning, or just at dusk, will keep a family amply supplied with delicious fruit, thus adding most materially to the comfort and the attractions of their home. Even if profit is the only object, a small space of ground carefully cultivated in fruit will pay better than many a large farm, exhausted by constant drafts upon its resources with small returns. I have seen farmers in the country who had large, rich gardens, neglected and overgrown, eagerly paying handsome prices for fruit to some one who had the enterprise to pursue a different course, and attend to a species of cultivation which they probably considered beneath them, or had not sufficient energy to undertake.

2176. The advice here given, as to the improvement of every moment in winter, and in early spring, for the advancement of work, will apply to the milder climates only of this country: in the whole northern part all that can be done is, to finish threshing and every species of in-door work, and to see, as before advised, that every tool, implement, harness, cart, wagon, &c., is in order for the approaching season of activity.

2181 to 2244. The remarks and directions by Mr. Stephens, relative to the calving of cows, and the accidents and diseases to which they are liable at this period, constitute an important practical treatise, which will be attentively studied by the owners of particularly valuable animals.

The system pursued is, it will be seen, much more defined and elaborate than anything known in this country. So far as my experience and observation go, cows in calf, when their milk fails, are placed with the young stock on some distant pasture. The general intention is to bring them home a few days before the time of calving; but it often happens that the calf is born in the field, and nothing known of its appearance for some time. If it is in a wild mountain pasture, the cow is almost sure to hide her calf, and does this so skilfully that I have occasionally known many days to pass before it could be found. In most cases, or at least in very many cases, when at home, the cow is left to the unassisted operation of nature, and instances of fatal results are, I think, rare. In times of difficulty, a council of village authorities generally devises some means of relief.

The subject of milking, also included under these paragraphs, is doubtless deserving of more attention than it has ordinarily met with in this country. This important operation is frequently left at night to hired men, who have already done a fatiguing day's work, and who, under such circumstances, hurry through with the business as rapidly as possible, often losing their good temper, and abusing the cows, thereby rendering them in many cases permanently wild and vicious.

2252. The milk pail. Fig. 197, does not seem to me of so convenient a pattern as the common pail, with a movable handle to fold down upon the top. The upright handle would be often in the way, and is extremely inconvenient when it is necessary to carry the pail full of milk. It would be excessively fatiguing to carry two pails of this kind at the same time for any distance. Tin is very commonly used in this country, and is perfectly convenient; it is light, easily kept clean, free from all taste or injurious properties, and, with care, quite lasting.

2268 and 2269. The operation mentioned in these two paragraphs is one which is novel to me, but which is recommended by a high authority as practicable. In many cases, as for the supply of families, for the purposes of city dairies, &c., cows of this kind would be extremely valuable.

2302. The sowing of spring wheat. This follows soon after the disappearance of snow, whenever the ground is found to be in a fit state for working. This period extends from the 1st of April into May. The culture of this variety of wheat has become quite extended in this country; but the quantity is still very small, when compared with that of winter wheat; on soils where this latter variety succeeds, spring wheat is rarely cultivated. The advantage which it has over the autumn-sown grain, is that of escaping the alternate freezing and thawing of winter, always so destructive on many soils, and which occasionally cuts off a great portion of the crop in the best wheat districts. It also, in most cases, escapes the Hessian fly and other dangerous insect enemies.

On the other hand, the crop is not usually so large as that of winter wheat, nor the flour of so handsome quality. It has much gluten, and makes excellent bread, but is of too yellowish a tinge for superfine flour. The crop is also very liable to rust in some sections.

These reasons have been sufficient to banish it from many farms, where it was first in high favor, and I am inclined to think that its culture is not increasing.

The districts where it has been principally sown, are the northern part of the State of New York, the States of Vermont, of Maine, and of New England generally.

There is a great number of varieties; those most prominent are the Italian, the Tea wheat, or Siberian bald, and the Black Sea.

2327. The broadcast sowing machine, Fig. 204, and the drill machines, Figs. 205 and 206, will not, in the Eastern States, supersede hand sowing for a long time to come; but in the Western States, where a farmer sows immense fields of grain on level mellow land, they are adapted exactly to his use, and have indeed already begun to make their appearance. I have noticed specimens of such machines at agricultural fairs, and have found that a conviction of their value was gradually spreading. Those that I have seen have been close imitations of some English or Scotch machines, though somewhat more simple in form, and much cheaper in price.

The practice of drilling wheat and grain generally, is, I think, decidedly gaining in favor; the results of a trial commonly being quite satisfactory. Some farmers, indeed, I am happy to say, are even beginning to think of weeding wheat in connexion with drilling it. A few years ago, and even now in many places, the mention of weeding a grain crop would have excited the most unmixed ridicule and contempt to be poured upon the unlucky innovator.

2345. The wooden rhomboidal harrows, Fig. 207, recommended by Mr. Stephens, have become very generally known in this country; they have, to a great extent, displaced the rude triangular and square implements, with six or eight huge teeth, which may still be seen in many places, caricaturing the process of pulverization by harrowing. I am not aware that the iron rhomboidal harrows, Fig. 208, have been introduced to any extent; indeed, while wood is so cheap, and will make so durable an implement, this variety is not likely to prove successful.

Within a few years, a new description of folding harrow has met with very general favor. It is known as the Geddes harrow, from the name of its inventor, Mr. George Geddes, of Onondaga Co., New York. Cuts of it may be found in all of our leading agricultural papers.

This implement appears to possess several advantages over the rhomboidal harrows.

1. It draws easier; because the line of draught passes through the centre, and there is none of the hitching vibrating motion which the double rhomboidal harrow always has, particularly in rough ground.

2. It is also more readily cleared from any foul stuff, as either side may be easily lifted while the harrow is in motion.

3. It accommodates itself more completely

to unevenness of surface; and on new land, where there are stumps and stones yet remaining, its shape permits it to glance off without being entangled or broken. In some cases, it is almost impossible to accomplish anything with other double harrows in such places.

The teeth of this harrow are usually made so as to track two inches apart, from centre to centre; on new rough land, the distance should be about four inches. Some farmers use a single rhomboidal harrow, or a simple square drawn by one corner. These must be made large to do much work, and being all in one piece, are consequently heavy and cumbrous. Being perfectly stiff and unyielding, they cannot accommodate themselves to inequalities of surface, and only work well where the ground is very smooth and mellow.

Where there is much foul stuff to clog their teeth, or where there are stones, stumps, and roots, the management of them becomes extremely laborious, and their operation quite imperfect.

2353. In this paragraph is a hint well worthy of notice. It is quite obvious that a quick motion of the harrow will pulverize and stir up the soil more effectually than a slow dragging one. For this reason, horses usually make better work in harrowing than cattle. A thorough and complete performance of this work is, as Mr. Stephens says, of more importance than is generally imagined; and increased attention to the harrowing is always to be seen on farms where the work of improvement has commenced in earnest.

2367. The Presser Roller, Figs. 211 and 212. This is an implement highly approved of in England and Scotland, and doubtless is of much value for light land. I doubt, however, if it will be introduced here to any extent, in the present state of our farming; there are many more important improvements for us, which will be adopted first. Such slow and expensive operations will never pay on land that has not previously been well manured and enriched. All the pressing in the world cannot make a poor worn out soil produce a heavy crop. It may, in consequence, yield more than it would otherwise have done, but the increase will not be enough to pay for the extra expense. We must bring up our soils to a fair state of fertility, before we launch deeply into what may be called the *luxuries* of farming.

2380. I can add nothing in the way of direction to the full instructions and descriptions given here.

This point of particularity and of finish in ploughing has met with much attention of late, and in consequence, the improvement has been very marked and encouraging. The character of our ploughs, and of our ploughing, compared with what both these were but a few years ago, is sufficiently decisive as to the change that has taken place. All of our reasonable and inquiring farmers have become convinced, that ploughing does not mean simply turning up the surface of the soil in an irregular and slovenly manner, with a plough that bobs in and out of the ground a dozen times in the course of each furrow; but that it is an operation to be performed with a good implement, and with great care; the intention of which is, to leave the field in a thoroughly light and pulverized state, to as great a depth as possible or advisable.

On reading such directions as these, evidently drawn from everyday practice on the best farms, we see, that notwithstanding our great advance, we have still much to do.

I am inclined to think that, in the extreme Northern States, the drilling of land to lie through the winter, although beneficial, is not, owing to the difference in climate, efficacious to the same degree as in Great Britain. There the ridges are exposed to successive frosts and thaws during the whole winter, so that the lumps and clods are, by the alternate expansion and contraction, thoroughly broken and crumbled down: here the frost, once set in, often remains unrelaxed till far into the spring, so that its action upon the land is comparatively quite limited.

The double mould board plough, Fig. 214, must be an excellent implement for forming drills, and worthy of adoption.

