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PRACTICE WITH SCIENCE.

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MDCCCXLI.

THESE EXPERIMENTS, IT IS TRUE, ARE NOT EASY; STILL THEY ARE IN THE POWER OF EVERY THINKING HUSBANDMAN. HE WHO ACCOMPLISHES BUT ONE, OF HOWEVER LIMITED APPLICATION, AND TAKES CARE TO REPORT IT FAITHFULLY, ADVANCES THE SCIENCE, AND, CONSEQUENTLY, THE PRACTICE OF AGRICULTURE, AND ACQUIRES THEREBY A RIGHT TO THE GRATITUDE OF HIS FELLOWS, AND OF THOSE WHO COME AFTER. TO MAKE MANY SUCH IS BEYOND THE POWER OF MOST INDIVIDUALS, AND CANNOT BE EXPECTED. THE FIRST CARE OF ALL SOCIETIES FORMED FOR THE IMPROVEMENT OF OUR SCIENCE SHOULD BE TO PREPARE THE FORMS OF SUCH EXPERIMENTS, AND TO DISTRIBUTE THE EXECUTION OF THESE AMONG THEIR MEMBERS.

VON THAER, *Principles of Agriculture.*

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CONTENTS OF VOLUME II.

APPENDIX.

LIST OF PLATES.

JOURNAL

OF THE

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

I.—*Report on the Diseases of Wheat.* By the Rev. J. S. Henslow, M.A., Professor of Botany in the University of Cambridge, and Rector of Hitcham, Suffolk.

At the general meeting of the Royal Agricultural Society, held at Cambridge, in July last, it was stated, that none of the Essays which had been sent in were considered worthy of the prize proposed on the subject of diseases in corn. I have since then seen these essays, and it was evident to me that the authors were ignorant of many facts long known to scientific enquirers, respecting the nature of these diseases, and the causes producing them. However valuable some of the remarks may have been, as the results of the personal and practical experience of their authors, these essays fell far short of what the Society really wanted. Upon my return home, it occurred to me, that a report on the nature of the diseases in corn might be serviceable to those who wished to prosecute an enquiry into the modes of preventing or palliating them; and I determined to look a little into the subject, and in case I could find sufficient leisure for preparing such a report, to do so. Although I was well acquainted with the fact, that certain diseases in corn were owing to the attacks of Fungi, I had never paid further attention to the history of these minute plants, than was required for their comparison and classification with numerous others of the same tribe; and I had no idea that the diseases which they produced in corn had occupied so much attention, especially with continental writers, as this enquiry has now shown me to have been the case. Very accurate observations and experiments were made upon this subject during the last century, and these have been added to, and improved upon, by a numerous class of observers, down to the present day. Several of their works I have had no opportunity of consulting, as I have but few of them in my own library; and our public library at Cambridge is also deficient in many, especially among the more recent foreign authors. Having so lately turned my atten-

tion to this subject, and that too at a season when so little time was left for observation or experiment, I have very little to offer which can in any way be considered an advance on the knowledge already on record. I have, however, examined wheat infested by five species of parasitic fungi; by the ergot; by the little animalcule which produces the ear-cockle or peppercorn; and by the wheat-midge. As I have been able to satisfy myself of the accuracy of previous observers on many points connected with the diseases occasioned by the attacks of these plants and animals, I shall confine my report to an account of them. I must beg it to be understood, that I am offering a very imperfect report of what is really known on the subject, and consequently that I can only propose a very defective sketch of what it may be right to attempt in making further experiments.—I have however thought it better to give this report at once, rather than delay it for a twelvemonth: for it cannot be before then that fresh opportunities will have occurred for making more extensive observations.

Section I.—*Remarks on Parasitic Fungi.*

As I shall in the first place notice the diseases occasioned by the attacks of parasitic fungi, a few general remarks upon the habits of these plants may not be unacceptable to the agriculturist. All fungi grow upon some kind of organized matter, none of them deriving their nutriment directly from the soil, water, or the atmosphere, like other plants. They are of great importance in the economy of nature, by assisting in the decomposition of decaying or decayed animal and vegetable substances. A few of them appear to grow upon healthy subjects, but these may possibly most frequently have originated on a part where disease or decay had already affected some alteration in the tissue; and then, by spreading rapidly from thence, they may afterwards occasion the decay of other parts also. None of this tribe of plants attain to any great size, when we compare them with many species of flowering plants, or even with many of those of other neighbouring tribes, (as the Ferns, &c.) which never flower. Among fungi we find a multitude of extremely minute species, which it needs the skill of an experienced microscopic observer to detect and examine; and it is also among the very lowest of the several groups, into which these minute fungi are classed, that we must search for the few species that produce the fatal diseases in corn we are about to notice. But if these fungi are themselves so exceedingly small, how much more so are those reproductive bodies, analogous to the seeds of flowering plants, by which they are propagated and multiplied! So very minute are these Sporules (as Botanists term them), that they altogether escape observation by the naked eye,