If the cultivation of root crops, as turnips, carrots, &c., gain ground in this country, drilling will become a more important operation than it is at present, particularly where the portable manures, as guano, poudrette, bone dust, &c., are used. Many farmers are now practising drilling in their potatoes after the Scotch fashion. All those who have tried this, will perceive from the result of their own experience, that the precautions and the nicety of work recommended here are not superfluous, but absolutely necessary to insure a full and even growth of the crop. The great difficulty in most fields of drilled potatoes that I have seen among us, has been irregular covering, so that the crop came up unevenly. This, of course, is only to be obviated by following these very directions just referred to, which may have seemed at first ridiculously precise and notional.

2407. Beans, of the kinds grown in Great Britain so extensively as a field crop, are almost unknown in this country, for the reason that both beans and bean meal are scarcely ever fed to stock. They are, as analyses already cited have shown, an exceedingly nutritious food for working animals; but while we can grow Indian corn with so much greater facility, it is not probable that we shall find any advantage in their cultivation on an extended scale.

The small white bush bean, grown so extensively for the table, and which is capable of flourishing on the poorest light soils, is an entirely different crop. The English horse bean requires, as mentioned in par. 2410, a rich mellow soil. It has a strong straight upright stalk, requiring no support, and these stalks, under the name of bean straw, are, unlike any of ours, valued for fodder.

The powerful grubbers, Figs. 215 and 216, may very probably be viewed with much astonishment and suspicion by many of our farmers: indeed, Fig. 216 looks like a new variety of locomotive engine, that would work of its own accord, and tear up everything in its path. I can say, from personal observation, that these machines make excellent work: but think that, like the presser before mentioned, they belong to a higher stage of cultivation than has been attained on most of our land. Strong as they are, they would not bear the work of newly cleared forest land, even if a team powerful enough to draw them through could be found; and the long cleared farms must be brought up by cheaper means, before we can afford to employ machines costing about $75 each, and requiring very heavy teams to drag them even at a slow motion.

The operation of these large grubbers, it will be perceived, is a sort of subsoiling; it being intended to stir up and mellow the lower soil, without affecting the upper. The tines are so shaped in both figures, that roots, bunches of weeds, &c., will gradually work their way up to the surface, and be left there. They are, indeed, sometimes used for the especial purpose of cleaning land that is foul.

It would be very difficult to work them on land that had not been already ploughed deeply and subsoiled; at least they could not, on most soils, be worked under such circumstances to their full depth.

2433. An implement like Fig. 218 would be quite useful for the purpose which is here assigned to it, of spreading the manure in the bottom of the drills. It is far inferior to our more elegant and convenient fork for all other purposes, and in fact is quite as heavy as one of the largest sized six-tined forks now used here. The short straight stiff prongs are, however, very useful for the purpose referred to above.

2434. Implements like the drill barrow here figured, Fig. 219, have been largely introduced. The difficulty with most of them is, that they will only drop seeds well in a continuous stream. They also, for the most part, are found defective when it is attempted to sow large seeds, such as corn, or beans, or peas. With seeds that are rough and rather bristly, such as those of the beet, they almost invariably fail. I have seen a number of them tried with beet seed, but never knew one succeed in dropping them evenly. With the small seeds too, such as those of turnips, there are few of them that work well. They are apt to drop the seeds irregularly, now leaving blanks, and then dropping twenty or thirty at a time. The disappointment in the turnip and other crops, arising from the use of these imperfect drill barrows with which the country has been overrun, has led many farmers to entire discouragement in the cultivation of roots.

Another obstacle to the very extensive use of drill barrows, is the fact that few of them will drop seeds otherwise than in a continuous line. The favorite way, and probably the best way of planting Indian corn, is in drills, and therefore most of the barrows are useless for this exceedingly important crop. The drill here figured would not answer such a purpose, nor do any of the common ones of other constructions that I have seen.

There is, however, one barrow to which my attention has been lately called, the principle of which is evidently valuable and correct. I have seen it under the name of "Page's Improved Seed and Corn Planter," but there may be other names and other inventors of the same principle. The part which drops the seed is an endless belt with cups on it at certain distances, of different sizes for different seeds. In planting corn, each of these cups, in passing through a reservoir of seed, takes up five or six kernels, and drops them at intervals, regulated by the rapidity with which the machine is driven, and the distance between the cups on the belt. A small coulter runs just before the tin tube into which the cups discharge their loads. This excavates a furrow deep enough for the seed bed, and a broad rather heavy wheel running behind, covers the seed when dropped. It is said that one of these barrows will plant ten acres in a day, but I have no experience as to the accuracy of the statement. There is no doubt but it would go over the ground; but I should fear that with so swift a motion as would be necessary, the work might be imperfectly done.

The principle of this barrow is unquestionably a good one, and capable of being brought to great perfection. There is no liability to choke, and there are no small holes to be stopped by a sudden rush of seed. The upper part of the belt, too, may be left uncovered, so that the person who has the handles can always see if the cups are running full, and if they discharge themselves properly. The conducting tube can be made so large at the bottom, as to obviate all danger of its choking there. I suppose that belts are made for this barrow in sets, leaving different sizes of cups for the various kinds of seeds that are to be sown.

2438. I do not see that any particular advantage would arise from attaching a seed sowing apparatus to a plough; as described here, it would embarrass and hinder the ploughman in various ways, and I should think that the consequence of adding so much machinery would be, that neither the sowing nor the ploughing would be effectually done. I have, however, never seen this apparatus at work, and it may go better than I have thought.

2443. The drill harrow, Figs. 220 and 221, is an implement that I have never seen or heard of in this country, and I am inclined to think that it is by no means universally employed, even in Great Britain. I have, however, seen it there on many farms, and heard it highly spoken of. The form will at once explain its object; it is intended to run lengthwise on the drills, and by its semicircular shape to embrace and pulverize every portion of them, the sides and hollows, as well as the tops. It is run along the drills of potatoes, as well as beans, soon after they first come up. One might naturally suppose that injury would be done to the young plants, but on the contrary, they seem to flourish under this rough treatment. The earth around them is thoroughly broken and loosened, and weeds are also in a great measure destroyed. A work is thus done by this harrow which could not be done by a flat one, the use of which, under such circumstances, would be destructive to a great portion of the crop.

2452. Peas are a much more common crop in the United States than beans, but still have not usually been considered of sufficient importance for insertion in the Patent Office Reports, among the statistics of other crops.

A variety called the cow pea has been much recommended at the South and West for fodder. It is often cut green, and stacked in layers of about one foot in thickness, with some dry straw or common fence rails between each layer; a plentiful sprinkling of salt is necessary at the same time. It is almost superfluous to state that the *rail practice* is not recommended where straw can be had. If great care is not taken in the curing, when this is attempted to be done in the ordinary way, the leaves drop off, and nothing but dry stalks remains. When cut at the right time, and properly saved, it is a fodder of much value, and the produce per acre is very large.

This plant is also extensively employed as a fertilizer at the South, where the summer heat is too intense to allow the growth of heavy clover crops. Its vine being large and long, a great bulk of organic matter is added to the soil when it is ploughed in. Two crops may be turned under during a single season. Some planters pasture stock upon the second crop. The increased weight of the animals while feeding is thus lost to the land, but, on the other hand, the vines are trampled down and consolidated, so that they are more easily covered by the plough: the droppings of the stock also constitute a dressing of manure immediately available for the next crop.

In the North, a favorite mode of cultivating peas is to sow them with oats, in the proportion of one third to two thirds. A variety which has a light vine should be selected, as that is not so likely to overrun and bear down the oats.

When peas are cultivated alone, they are got into the ground as early as the season will permit. From three to four bushels per acre is the quantity usually sown. Small light ploughs, sometimes arranged in *echelon*, or *gangs*, are preferred for covering them. When it is attempted to cover so large a seed with the harrow, many are unavoidably left upon the surface and lost.

In the statistics of the State of New York for 1846, I find that, while the whole number of acres under cultivation in the State was 11,737,276, there were 117,379 acres in peas, and but 16,232 acres in beans. The largest crop of peas per acre was 56 bushels, the largest crop of beans 114 bushels The average product of all the acres sown to both crops was small. There are, in fact, very few cultivators who do justice to either of these crops: the bean particularly is sown upon land which will scarcely bear anything else, and which, therefore, goes by the opprobrious name of white bean land. Under these circumstances the crop is naturally small and insignificant. If the treatment were such as has been described to be the practice in Great Britain, and some of their varieties tried, the result would doubtless be very different; and the crop would rise into more estimation, as one to be occasionally grown with advantage.

A mixture of peas and beans, sown as recommended in par. 2455, would doubtless be successful. I should like to see this crop tried, and the whole mown and cured like hay, while the stalks were yet quite green, and the seeds unripe. I am inclined to think that such hay would prove extremely nutritious, and that the produce per acre would be quite heavy. The stalk of both the bean and the pea, cut in the state just mentioned, would doubtless be rich in nitrogen, and also, as we know from examinations of their ash, in the most valuable inorganic substances.