and can only be just distinguished by the highest powers of the microscope. Many of these kind of fungi live beneath the scarf-skin, or epidermis, and within the very substance of certain plants. In the progress of their growth, they raise blisters under the epidermis, and, when arrived at maturity, they burst through it, and then form spots or irregular blotches of various colours, which are frequently orange, brown, or black. These spots (or *sori*) are masses of fructification, and are surrounded by the tattered edges of the ruptured epidermis. A vast number of these fungi are known to botanists. Like parasitic animals, they are restricted in their powers of attack, being able to live on certain species only, and even on particular parts only of particular individuals of these species. There is often a strong general resemblance between many of them; but a naturalist will readily detect such important differences between two fungi which may infest distinct species of plants, that he is compelled to consider them also as species distinct from each other. Thus it happens in the animal kingdom, that different species of flea, and different species of lice, can exist only on particular species of quadrupeds or birds. The flea which infests dogs is distinct from that which annoys man. So also with these parasitic fungi; some are restricted to one species of plant, some to another: but, generally speaking, most of them are capable of living upon more than one species of the same genus; where, of course we might expect the resemblance in all points to be very close. Some fungi confine their attacks to the seed, others to the stem or leaves, and some even to one side only of the leaves. One of those which attack wheat lives only on the grain, another more particularly attacks the short stalk (*pedicel*) on which each flower is seated, whilst three of which we are about to speak are restricted to the straw, chaff, and leaves; but all five live at first beneath the epidermis, and not upon it. In this respect they bear a close analogy to those parasitic animals which live within the bodies of other animals, some immediately beneath the skin, others in the intestines, and others again within the very substance of the muscle. It is the extraordinary minuteness of the sporules (or seed-like bodies) of these fungi, which allows of their being absorbed by the roots, and probably also through the pores of the stem and leaves of plants; and then they are conveyed by the sap to the various parts where they are enabled to germinate, grow, and fructify. The sporules of fungi appear to be every where dispersed through the atmosphere, ready to germinate wherever they may find a dead or living subject in a condition suited to their attack. Common mouldiness, for instance, which so readily forms on many substances in moist situations, is the most familiar example of the inconceivable numbers in which the sporules of a minute fungus

are every where diffused. The difficulty of admitting such a universal dispersion of these sporules, has induced some modern philosophers to support the old exploded theory of spontaneous generation. Of this theory, however, we may safely assert, in the present state of human knowledge, that it involves difficulties an hundred fold more inexplicable than any which attend on the opposed theory, which teaches us that all living creatures proceed from similarly organized beings, originally called into existence at the fiat of the Almighty. We shall therefore consider these minute fungi to be plants, which have proceeded from, and are capable of reproducing their kind by means of those minute sporules, with which direct observation has made us well acquainted.

Section II.—*On the Bunt, Smut-Balls, or Pepperbrand.* (*Uredo caries,* Dec. *Uredo fœtida,* Bauer.)

The fungus which occasions this well-known and much dreaded disease has hitherto been met with only in the grains of wheat. Its presence is readily recognised by the peculiarly disgusting odour of the infected ear. It may be detected in the young seed, even in the very earliest states of the flower bud; and when fully ripe it most frequently occupies the whole interior of the grain, but without bursting the skin, so that the wheat seed retains very nearly the same size and shape that it would have assumed had it been perfectly sound. When examined under the microscope, the Bunt-fungus is seen to consist of vast numbers of extremely minute globules, of a dark-colour, and which are at first attached to a mass of matted thread-like matter, analogous to what is termed the spawn in mushrooms, and other Agarics—and which in those plants spreads underground, and frequently occasions the remarkable appearances called fairy-rings. It is not easy to see this spawn of the Bunt-fungus, but the little dark globules called spores, may readily be detected. They may be considered analogous to the seed-vessels of flowering plants, and each of them contains a mass of almost inconceivably minute sporules, by means of which the plant is propagated.