Probably the cow pea of the South, noticed in a preceding paragraph, furnishes a hay much similar to what this might be. In sowing for such a purpose, it would be better to sow broadcast than with the drill barrow; as, in the first case, the stalks, growing thickly, would run up tall, and thus furnish a greater bulk of fodder.

As to the varieties of peas sown in field culture I can say little, and I suspect that there can be little said by any one, as all evidence of any pure variety has long since been lost from the samples that we ordinarily see, although they frequently have some local name.

2464. Tares are little known in this country, although the purpose to which they are applied, that of summer forage, is one which should command the attention of our farmers. We all know that during the last months of midsummer there are very commonly a few weeks of dry weather, during which the pastures dry up, and feed of every description becomes scarce. The cows give little milk, as the best pasture is necessarily reserved for the working cattle and horses. In many cases these last have to be even fed on grass from the meadows, which should have been made into hay for the winter's supply. It is well worth considering, if a small plot of ground in a convenient situation, sown with tares, or some other prolific green crop of the same nature, and which came into its full size at about the proper period, would not pay very handsomely for the trifling investment which would be necessary. Tares are said to be an extremely nutritious food, and, when given with a little grain, will keep stock in excellent order. The oats that are recommended to be sown with tares as a support, are in themselves, when cut green, a highly valuable article of food.

I am not aware how far this plant would flourish in our country, but should think it worthy of a fair trial, among other green crops intended to serve the same purpose. To some of these I shall call attention in connexion with their proper paragraphs.

2473. The roller is an implement which has long been known in this country, and extensively used upon farms scattered here and there; still the full extent of its beneficial effect is not even yet known as it ought to be.

On all light land it is valuable for the purpose of consolidation; the earth is rendered so compact by its pressure, that it affords a firm support to the roots of plants. If seed has already been sown, it presses the whole of it beneath, or at least even with, the surface, and compresses the earth around each seed, so that it is kept moist, and takes root speedily. On stiff soils the same effect is to be perceived, although in a less marked degree, as they are naturally compact. The chief good on such soils is the crushing and pulverizing of hard lumps, which would interfere with the growth of plants, and with every subsequent process of cultivation. The best time to use it upon such ground, is as soon as possible after ploughing; the lumps are then not too wet, and have not attained the degree of hardness which they afterwards do, under the heat of the sun. On land that is to be seeded down to grass, a rolling after the grass seed is sown is of great importance, both in the immediate consequences connected with the taking of the seed, and as to the nature of the surface for mowing and raking during haying. The small stones are pressed down even with the surface, the little inequalities are smoothed, and the scythe can be laid close to the ground without fear of injury. For this same reason it is well to roll meadows in the spring, as soon as they become hard after the frost is out of the ground. This operation presses the soil firmly around the roots of the plants that have been thrown out by frost, or disturbed in any way—benefiting the solidity and evenness of the turf, and its subsequent growth. It also in this case smoothes the surface and presses down small stones, as mentioned before. Every practical mower will recognise the advantage of this procedure, for there are few who have not execrated the small stone, or projection of earth, which has dulled their scythe effectually, perhaps in the very first swathe; and, if there were no grindstone near by, condemned them to labor all day with a disabled tool.

The wooden roller, although cheap, has still other objections than those mentioned by Mr. Stephens: it soon wears uneven and splintery, and in consequence, whenever the ground is rough, clogs badly with dirt. This renders it hard to draw, and at the same time interferes materially with its beneficial action. The iron roller can be arranged with a scraper running close to its surface, so as to take off all of the dirt as it revolves. This would wear away a wooden roller too rapidly.

The iron rollers are now made and sold in this country at very reasonable rates. Some of those I have seen are too great in diameter to produce the best effect; the diameter of two feet, given by Mr. Stephens, has been well established as the best under most circumstances. The frame built over the roller, as in Fig. 222, has an advantage in permitting the weight of the roller to be indefinitely increased by loading, if necessary. This plan is vastly superior to one which I have occasionally seen, of having a box in front of the roller, bearing upon the tongue, and consequently upon the horses. The weight of the driver, also, in Fig. 222, may be added to the roller without distressing the team. The cast-iron rollers made here have all, I believe, from two to four segments. That these are necessary, all will believe who have seen the hole made by the near end of a long undivided roller when turning a short corner in the field. So far as my knowledge extends, the horses are always driven abreast in a roller, and not as in Scotland. I cannot discover any advantage in attaching the horses one in front of another to the roller. They require more attention to make them draw evenly, more room to turn in at the ends, and are not by any means so easily managed, particularly if the driver sits upon the roller.

2476. A remark or two is suggested by this and succeeding paragraphs, relative to the care which is shown by farmers abroad in the selection of seed, and in its preservation when they have obtained good varieties. How often do we see here a season's labor in a considerable degree lost, owing to the use of bad or imperfect seed! When the dealers in seeds are honest, they may not grow all of their seed themselves—indeed they rarely do so—and are, of course, liable to injure their customers by selling a bad article unconsciously. If the farmer, on the contrary, grows his seed carefully on his own land, watches its ripening, and cuts it at the proper time,—afterwards taking due care for its preservation, he is sure of his crop, so far as the important item of good seed is concerned. There is another point, too, that may be brought into the account. It is not every farmer who undertakes it, that will or can exercise the care, perseverance, and skill, necessary to produce uniformly reliable seed. Whenever a man can establish a reputation on this point, his seeds will meet with a ready sale at high prices, and thus prove a remunerating article; indeed, scarcely anything would pay so well. Seed wheat, seed corn, seed oats, seed peas, of good and *pure* varieties, known to be such, are always readily sold far above the market prices. A person who wishes to succeed permanently in this business must not deal in fancy seeds, with long flourishing names, but confine himself to varieties of known excellence; never lending his name to a variety because it is new, but trying everything for himself. In this way a reputation may be built up which would inspire confidence among the farming community, and lead to their purchasing from such a person at his own prices, in preference to all others. It would require time and patience to accomplish this, but such a reputation once established would last.

2484. On the sowing of oats. Oats constitute one of the most important crops in the New England and some other Northern States. After Indian corn, in those States where wheat is not a leading crop, comes oats. In going south their quality deteriorates, and in many places their weight is said to be no more than from 20 to 25 lbs. per bushel. The reasons for this deterioration I have already given, so far as my opinion goes. The climate seems to be too dry and hot, and the growth too sudden, for the full and perfect development of the seed as we find it in Great Britain. This difference may probably be lessened, certainly in a degree, by more care in the selection of varieties and of seed—perhaps by importation frequently of heavy samples. I have known instances where one or two crops at least, grown on good land from a heavy English variety, equalled the original seed in weight.

As to the varieties of oats ordinarily used, there is not much to be said; for the seed usually sown, if selected at all, is simply because of its being a good sample. By far the greater proportion of the oats sold in our markets is without a name, except perhaps that of the district whence they come. Improved varieties are now being gradually introduced, and are gaining some favor. They will doubtless be preferred when their merits come to be understood. This point demands attention, and is, at present, more worthy the consideration of skilful farmers than any other in the cultivation of this grain. If we can gain a few pounds' weight per bushel, such oats will soon command a uniformly higher price than the lighter samples, and so will compel a general effort at improvement. Many of the choicest English varieties have already been brought to this country, but, as a general rule, they soon become mixed and lost. The potatoe, barley, and a kind called the imperial oats, have been much recommended; also, the horse mane, or black and white Tartarian. The last seem to have found much favor in some parts of New York, although they are fast becoming mixed. This mixture is in many cases intentional. I notice one account of a premium crop, where black and white oats were sown in equal proportions. One or two varieties of skinless oats were grown to a certain extent a few years since, but I believe that they were not found an advantageous variety for general purposes, and that they have now almost, if not wholly, disappeared.

2487. My remarks as to the probable advantage of introducing new varieties, are supported by the opinion of Mr. Stephens in this paragraph, as he thinks that the oats at present in highest favor in Scotland, are so because they are recent kinds, and therefore more luxuriant, hardy, and productive.

Oats are got into the ground in this country, at as early a period as the season will allow; that is, as soon as the fields are in a proper condition for working. One good ploughing is generally thought sufficient. The seed is sown broadcast, and three bushels an acre has ordinarily been considered quite enough. Many excellent practical writers are now recommending three and a half to four bushels; and in some reports on premium crops I have lately seen it stated, that rather more than five bushels were sown. This approaches nearly to the quantities mentioned by Mr. Stephens, par. 2493—five to six bushels.

I am inclined to think that such heavy sowing would prove injurious rather than beneficial on very light land, or on exhausted soils, where little manure had been applied, much of this crop being unfortunately grown upon such land. In these cases there is not sufficient strength to mature so many stalks of full growth as come up; consequently at harvest the straw is short and slender, while the grain is thin and scanty. On rich land, thick sowing as above would succeed; thin sowing of oats there would not answer so well as thin sowing of wheat; the time occupied in the growth of the former crop is so short comparatively, that there is little opportunity, except in the case of some particular varieties, for *tillering*, or throwing out more than one shoot from the same root. The potato oats, and some other kinds, are said to tiller on rich land almost as much as wheat.

Mixtures of oats with other seeds have lately come much into vogue in many parts of the country: oats with barley, oats with rye, oats with wheat, &c. Oats with peas have already been mentioned. Some of the agricultural societies give premiums for these crops, and they seem, particularly in some of the Eastern States, to be gaining in public favor.

2501. The broadcast and the drill sowing machines alluded to here, have already been noticed. I may mention among those that have been introduced more or less extensively, Pennock's Patent Seed and Grain Planter, Sinclair and Co.'s Patent Grain Drill, and Peirson's Patent Seed Drill. As I have before observed, neither these nor the broadcast sowing machines differ materially from the Scotch and English machines. Machines of a construction so simple and efficient as those described by Mr. Stephens, will soon find their way to the farms of our most enterprising improvers. In the east, where farms are small, or rather the breadth cultivated in grain is small, they will probably travel from one farm to another—a single machine sufficing for the sowing of a dozen, or at least for a number of farms.

Their use will, however, be limited, until the farmers get into the habit of finishing and clearing the surface more perfectly than they do at present; unbroken clods, bunches of grass or roots, and fixed stones, interrupt and render imperfect the action of all machinery for sowing. Until such obstacles are removed, it is probably more economical, and certainly less trying to the patience, to sow by hand entirely. I have myself seen enough machines tried upon rough and poorly cultivated land, to comprehend the many vexations attendant upon their almost invariable failure, and to understand the feeling of mingled mortification and relief with which the farmer returns to his old methods, amid the ridicule of his less enterprising neighbors. The fact is, that no one should attempt to use a machine until his land is thoroughly prepared; until it is mellow and smooth in every portion of its surface. The mention of six harrowings by Mr. Stephens, in Par. 2496, shows the care which is taken in this respect abroad; the hint about *sharp teeth* to the harrows is also well worthy of notice. It should, moreover, be remembered, that the mere use of the machine will not produce a good crop upon poorly manured, exhausted land, let it be ever so finely cultivated. If all these points had been attended to in the instances mentioned above, the laughter and ridicule might have been transferred to the other side, and the farmer would have soon seen his neighbors, one by one, silently following his example.

2504. I am not aware that the Meadow Crane Fly, the insect figured here, ever effects any such injury in this country, as is ascribed to it in the above paragraph. If not the same insect, we have one of the same family, and much resembling this; but it is not very abundant, and never seems to do any noticeable harm, either in the perfect or the larva state. No mention is made of it in our agricultural reports, and I am inclined to think that we are exempt from this insect enemy.

2512. The wild mustard (Ráphanus Raphanéstrum) is not so common in our grain fields as the charlock (Sinàpis Arvénsis), which is very abundant; in some parts of the country it seems to cover whole fields when in flower. Perhaps the method here mentioned for destroying the wild mustard would prove equally effectual in the case of charlock.

2513. Of Lucerne. It is said by some of the best English authors that their climate is, with few exceptions, not sufficiently dry and warm for the cultivation of this plant, which is supposed to have originated in the south of Europe. It is a deep-rooted perennial, with tall stems much like clover, and flowers in violet-colored spikes.

It requires a mellow, rather light soil, with a dry subsoil, and of very good quality. When sown broadcast, as recommended in par. 2516, there is much less trouble in keeping it clean, but Loudon says that the yield is not by any means so great. It is three or four years before it comes into full bearing, but after that it lasts for a number of seasons with very little diminution. It may be cut five or six times in a season, and yields an immense weight of fodder, which is very nutritious.

I find in the Albany Cultivator, and divers other agricultural periodicals, accounts of the cultivation of Lucerne in various parts of this country with success: in New York, Massachusetts, Ohio, and Alabama. Most of those who have tried it speak well of it, and the dry warm climate of our country must be adapted to its growth. Its cultivation, however, does not spread, and it is very uncommon to see even a small field of it. The reasons for this are probably to be found in the fact, that the ground, to insure success, needs careful preparation and enriching, and frequent doses of manure afterwards, to keep up the production. Then it is also a long time in coming to its full size, and requires much labor to keep it clear from weeds. True, the crop, when once obtained, is heavy; but the same labor and manure bestowed on other crops that fall better into a rotation, would probably produce far greater returns. From the operation of these causes, the culture of Lucerne has not extended itself greatly, and probably will not do so. It may, at the same time, be found highly advantageous, where soiling is practised at all, to have from half an acre to an acre in some convenient place near the farm buildings, where a free application of manure would produce a supply of excellent green food on all occasions during the summer. When sown broadcast, the quantity of seed, according to Mr. Stephens, is 20 lbs. to the acre; when drilled, it requires but about half of that weight.

Loudon says that there are no varieties of Lucerne, besides the Medicago Sativa, that are worthy the adoption of the cultivator. He mentions three or four other varieties which are known in Switzerland and the south of France, but seems to think that they have no properties of great importance. One of these is Medicago Falcata, named in par. 2521.

2524. Sainfoin is another deep-rooted perennial, with branching spreading stems, and very showy red flowers. The appearance of a field of it, when in bloom, is very beautiful. It is said that light calcareous soils are best for this plant, and that upon such soils it will yield well, in situations where it is almost impossible to produce good clover, or good pasture of any other kind. It is mown and made into hay like clover, and is well worthy of a trial among us in suitable land, as it is said to be remarkably nutritious. It does not seem to require so much care as Lucerne, and comes quicker into a condition for use, although, unless under very high cultivation, its produce per acre is not so large. It will last from eight to ten years, if necessary, in a profitable state; although, I suppose, it would need occasional top-dressing during that time. This crop, so far as I can learn, is entirely unknown to the farmers of this country.

In Europe a variety of other crops are cultivated for forage, which are not mentioned here by Mr. Stephens. The common broom (Spàrtium Scopàrius), parsley (Apium Petroselinum), Semadilla, and many others, have been occasionally introduced, and with good success. Their culture, however, has not extended greatly, probably for the reason that they possess no especial advantages over some plants already in cultivation.

Spurry (Spérgula Arvénsis) is a small annual plant, which is much sown on poor, dry, sandy land in some parts of Europe. It will grow where scarcely anything else will flourish at all. It is said to be more nutritious than any other variety of forage, and may be sown and cut within the space of eight or ten weeks. Several crops of it may be obtained in the course of a single season. For very poor, light soils, this seems to be a valuable crop, as it will afford good pasture upon them, and if turned under, may bring them into a condition to bear more profitable crops.

2538. Of the lambing of ewes. The period for this event, on the farms of England and Scotland, is generally much earlier than that considered advisable by our best farmers in the Northern States. The spring is so much later here, that an abundance of fresh succulent food for the ewes cannot be relied upon before May. The early lambs are also exposed to sudden storms and cold weather, which result in much injury, even when not absolutely fatal. Many endeavor to defy the season, and to produce early lambs for market, by providing warm close sheds, and by feeding the ewes on succulent food, such as turnips, potatoes, &c. This will answer where a ready market and high prices can be obtained; otherwise, and particularly with a large stock, it is so expensive and troublesome, that the majority of farmers prefer to have their ewes lamb in May, as most convenient, and at the same time most profitable.

The care of ewes previous to lambing, and all of the necessary precautions so fully described here, indicate a degree of care and watchfulness on the part of the shepherd which is seldom seen in America, but which in a valuable flock would doubtless, here as well as there, amply reward the owner.

As to any comparison of the number of lambs produced by different breeds of ewes in this country, it is, on a very extended scale, almost entirely out of the question, so great has been the intermixture of the several varieties. The Merinoes and the Saxons seem to have been most abundant, and these are to be found in every grade of perfection and purity, as well as in every grade of imperfection and *impurity*. The two last words, I am inclined to think, should be applied much more often than the first. It is owing to the preponderance of these mixed and neglected breeds, or rather crosses, that mutton has been considered such an inferior kind of meat in this country. Now, however, there is a rapid change going forward in this respect. Within a short period nearly all the best English breeds have been introduced: the Cotswolds, the Leicesters, the South Downs, and the Scotch Cheviots. These are finding their way over the country, and are highly prized wherever the production of mutton is an object of importance.

Where fine wool is most profitable, the Saxons and Merinoes will continue to prevail. Of these breeds we have had for many years celebrated flocks, kept in the utmost purity, and from time to time improved by fresh importations. It is said that some flocks of Merinoes now in this country are equal, in every point of excellence, to the finest flocks of Spain.