The reproductive powers of fungi are quite beyond our comprehension. Fries, one of our greatest authorities, has calculated that a particular fungus may contain 10,000,000 sporidia.* Mr. Bauer has accurately measured the spores of the present species, and finds their diameter is not more than $\frac{1}{1600}$ of an inch.

* The terms *sporæ*, *sporulæ*, *sporidia*, &c., have either been applied synonymously or vaguely by different authors. The more modern practice appears to be, to use *sporulæ* for the ultimate granules analogous to seeds; *sporidia* for the cases or vessels containing them; and *sporæ* for an additional covering, which sometimes includes several *sporidia*.

A single grain of wheat (estimated at less than the $\frac{1}{1000}$ of a cubic inch) would therefore contain more than 4,000,000 such spores; but it is hardly possible to conjecture how many sporules each spore contains, since they are scarcely distinguishable under very high powers of the microscope, and then appear only as a faint cloud or vapour, whilst they are escaping from the ruptured spores. A reference to Mr. Bauer's plate and account of this fungus, in the 'Penny Magazine' for 1833, p. 126, will furnish the inquirer with very accurate details of its structure and peculiarities.

When this disease prevails, it greatly deteriorates the value of the sample; imparting its disgusting odour to the flour, it makes it less fit for bread; but I understand that ready purchasers are to be found among the venders of gingerbread, who have discovered that the treacle, and whatever else they mix up with it, effectually disguises the odour of the fungus: if this in itself is really innoxious, there can be no objection to such a mode of employing the tainted flour; but some are of opinion that it is to a certain extent deleterious. Although the Bunt-fungus confines its attacks to the young seed, it seems to be a condition essential to its propagation, that it should be introduced into the plant during the early stages of its growth, and that its sporules are most readily absorbed by the root during the germination of the seed from which the plant has sprung. It has been clearly proved that wheat-plants may be easily infected and the disease thus propagated, by simply rubbing the seeds before they are sown, with the black powder, or spores, of the fungus. It is also as clearly ascertained, that if seeds thus tainted be thoroughly cleansed, the plants raised from them will not be infected. This fact is now so well established, that the practice of washing or steeping seed-wheat in certain solutions, almost universally prevails. Upon simply immersing the grain in water, the infected seeds float, and on the water being poured off nothing but the sound ones remain in the vessel. This simple process, however, is never perfectly effective, because, in threshing the wheat, many of the infected grains (smut-balls) are crushed, and the spores are dispersed in the form of a fine powder, which adheres with considerable obstinacy to the surface of the sound grains, by means of an oily or greasy matter found in the fungi. In order to detach them thoroughly, it has been considered useful to add some alkaline ley to the water in which they are washed; because oil and alkali unite and form a soapy substance, and then the spores will no longer adhere to the surface of the grains of wheat. Lime, possessing alkaline qualities, has been long employed for the purpose. Common potash, and substances containing ammonia, as the liquid portion of stable manure, have also been used. But, as some persons employ brine, sulphate of

copper, arsenic, and a variety of other materials which do not possess alkaline properties, it is supposed that all these solutions act rather by destroying the vegetative properties of the fungi, than as a means of removing them from the surface of the grains. It may therefore be worth while to institute a set of experiments to determine which supposition is really correct. Perhaps some portion of the effect may be owing to the increased specific gravity of the liquid; or perhaps some portion of the solution may be imbibed by the steeped corn, sufficient to prevent the sporules of the fungus from germinating within the substance of the plant; just as corrosive sublimate, essential oils, and Russia-leather prevent the formation of mouldiness. I may also add that the temperature at which the solutions are applied may be of some importance.

Section III.—*On the Smut or Dust Brand (Uredo segetum).*

This disease is produced by another fungus, which is often confounded with the last. The smut-fungus, indeed, resembles the bunt-fungus in colour and shape, but its spores are not half so large, and it possesses none of that disgusting odour which characterises the latter. Although this fungus is generally supposed to attack the grain, much in the same way as the bunt-fungus, only that it more thoroughly destroys it, this is not the case. M. Ad. Brongniart has shown, in the 'Annales des Sciences,' vol. xx., p. 121, that the smut-fungus destroys the ear, by first occasioning the innermost parts of the flower to become abortive, whilst the little stalks (*pedicels*) on which these are seated swell, and become very fleshy. The fungus then consumes the whole of this fleshy mass, and at length appears between the chaff-scales in the form of a black soot-like powder. It is stated, however, by others, that it does not confine its attack to the ear; and though I have not myself witnessed its effects on other parts, it is described as infecting both chaff, straw, and leaves. The spores, when ripe, burst through the epidermis, and disperse in the form of a black powder, resembling charcoal. Mr. Bauer has given figures, and an account of this fungus also, in the 'Penny Magazine' for 1833, p. 180. He there gives the dimensions of the fungus, by which it appears that the diameter of a spore is not more than the twenty-eight hundredth of an inch.