Our sheep districts are usually hilly and bleak, and good shelters for the flock during the winter, are indispensable to their well-being; these same shelters, if properly constructed, are found amply sufficient for the breeding ewes in spring. The farms not being so extensive, nor the flocks so large, as in Great Britain, it is practicable to drive them every night, or at least always in bad weather, to these inclosures, and to place the feeble tender ones under a warm close shed. This is particularly necessary for the fine woolled varieties, the lambs of which are delicate, and subject to injury from inclement storms.

It will be perceived that the condition of flocks in this country at the time of lambing is quite different from that of those described under this head in the present work. Our flocks, being ordinarily small, are easily kept together near home, and are consequently more easily sheltered and attended to in every way. As sheep husbandry extends itself into the uncultivated regions of the north, and the wide prairies of the west, flocks will be larger, and then the necessity for such instructed careful shepherds as are here described, will become more apparent than it is at present. Men will be needed who have studied this business as a profession, and who will devote themselves wholly to the care of flocks.

In addition to the methods recommended by Mr. Stephens, for making the ewes take strange lambs, I have seen another noticed as worthy of attention in such cases. It is simply to sprinkle fine salt over the lamb; the ewe, while licking this, will soon, it is said, become familiarized with the stranger. Rubbing the lamb thoroughly with warm milk is also a prescription said to be efficacious.

Figs. 227 and 228 represent implements which would be of little use to the American sheep farmer. By the time that grass has attained a sufficient height in his pastures to justify turning out the sheep, all danger of lasting snows is over. In case of a squall covering the ground for a day or two, the easiest plan is to bring the flock back to the barn and sheds.

2615. This paragraph, and Fig. 229, to which it refers, are especially worthy of notice, as showing the evil of irregularly-shaped fields. The one here drawn is, however, remarkably regular in its outline, when compared with many that may be seen daily on farms in almost every neighborhood. The time lost in ploughing crooked, triangular, and rounded lands, becomes quite a serious item in the year's work; but the evil does not cease with the ploughing. If it is a crop in which the cultivator or any other horse implement is used, the same difficulty recurs constantly; the turnings cannot be made without delay and injury to the crop at, or near, each extremity of the rows.

2623. This is a very good method for executing a species of subsoiling If the second plough be a large and heavy one, with the mould board taken off, it will answer very well for a subsoil plough. On much New England land, as I am well aware, the progress of the second plough would soon be stopped by stones; but still there are many districts where such obstacles do not exist, and where this operation is perfectly practicable. There are light subsoil ploughs now made, for a pair of horses or single yoke of cattle, which would be precisely suitable to use in this way.

2630. The ribbing coulters, Fig. 231, are evidently upon the same principle as our cultivators. These latter would do the same work when spread to their full extent, and all fitted with such coulters as are figured here. They would, I think, be more convenient in every respect.

2631. Of sowing grass seeds. When grass seeds are sown, either with oats, barley, wheat, or any other cereal crop, the white and red clover, and the Timothy or cat's tail (Phleum Pratense), are almost universally employed. This last is also extensively known under the name of *herd's grass.* It is a prolific and hardy grass, making excellent hay for every kind of stock when mixed with clover, and the various other grasses which find their way naturally into almost every meadow.

This was one among some fifty grasses experimented upon at Woburn in England. These experiments were made with great care, having in view the determination of numerous points relative to the various grasses; such as their prolific qualities, the soils and climates to which they were adapted, the quantity of nutritive matter afforded by a certain bulk of each, &c., &c. They were very elaborate, and have become quite celebrated.

Timothy was assigned a high rank by the Woburn experiments, as being among the most prolific for hay, and being, as to its nutritive value, comparatively very excellent. When grown alone, or with but a small proportion of other grasses, its hay is in request for horses. In Pennsylvania, and the middle States generally, there is a grass of the family *agrostis*, also known by the name of herd's grass, but in reality quite different.

I am of opinion that our farmers might, with good prospect of advantage, try the experiment of introducing some of the standard English varieties into their permanent meadows and pastures. Where one or two years' grass only is desired before breaking up again, perhaps the present system will answer as well as any change.

The orchard grass, or cock's-foot grass (Dactylis Glomerata), has become somewhat known. It is very highly spoken of in the Woburn experiments, both as nutritious and extremely productive. Some cultivators consider it coarse, but the general voice is in its favor, particularly for pastures.

The perennial rye grass (Lòlium Perénne) has also been tried occasionally here, but I am inclined to think that there are better grasses for our climate. Its yield of hay is not so great as that of our known grasses, nor, according to some experiments, is this hay remarkably nutritious. Its growth is over, I should think, too early in the season for the purposes of our pastures. It grows freely on almost any tolerable soil.

The adaptation of grasses to soils should also be studied. Timothy, for instance, is not adapted to dry and light soils, but clover may be made to flourish perfectly well in such situations. Then also for hay, care should be taken to sow varieties that ripen about the same time.

The red top (Agrostis Vulgaris) is by many considered a good mixture with clover and Timothy, although it is not very highly esteemed by many of the English authors.

The varieties of the fescue grass (Festùca), and the meadow fox-tail grass (Alopecùrus Praténsis), are among the most esteemed of British grasses, for both dry and wet meadows.

The American spear grass (Pòa Praténsis) is included by Loudon among what he considers six of the best British grasses, and also stands well in the Woburn experiments. This is a natural grass in most of our best permanent meadows.

The sweet-scented vernal grass (Anthoxanthum Odoratum) is also found naturally in most meadows, and communicates its well-known delightful odor to the hay. This flourishes best on deep, rather moist soils, and is valuable in such situations for early pasture. Its hay, however, is not of the first quality. I have had samples of this grass sent in, with the inquiry if it was a good grass for cultivation alone, and have for the above reasons returned a negative answer. There may be one exception in the case of bogs, or wet land, where other grasses of a more valuable nature will not grow.

The quantities of grass seed sown per acre vary so much in different parts of the country that it is almost impossible to mention any fixed weight or measure. Our best farmers fully come up to the weights mentioned by Mr. Stephens, and often exceed them; but in many parts of the country by far too little is sown, and the natural result of this false economy is poor crops of grass.

The proportions of clover and Timothy are equal, or varied according as one or the other is desired to predominate. Red clover is in more common use than white; the latter finds its way naturally into good pastures. Where it does not come in of its own accord, there should be a small quantity sown.

Machines for sowing grass seed are as yet little known among us, though in the east there are few farms of such extent as to demand their employment, but in the south and west they will probably soon be used with advantage. It is common in sowing grass seed to mix ashes with it; the ashes in still weather show the space of ground covered by each cast, and are at the same time a beneficial top dressing. The small quantity of seed being as it were diluted by the ashes, is also more evenly distributed.

When land is seeded to grass on winter grain, the seed is frequently sown on the melting snow in spring, and with very good success. On the white surface of the snow it is easy to see if the sowing is even.

Some farmers, instead of sowing the grass seed after the first harrowing of spring grain, recommend the practice of wetting the grain thoroughly before it is sown, and then of mixing the grass seed with it. Some of the dry seeds adhere to each grain, and thus a pretty equal distribution is obtained. I have never seen this plan tried, but should think that it would save little time, if any, and that the work would not be so well done as by the common way.

In place of employing a light harrow as represented by Fig. 232, for covering grass seed, this is usually done by means of a thick, flat evergreen, about ten feet in length by eight or ten in width. Where a single one of sufficient size cannot be found, three or four smaller branches are fastened together by a cross-piece. If this brush is carefully selected, it does very good work, and leaves a handsomely finished surface, on ground that has been previously well prepared. It is a humble imitation of Mr. Smith's iron web harrow, described in par. 2653.

2683. The opinions here given as to the superior advantage of sowing clover with buckwheat, are worthy of notice by farmers who have difficulty in making clover take, when sown in spring with the usual grain crops.

It does not seem necessary to say much in addition to the account Mr. Stephens has given of the different varieties of Trifoliæ or Clovers. Most of those described by him are sub-varieties, of worthless, or comparatively worthless, character. We often see in our periodicals different kinds of clover mentioned, but in many cases the fancied differences are owing to variations of soil or climate, and after all, the true old red and white still maintain their superiority over the new comers.

2685. Of sowing barley. This has never seemed to be a favorite crop in the United States. The principal demand has always been for the purpose of malting, but the total abstinence movement has so greatly diminished this demand, or at least has prevented its increase in any degree corresponding with that of the population, that in many States the quantity grown is scarcely worth mentioning. I have consulted the Patent Office Report, and find there tabular estimates of the crops in all the States of the Union, extending over a period of several years. In no year does the crop of barley amount to one fifth of the rye crop, or to more than half of the buckwheat crop.