This disease is not so much dreaded as bunt, for two reasons; the spores have generally been dispersed before the corn is cut; and even when present in the flour they have no disagreeable odour. It is sometimes, however, very injurious, by diminishing the produce. It is comparatively rare in wheat, but very common in barley, and even more so in oats: rye does not appear to be sub-

ject to it. It has been observed in several grasses, and I have this year noticed it in the "common oat-like grass" (*Arrhenatherum avenaceum*). Like the bunt-fungus, so also may the smut-fungus be kept in check by carefully steeping the infected grain; but this process does not here appear to be so thoroughly effective as in the former case. Probably the earlier ripening of the spores causes the sporules to disperse in the fields, and so keeps up a greater out-door supply of them. If of two evils we might choose the least, it would certainly be more desirable that the corn should be attacked by smut than bunt. I know not how an idea has originated, which I find prevalent among farmers, that a little smut in the barley-crop is a good sign: I can only suppose they mean to say the less the better. It seems to be most likely that both bunted and smutted corn cannot be very noxious, as fowls which have been fed with them receive no injury. At the same time it is asserted that the straw of corn infested with the smut-fungus is distasteful to cattle; but I am not aware that any experiments have hitherto been made with a view of ascertaining whether it is actually injurious to their health.

Section IV.—*On the precautions to be taken against Bunt and Smut.*

Whatever some persons may hope, when they suggest the possibility of our effectually exterminating the bunt-fungus, provided a system of carefully steeping all seed-wheat were universally to prevail, the most sanguine calculations could never count upon the extermination of the smut-fungus with any prospect of success. Since the smut-fungus does not confine its attacks to corn, but is also found in the grasses which grow in pastures and by the road-side, a plentiful supply of sporules will always be kept up, to warrant our believing that we shall never expunge this species from the British Flora. Still we may feel assured, that precautionary measures may materially lessen an evil which cannot be wholly avoided. Since the sporules of the two fungi which produce bunt and smut enter the plants they attack by absorption at the roots, and since they are buried with those seeds to whose surface they have attached themselves,—it is evident that too great care cannot be bestowed in procuring clean seed, or in purifying such as may accidentally be infected. From a variety of considerations, it has always appeared to me strange that practical agriculturists are accustomed to pay so little attention to the raising of pure seed-crops. There may be reasons, which I do not properly appreciate, that would render it inexpedient to cultivate a seed-crop apart from the rest of the produce raised on a farm; but I should have thought that it was always worth while for every farmer to set aside some portion of

ground to be more carefully tended than the rest, for the purpose of securing good and perfectly clean seed. Among other reasons for such a practice, he would then be able to weed his crop from every plant infected with bunt or smut, before the fungi ripened. The benefit of steeping wheat, in some mixture or other, being thoroughly established, but it being still uncertain to what cause the success of this practice should be attributed, a few experiments might be undertaken, with a view to determine this point. These would tend to point out which of the numerous substances now in use were most likely to be really serviceable, and which of them might advantageously be dispensed with. I shall therefore venture to suggest, in the following sketch, the kind of experiments that may be called for; and they may readily be added to, or improved upon, by those who are willing to interest themselves in this inquiry. A parcel of thoroughly bunted or smutted seed should be divided into a number of small packets, each of the same weight; or if very small, each containing the same number of grains. When any of these packets are steeped or washed, the floated grains, and the fungi which rise to the surface, may be kept apart for separate experiments, being carefully labelled "F. 1," "F. 2," &c., to show that they were obtained from the packets of seeds, "No. 1," "No. 2," &c. by this process.

No. 1. Seeds unwashed, to serve as a comparative experiment.
— 2. Washed in cold water only—(2*) in scalding water.
— 3. Washed in water with lime, the proportions specified.
— 4. Washed in water and brine.
(a) Mixed in the proportion of 2 water to 1 saturated brine.
(b) ,, ,, ,, 1 ,, 1 ,,
(c) ,, ,, ,, 1 ,, 2 ,,
(d) Saturated brine.
— 5. Washed in sulphate of copper.
— 6. Sprinkled, but not washed, with lime.

Another set of experiments may be prepared with clean corn, to be infected with the floated fungi obtained in washing the above.

No. 7. Rubbed with—
(a) F. 2, to serve as a comparative experiment.
(b) F. 3.
(c) F. 4.
(d) F. 5.

Another set may be prepared with clean corn, which should first be steeped in different solutions, and then rubbed with the fungi obtained by simply washing in water (No. 2).

No. 8. Steeped in lime, and rubbed with F. 2.
— 9. ,, brine and do.
— 10. ,, sulphate of copper and do.

These last may be repeated, by washing the seeds clean after they have been steeped, to remove any of the mixture that may adhere to the *surface.*

No. 11. Prepared as No. 8.
— 12. ,, ,, 9.
— 13. ,, ,, 10., &c. &c.

Section V.—*On the Rust, Red-rag, Red-robin, Red-gum.* (*Uredo rubigo,* and *Uredo linearis.*)

I believe that under the names here quoted, agriculturists have comprehended the attacks of what systematic botanists consider to be two distinct species of fungi; and which the experienced eye of the microscopic observer was alone likely to separate. They form yellow and brown oval spots and blotches upon the stem, leaf, and chaff; and when the spores have burst through the epidermis they are readily dispersed. Like those of the bunt-fungus, and smut-fungus, they consist of very minute grains, but their colour is different, varying from orange-yellow to brown, and their shape is not so perfectly sphærical, especially those of *U. linearis,* which are usually oblong. Both these fungi are very common on corn and grasses. I have within the last two months (of July and August) seen more of the Red-rag (*U. rubigo*) as it is here called, than of any other, of these corn-pests. It abounded in the form of an orange powder which exuded from the inner surfaces of the chaff-scales, but was scarcely if ever to be seen in the skin of the seed; it might also be traced in patches beneath the epidermis of the straw, but I did not observe that it had burst through the epidermis anywhere, excepting on the inside of the chaff. It seemed to prevail more among the rough-chaffed wheats, than others, and, in this parish, more especially in some fields of the variety called white-tunstall. At one time it appeared likely that these fields would be seriously injured by it, but some warm sunny weather coming on, the Red-rag lost ground, and I observed that the sori, or spots from whence the spores exuded, turned deep-brown. This disease is not so injurious as the true mildew; but although I shall speak of the latter as if it were produced by a distinct species of fungus, and in compliance with the present opinions of most systematic botanists, still I am very much inclined to think that both diseases are occasioned by the same fungus, under different forms or states of fructification. I did not witness the fact, but was told that the reapers had noticed several patches of mildew among the white-tunstall alluded to above. I much regret that I did not see them. My chief reason for supposing it probable that rust may result from a particular form of fructification in the same fungus which produces

mildew, rests upon what I consider to be a satisfactory observation made upon a closely allied species (*Uredo rosæ*) which infests the under surface of rose-leaves. It would be misplaced, in this report to discuss a merely botanical question at great length, but I may perhaps mention that I have satisfied myself by direct observation, that the fungus which first produces the orange-coloured spores of *Uredo rosæ*, also gives rise to other spores, of a very different form, (which botanists have considered to belong to a distinct genus, and have named *Aregma mucronata*). I have also met with a review of M. Unger's work 'Die Exantheme der Pflanzen' in the second volume of the new series of the 'Annales des Sciences,' in which it is stated that M. Unger, who, in common with a few other observers, considers many species of Uredo to be morbid secretions from the juices of plants, asserts, that they afterwards *change* their forms, assuming the appearances ascribed to other genera of minute fungi. But surely these plants are too distinctly, too regularly, and too beautifully organized to be the products of disease, like worts or purulent matter in animals. They are also too closely allied to other fungi, which are undeniably true plants, to allow of our considering them in any other light. There are doubtless great difficulties in accounting for the manner in which the minute sporules of these fungi find their way in sufficient numbers within the substance of plants, to produce the effects they do in certain seasons. But, after all, the difficulty of conceiving how this happens, is not greater or so great as that of accounting for the manner in which thousands of minute animals, just visible to the naked eye, sometimes find their way within the very muscles of the living human body. Upon corresponding with the Rev. Mr. Berkeley (who is our chief British authority in this department of botany) he referred me to a paper by Leveillé, in the XIth vol. of the 'Annales des Sciences,' in which Unger's hypothesis is clearly disproved, and these minute fungi shown to be true plants. With respect, however, to the identity of the *Uredo rosæ*, and *Aregma mucronata*, Mr. Berkeley remarks—"It is a point on which I could never completely satisfy myself; for the Uredo seems to be perfected, and drops its spores before the Aregma is produced, or when there are only a few spores remaining. It is, however, certain that several published Uredines are only states of Pucciniæ (the genus producing the mildew), e. g. *U. vincæ*, *U. menthæ*, &c. The early stage of *Puccinia pruni* is an Uredo. I have just been examining it." In a subsequent communication, and in reply to my remark that the Uredo was not *changed* into the Aregma, he observes "I agree exactly with you that the Uredo fully developed never is produced into the Aregma; and I see the Aregma produced in the way you sketch it, from sausage-like