The State of New York grows more barley than all the other States together, and it is largely exported from thence. Its use, as food for man, is exceedingly limited; but in some districts considerable quantities are fed to stock with advantage. Our agricultural papers usually say little about this grain, and in many districts one may travel for days without seeing more than half an acre of barley in a piece, and frequently without seeing any at all. In fact the only reason for wishing its more general introduction is, that it might occasionally be substituted with advantage for some other grain in a rotation. Perhaps, after all, we attain the same end more profitably by the cultivation of Indian corn—a much more valuable crop, and one which deprives the soil of the same class of substances.

The Chevalier barley, and various other famous English varieties, have been sown in this country with success. One ploughing is generally thought sufficient for barley, but I think there is little doubt that on most land the crop would be greatly the better for two. From three to four bushels of seed per acre are used, the latter quantity being considered preferable where the land is in fine order. When the season will permit, it is well to have the land prepared, and the seed sown, before May.

2712. Of the treatment of dunghills. The remarks under this head, in paragraphs 2714 and 2715, will doubtless recall to the minds of many farmers, as they do to mine, fields overrun with weeds from the use of long manure. This is particularly apt to be the case with the potatoe crop. In the early part of the season the weeds are usually kept down, but after about the second hoeing they begin to be neglected. The potatoes, unlike Indian corn, do not shade the land sufficiently to keep down weeds; as soon as a pause in cultivation takes place, the little weeds which have escaped notice among the potatoes commence growing vigorously: as the potatoe tops begin to die they flourish still more, and hence we often see on farms, otherwise in good order, fields of potatoes in autumn quite overgrown by weeds.

The proceedings in making up and turning dunghills are much the same in this country as those recommended by Mr. Stephens, except that they are scarcely so methodical, and that the *women* would be highly indignant at the idea of their taking a share in such an employment, even if they were to be allowed the privilege of the Berwickshire females with regard to their petticoats.

Men must become few in number, and deficient in energy, before American women are driven to turning over our dunghills as a means of earning their bread. I can see women employed in some light and neat work in the hay field or corn field with more patience, though not even then with approval; but such an occupation as this seems to me calculated to destroy all remains of feminine delicacy, and all of that natural womanly refinement which we expect to see even in the wife and daughters of the humblest cottager, and which in every station is invaluable for its softening and civilizing influence upon the other sex. If our women are to become as coarse and masculine as our men, which must be the result of engaging constantly in such employments, we may bid farewell to that remarkably high degree of cultivation, propriety, and intelligence, for which the poorer classes in many of our States are so justly distinguished.

The practice among many of our best farmers of carting weeds, vegetable mould, leaves, earth, &c., into their yards, and spreading them over the surface before winter sets in, has been already alluded to. These materials, during winter and spring, become thoroughly mixed with the straw and manure which accumulate, and also soak up a great portion of liquid which would otherwise have escaped, and run away from yards having no tank. If a portion of the manure is carted out to make a heap in spring, this earth, &c., is of further use to check too rapid fermentation. A layer of fresh earth may with advantage be applied upon the top of the heap for the same purpose, and also to absorb ammonia, which might otherwise escape during fermentation. A little gypsum or plaster of Paris, mingled with the outer layer, will materially aid this action. It would be found an excellent plan to pump or pour the liquid from a tank, or from hollows in the barn yard, upon the surface of such heaps.

They ought to be located so that their drainings could not run away from the land. Many farmers make the top of their compost heap quite flat, or even a little inclining from the circumference to the centre, in order that the rain which falls may soak in rather than run off. In the climate of Britain this would probably make the heaps too wet; but here, where we have so much dry sunny weather, after the period at which such heaps are made up, I do not think that any injurious result arises from such a practice.

Where dung is thoroughly fermented in heaps, unless great care be exercised, there will be a very considerable loss during the process, both by drainage and evaporation. This decrease is to the amount of nearly half, unless a portion of the escape is in some way intercepted. The various methods already indicated will preserve much of it, and, of course, increase in an equal degree the available resources of the farm. Manure will not, on much of the land in this country, bear to be applied in as long and unfermented a state as might be proper and advisable in Scotland or England. The climate there, as has been explained, is damp and rainy, and for this reason the fermentation and decomposition of manure goes on during the whole season in the soil. Here, on the other hand, if long manure be buried at the usual depth, particularly if it is dry when applied, it will frequently in most soils remain almost entirely unchanged through the whole season, particularly if the land is light. On heavy land such a result need not usually be apprehended; but for light land in this climate, yard manure is most economically and advantageously applied in a decomposed condition. The crop then receives the benefit of its application immediately, and thus it is plain that the unavoidable loss which must, with every precaution, occur during fermentation, is after all, under certain circumstances, profitable.

This distinction between the action of different soils on manure, rendering it advisable to apply it in different states of decomposition, is worthy of more attention than our farmers have hitherto bestowed upon it. In close connexion with this subject is also to be studied, with prospect of advantage, the state in which manure is best adapted to the several crops. Much information upon both of these points is to be found in various parts of the present work.

The degree of care in the preparation of manure, described in paragraphs 2727 to 2730, is certainly far beyond anything that we see in this country, and is, I rather think, some degrees beyond the majority even of British farmers.

2732. On the planting of potatoes. The old system of planting potatoes which formerly prevailed, and does still prevail in many districts, was—to excavate a large hole with the hoe as the first step; into this a fork full of manure was dropped, the potatoe deposited on the manure, and the whole then covered with the hoe again. This way of planting is so tedious, and so slovenly, that it ought at once to be abandoned wherever any other mode is practicable. I am aware, at the same time, that on much of our newly-cleared land—abounding with stumps, roots, and stones—the highly-finished methods described under this head cannot be adopted. I have repeatedly seen attempts at such methods fail, owing to the impossibility of covering the potatoes properly and equally.

Even on very rough land, however, a modification of the Scotch process may be practised with advantage. A single deep furrow may be ploughed, into the bottom of which the dung and potatoes are dropped, and then covered with a hoe. The soft earth from the upturned furrow renders the covering both quick and easy work. On mellow, clear land, the Scotch method is now in common use. I have never seen it carried out in such perfection of detail as is shown in Fig. 236, but have no doubt that such an arrangement and subdivision of work might advantageously be practised for planting on a large scale, always substituting men and boys for women and girls.

Since the almost universal prevalence of the potatoe disease, it has not been the practice to manure very highly for this crop. The general opinion seems to be that the most luxuriant crops are particularly liable to suffer. Many farmers substitute various mineral manures, for a portion of the whole of that which they have been accustomed to apply from their barn yards. Some have thought that in this way they had discovered an infallible remedy, and accordingly, lime, gypsum, charcoal, common salt, &c., &c., have all been strongly recommended. These substances do, in certain cases, seem to exert a modifying influence; but it is none the less established that they all have failed, not only once, but many times.

It would be of no service to enter further upon this much vexed question, as, after all, we must end with the confession, that our knowledge of it is quite imperfect. We have been for a time comparatively free from its ravages, and may hope that it will not again become generally prevalent.

2738. The practice of cutting seed potatoes, when of fair size, is almost universal, but there are many who are tempted to sell off all that are marketable, and reserve only the very small ones for seed. It is true that Mr. Stephens gives an instance where such planting was quite successful, but I think that the experience of farmers generally would be against him on this point, and would decide that it is with the potatoe as with other crops,—poor seed cannot be depended upon for good crops.

2741. It is quite common to defer the cutting of seed potatoes until the very day of planting; indeed this part of the work is frequently done by an old man or a boy in the field itself. I think that such a practice causes the loss of many plants, the freshly cut surface affording a ready lodgment for decay. This evil influence is particularly felt when a cold, wet season after planting, retards vegetation, as then the decay has more time to spread. Even when it does not quite prevent the young shoot from putting forth, and appearing above the surface, it renders the subsequent growth sickly and stinted, because of the scanty nourishment which is received at first from the partially decayed parent tuber. When the potatoes are cut a few days before planting, and spread as recommended in par. 2741, the water evaporates from the freshly cut surface, and leaves a white coating of starch. This becomes so thick as to almost equal the real skin of the potato in its protecting powers; and the cut piece may often be taken up with it unbroken at the end of the season, when the crop has ripened.

I believe that it is universally conceded at present, that the rose, or the crown end, of the potatoe, is that which is by far the most valuable for planting, and that the usual way of cutting is to divide the potato lengthwise, rather than as marked in Fig. 234.

2742. It seems necessary to enforce Mr. Stephens's caution as to the use for seed of potatoes that have already sprouted. I have had some experience with such seed myself, and have frequently seen others fall into the same error. Seed potatoes, and in fact all others, should be kept in some place where the temperature is so low as to prevent them from sprouting, and growing together, in such masses as may frequently be seen. It is not uncommon, in some cellars, for this growth to proceed so far that new potatoes of small size are found among the old on removing them. In such cases, while tearing the masses of potatoes apart, in cutting them, and finally transporting them to the field, these long shoots are so bruised, broken off, or wilted, that they will not grow. But their production has been a drain upon the substance of the potatoes. They are no longer firm, but soft, and as if withered; a portion of their first and best vital energies has been expended, and a considerable time must elapse before there is sufficient strength to put forth new shoots, if indeed they accomplish this at all. Every one who has seen the quantity of shoots and roots that are removed from a bushel of potatoes, when they have grown badly before taking out to plant, will understand that the loss suffered in this way is of a serious nature.

It is rather a favorite practice in this country to plant potatoes on the first breaking up of new ground, and also on the first ploughing of tough sward, or of old grass land. The cultivation of potatoes, and the peculiar natural growth of the crop, leaves such land in a fine mellow state. In some cases manure is spread upon the turf, and then turned under by the plough. Sometimes the manure and the potatoes are placed in the bottom of every alternate furrow, and then covered as before. Very good crops are often obtained on turf without the use of manure, and the potatoes grown in this way are frequently of excellent quality. I have seen notices of fine crops where the furrow slices of turf were laid over quite flat, and the potatoes then planted in holes made between the edges of the furrows, so that they were actually laid under the turf. Crops grown in all of the foregoing ways are apt to be very grassy and weedy, and are moreover extremely difficult in many cases to clean.

A practice pursued in some of the Southern States is, to plant the potatoe in the usual way, covering it very lightly, and then to strew the soil with straw, or young fine branches, to a depth of several inches. It is said that the potatoes produced by means of this singular method are abundant. No cultivation of any kind is required after the planting and covering is over, as there is no opportunity for the growth of weeds.

In the Northern States some farmers pursue a practice slightly analogous to this, in placing the manure *above* the potatoes, and then covering lightly with earth.

These methods both derive a considerable degree of theoretical plausibility from the fact, that the growth of the potatoe tubers seems to be rather towards the surface than downwards. The original tuber or set planted is usually quite as low in the earth as any that have grown from it. Every farmer knows that when his crop is heavy, it is frequently difficult to prevent entirely the protrusion of some of the potatoes above the surface. In an account of one of the southern methods before described, I have seen it related that the new potatoes were nearly all found *above* the inverted turf, while the original set had been planted *below* it.

It does not, therefore, seem unreasonable to suppose that there may be an advantage, when planting, in placing at least a part of the manure above the potatoe. Another reason why this practice may be a good one in dry soils is, that the manure or turf above the seed is more efficacious in keeping it always moist during the early part of its growth, and until the plant is large enough to shade the ground for itself.

2752 and 2753. The care manifested in these and other paragraphs, relative to the speedy deposition of the manure and covering of the seed, after the drills are opened, may well be copied among us; for without doubt the growth is likely to be more rapid and vigorous when the potatoes are planted in a fresh warm soil, before the manure has time to dry up and lose a portion of its value by evaporation.

It is very extensively the custom to dust over each hill of potatoes with plaster, often mixed with ashes, soon after the young shoots appear above the surface: this is certainly an excellent application. On most soils the constituents of gypsum (plaster), and of ashes also when those are used, are directly available for the inorganic part of the potatoe. Where these chemical ingredients are already present in the soil, this addition upon the surface is still of use by attracting moisture, thereby keeping the earth immediately around the tender plant in a mellow and soft condition.

Nearly all of the improved varieties of foreign potatoes have been introduced into this country, and we have besides these an immense number of kinds resulting from seed in our own soil.

Perhaps no variety has been more extensively cultivated at the north than the Mercer, or Chenango, or Neshannock potatoe. It is a rather long, white, and flat tuber, yields well, and is excellent for the table. It has proved on many farms more than usually liable to the attacks of disease. The Carters are considered unsurpassed for the table.

The Early Shaw, or Mountain June, or Early June potatoe, is a somewhat celebrated early variety, of remarkable excellence for eating. It is not a great bearer, but is said almost invariably to escape the attacks of disease.

The Long Red, or Long John potatoe, also called the Merino, attains often to a very great size, and is extremely prolific; but, like most large potatoes, not remarkable for the table. It has a very long tuber, with numerous eyes, often deeply sunk.

The Cow Horn, Lady Finger, and Western or Buffalo Red potatoes, are not very generally cultivated, nor are they very desirable varieties for ordinary cultivation.

Beside these may be mentioned the Long Whites, the Blue, White, and Red Kidneys, the Pink Eyes, the Blue Points or Blue Noses, &c., &c. Many of these are standard varieties, but I can only mention their names here.

The coarse varieties are not general favorites. A French potatoe of this description, called the Rohan, will be remembered by many. It was extremely productive, and caused a great sensation. Single tubers, or even slices with one or two eyes, were sold at high prices for a time; but the quality was soon found to be very inferior, and it was also discovered that, after all, its capacities did not extend to the production of large crops on poor or unmanured soil. The excitement consequently died away, and the name of Rohan potatoe is now seldom heard, unless coupled with some epithet of disapprobation.

2780. I do not think that any such degree of despondency as is here expressed by Mr. Stephens, is felt in this country. The disease among the potatoes has prevailed extensively, it is true, but never so extensively or so universally as in Europe, excepting, perhaps, some limited sections. For several years its prevalence seems to have been rapidly decreasing, and from many States we hear nothing of it. Alarm seems to have subsided in a great degree. It is true that we may be attacked again, and even more fatally than before; and yet there is good reason to think that our knowledge of the causes and phenomena of disease has become so extensive, that we can hope to combat it a second time more successfully than at first. Our farmers at present, from anything that I can perceive, cultivate the potatoe crop as extensively as they have ever done.

2797. It has been supposed by many, that the potatoe became diseased from the effects of too long cultivation in very rich soils, and that by returning to its native country, and bringing thence a new stock, we might go on again with the crop vigorous and healthy for a number of years. In several instances potatoes have been brought from South America; but I have been unable to learn that these in any case have proved more free from disease than the varieties originated here.

The same result seems to have uniformly attended the efforts to raise disease-proof varieties from the seed. In numerous cases new and seemingly hardy varieties, produced freshly from seed, have failed quite as badly as any others.

2805. The general remarks in this and the preceding paragraph, as to the inferiority of street manure to good yard manure, are doubtless correct; such an inferiority is what we should naturally expect, from our knowledge of the nature and origin of the two manures. I do not, however, agree with the following quotation from Professor Low.

"Lime does not appear to act in a beneficial manner, and is rarely applied directly to this crop."

The best analyses of the potatoe tops, leaves, and stems together, show that they contain a very considerable proportion of lime; hence, although there is not a large quantity in the tuber, this substance is valuable for the growth of the stem and leaves. From its action upon these parts of the potatoe result the good effects spoken of by Professor Johnston, as known to be produced by liming the potatoe crop after it is above ground, and before it is earthed up. Much of the benefit arising from the application of plaster in this country, probably arises from the lime which it contains. It is also on many soils extremely valuable for the potatoe crop, on account of the decomposing influence which it exerts so powerfully upon every kind of vegetable matter. This is especially true when potatoes are planted upon cold, sour, imperfectly drained land. Here lime sweetens the soil by neutralizing the hurtful vegetable acids, and forms with these acids combinations that are actually nutritious for the plant.

2810. The quantity of nitrogen here said to exist in the potatoe sprouts is to be noticed as bearing upon what I have already stated, relative to the injury suffered by allowing the shoots to grow long, and to be broken off before planting.

2813. On paring and burning the surface. The flanchter spade, Fig. 238, I have never seen in this country, but think that it might be used occasionally with advantage where a plough could not do the work. Thus, in draining a bog, where the surface is covered with bunches of bent grass, and other sour wiry grasses, the hummocks formed by the roots of which are almost indestructible, it is necessary to dispose of these obstacles to successful cultivation as speedily as possible. If the bog is deep and soft, it is not probable that the drains will dry it sufficiently during the first season for the access of cattle and ploughs; in that case an implement of this kind would save much time, by cutting up the lumps and bogs, so as to prepare the land for ploughing at an early period in the next season. These bogs, after drying, when piled in heaps, will burn as described by Mr. Stephens. The ashes, spread over the surface, and finally ploughed in, form one of the best varieties of manure for the amelioration of such boggy, peaty land. I have seen cases in Scotland where this burning was repeated year after year, until the surface of the field had been lowered several feet, and a fine rich soil formed from the mixed peaty substance and the ashes. In other cases they take off several crops after the first burning, and then, when its effects begin to fail, burn again. When a bog is formed of vegetable muck, the first burning, destroying the bents and bogs on the surface, will be found sufficient; for this material comes very speedily into a state fit for cultivation, after it is laid dry. But where a real peat has formed, repeated burnings may be necessary, for peat resists all decomposing influences with great obstinacy, particularly when once dried. If it has lain in the sun for a time, no amount of soaking seems competent afterwards to soften or dissolve it. Among stones, unless great care were exercised, this flanchter spade would speedily become dull and useless.

I do not think that in our climate such an expensive implement as that shown by Fig. 240 is at all necessary. Any plough which would turn a wide thin turf on edge would answer the purpose, and in the last days of summer the whole surface would soon become as combustible as tinder. In fact some bogs can be burned pretty deeply in dry seasons, by merely setting fire to the untouched surface.

In most situations it does not seem to me advisable to do more than merely burn the surface parings, because by going deeper we destroy organic matter, which, if not valuable in its original situation, might be used with great advantage in forming composts, &c., for other land.

On land which can be cultivated without it, as is said in par. 2840, burning should not be employed at all. It is, I think, only to be advised in this country under the circumstances already described.

2842. I must confess that the test mentioned here is a strange one to be applied in all cases, and doubt if it will afford results which are so infallible as the author seems to consider them.

2843 to 2958. In addition to these concluding paragraphs of spring, embracing the farrowing of sows, and the various points connected with the hatching and rearing of fowls, I can say little. The latter is a subject which is now engaging much attention, particularly among amateur farmers, who are importing all of the finest foreign varieties, and are making improved breeds quite common in the Eastern States. There has been such a number of works issued within the last few years, to meet the wants of those who are new in the management of this feathered stock, that any observations from me would seem utterly superfluous. I cannot help thinking, however, of the horror and disbelief with which many fowl fanciers will read par. 2954, wherein Mr. Stephens courageously asserts that the pip and other like diseases that chickens are heir to, are a species of popular fallacy, and actually calls them absurdities. I am convinced that sundry zealous advocates will immediately take up the cause of the pip, and maintain it as stoutly as certain of our farming friends do the transmutation of wheat into chess, perhaps with more truth.

Any notes, however brief, upon American agriculture, would seem incomplete without at least a few words relative to the cultivation of our greatest national crop—Indian corn. This is a chief article of produce from north to south, and from east to west. The varieties cultivated in Canada, and the Northern States generally, while less imposing in appearance, produce equally well with the large southern varieties, having stalks from twelve to sixteen feet in length.

Indeed the premium crops at the north are usually larger than those that we hear of at the south, while the average product per acre of New York, Ohio, and other Northern States, is, to say the least, quite as high as that of Tennessee, Virginia, Kentucky, and the other great corn growing States of the south. The aggregate amount of the crop for the whole Union is enormous, being probably near 600,000,000 of bushels in a favorable year.

April and May are the months for planting corn at the north. It is seldom that much is done before the 15th of April, and it occasionally runs rather far into June. The previous cultivation should not differ materially from that previously described as best for potatoes, the great aim being to secure a deep and mellow soil. The land is generally ploughed during the preceding autumn, and then cross-ploughed in spring. Many, however, prefer planting immediately upon the turf, turning it over flat, and harrowing until a good depth of fine mould is secured. Excellent crops may be grown in this way, but if the turf is not turned entirely over, or if it is disturbed by the harrows, the field is apt to be very grassy and weedy. On the western prairies a boy is sometimes set to follow the plough, and drop seed in every other furrow; the next furrow is turned over upon it, thus laying the grass side on the corn. This is called a sod crop, and could only be successful, even in an ordinary degree, upon land naturally very light and mellow. In some places it is the practice, when ploughing grass land for Indian corn, to turn two furrows in opposite directions, so that they meet together and form a broad ridge, leaving the turf under them undisturbed. The corn is planted on these ridges, and is often quite good, but the practice is extremely slovenly. The crop is inevitably grassy, unless the greatest care is taken in cleaning, and that is not to be expected from farmers who pursue such a system: a portion of the ground, nearly half in fact, is left undisturbed, so that the roots only penetrate it with difficulty, if at all.

The custom of manuring corn in the hill, after the same manner that I have mentioned under the head of potatoes, is happily fast becoming obsolete. The manure is now either spread broadcast before ploughing, or placed in drills, the former being the prevalent mode. Heavy manuring is essential to this crop on most land: but where the soil is already very fertile, there is some danger of forcing too luxuriant a growth of stalks and leaves, so that the ears are small and ill ripened. This is particularly to be feared on such land when highly nitrogenous manures are added; inorganic manures might, at the same time, prove beneficial.

If the land is poor, and not well manured, a distance of three feet between the hills seems advisable. In the opposite case, two feet and a half in one direction by two in the other, is not uncommon; although three feet between the rows seems better, as admitting light and air more freely, and also the passage of a cultivator between the rows in one direction. It has even been planted at distances of a foot in the rows, and very heavy crops have been thus obtained, but only by the use of a variety having a small stalk, upon a remarkably rich soil, and with the concurrence of a very favorable season. In all ordinary cases, such thick planting only produces a great burden of stalks and leaves, with little corn, and that of an inferior quality.

Two and a half feet in the rows, and three feet between them, seem proper distances to recommend for good soils at the north; the southern varieties are so large that three, four, and even five feet, are always left between the hills in each direction.

Marking the rows with a marker is fast becoming universal; the appearance of the crop is not only neater, but its cultivation easier and more effective, for the reason that all horse implements pass readily through the rows at a gauged width, the only care being to keep the horse in a straight line.

I have already, under the proper head, mentioned the necessity of a good machine for dropping corn in hills at equal intervals, and have described one which seemed well adapted to the correct performance of this operation.

The soaking of Indian corn, for twelve hours before planting, promotes the rapidity and certainty of its vegetation. If left in water so long as to sprout, there is danger of its perishing in case a few days of dry weather succeed the planting. Various steeps have been found beneficial. Nitrate of potash, or saltpetre, a little common salt, or a small proportion of sulphate of iron or copperas, have been frequently used with marked effect; muriate of ammonia is another good ingredient of this steep. An excellent practice is to roll the seeds, while yet moist from the steep, in plaster of Paris: some also recommend a covering of tar previous to applying the plaster, in order to keep off crows. There is some danger of making a thick, hard coating in this way, that will prevent the seed from sprouting, being both water and air proof.

A small quantity of plaster, or of plaster and ashes mixed, also occasionally a little lime, is often thrown upon each hill of corn after the first hoeing, in the same manner and with the same effect that has been mentioned under the head of potatoes. About a gill is applied to each hill.

Care is well bestowed in the selection of seed for this important crop. For this purpose early and well formed ears, from stalks having at least two each, should be selected in the field, picked, and kept by themselves in a dry place, until required for use. The seed corn should then be taken from the middle of the cob alone, leaving that which covers an inch or two on each end as inferior. This latter fact has been proved by a variety of experiments.

As might be expected, the varieties of corn are very numerous. I shall only notice a few of those that are most prominent.

At the north, yellow varieties greatly predominate, while at the south, we find more commonly the white, having seeds of superior size. Many varieties are only designated by the number of rows on the cob: there is the eight-rowed white flint, the eight-rowed yellow flint, the six-rowed, the twelve-rowed, &c.; some kinds even go as high as sixteen rows, but in this case the seed is small, and the cob very large in proportion.

Other kinds are named from the shape of their seed. Thus, a number of varieties of gourd seed corn are in great repute at the south and west. These have a remarkably large seed, lighter and more farinaceous than the flint varieties generally cultivated at the north, making also a whiter and more tasteless meal.

A variety called the China tree corn has been highly spoken of at the south, but I have never seen it. It is said to produce a very unusual amount of leaves, and is therefore valuable for fodder. The small Canada corn has been extensively introduced at the north, but it is too diminutive a variety to compete with others almost equally hardy and early in ripening, and which are at the same time far more productive: such are the Dutton and the Brown.

The Dutton corn is extensively cultivated, but seems, in many districts at least, to have passed the acme of its popularity. Its cob is very large, and to this is doubtless to be ascribed a part of its present disfavor. These large cobs are difficult to dry thoroughly when the corn is stacked before husking, or piled in the crib before shelling.

In bad seasons this peculiarity prevents its early drying, and frequently causes it to mould. I think the deterioration in this variety is owing in a good degree to carelessness in the selection of seed, and to mixture with inferior kinds. It is probable that careful cultivation for a few years would restore much of its original celebrity, as I have visited many farms where it does not seem to have lost ground at all.

A variety which has gained much favor in some sections within the last few years, has been called the Brown corn, from the name of its originator, a farmer on one of the islands in Lake Winipissiogee. It was produced by careful cultivation in a high latitude, and for successive years, of selected seed from the common eight-rowed yellow corn. The butt ends of the cobs are small, and the points entirely covered with kernels. The ears are from ten to thirteen inches in length, the stalk medium size, and prolific. More than a hundred bushels per acre have been grown. From all that I have seen and heard of this variety, I am inclined to think that we have few that surpass it.

The Oregon and the Baden varieties have been cultivated with success at the south. The Golden Sioux, the King Philip, and the Yellow Dent, are northern yellow varieties. The Rhode Island white flint and the Tuscarora, are two of the few white kinds that have found favor at the north. The Dutton corn is said to be an improved variety of the Golden Sioux.