curved bodies arising from the receptacle of the Uredo, and containing globular orange bodies exactly like that of Uredo; but I am not at present prepared to assert that Aregma is only an altered form of Uredo." Perhaps I have said too much on this purely botanical question; but an independent testimony in microscopic observations is often of value; and repeated observations have fully satisfied me of the truth of what I have advanced.

It will now rest with agriculturists to observe whether mildew is not always preceded or accompanied by rust—and botanists must determine the manner in which the three forms of spores developed in these diseases are related; if indeed they really belong to the same fungus. My *conjecture* is—that whilst one of the uredines (*U. rubigo*) is a particular form of spore, which does not undergo any further change, the other (*U. linearis*) is the young state of a distinct form of spore which, when further advanced, is called *Puccinia graminis*. I may add, that in order to be quite positive that I had found the *U. linearis*, I sent Mr. Berkeley a specimen of the straw to ascertain his opinion whether I was correct in supposing that the three fungi were co-existing in the same plant. He replied, "I perceive in your culm, *Puccinia graminis* intermixed with *Uredo linearis*, and a few bad specimens perhaps of *Uredo rubigo vera*." With Mr. Berkeley's opinion against me, I offer my conjecture to future observers with the greatest hesitation.

Section VI.—*On the Mildew (Puccinia graminis).*

If agriculturists appear to have confounded under the name of rust, the attacks of fungi which botanists consider to belong to two distinct species; so also have they frequently applied the name of rust as well as mildew to the disease we are about to notice. It will be seen by what I have stated in the last section that I am inclined to consider these two diseases to be mere modifications in the attack of the same species of fungus, but that further observations are required to settle this question. For the present, then, we must consider the mildew-fungus not merely as a distinct species, but also as belonging to a different genus from the two rust-fungi. The form of its spores is indeed very different from those we have already noticed. Mr. Bauer long ago published figures in which all the forms of the mildew-fungus are accurately delineated. This plate accompanies a short account of mildew by the late Sir Joseph Banks, which was published as a separate pamphlet, but afterwards reprinted in the second volume of the "Annals of Botany;" again, in "Curtis's Account of Grasses;" and again, but without Mr. Bauer's figures, in the sixth volume of "the Pamphleteer." The ripe spores of this fungus are little intensely dark-brown club-shaped bodies, having the thicker end

divided into two chambers, each filled with sporules. They taper gradually at the base into a fine stalk. The sori (or patches of spores) are composed of multitudes of these bodies, which sometimes burst through the epidermis of the stem and leaves, in such profusion, that the whole plant appears as if it had been scorched. I have observed this fungus intermixed with the rust-fungi in a way which strengthens my opinion that they are identical; but I do not wish to discuss this point any further, as my observations on mildew have hitherto been very slight. The only example which this year came under my notice, occurred in two fields at Audley-end, in one of which Lord Braybrooke informs me, "that wheat was never grown before, the ground having been sheep-walk and absolutely worthless, until it was ploughed up some years ago, and since been farmed on the four-course system. The ground being much exposed, and with a northern aspect, the ploughmen call it Freeze-land. The seed was supposed to be pure Talavera." The seed in the other field was Hickland's-prolific. As these fields were mildewed in a season remarkably free from this blight, these circumstances are worth recording—and in addition I may observe, that the soil was poor chalk-land, and the field of Talavera surrounded on all sides by high hedges and plantations. The mildew in the other field was confined to one corner.

Section VII.—*On the precautions to be taken against Rust and Mildew.*

I have very little that is satisfactory to report on this head. I do not think it has been clearly determined by experiment, whether the sporules of the rust and mildew fungi are absorbed by the roots of corn, like those of the bunt and smut fungi; or whether, (which seems to be the more prevalent idea) they enter through those minute pores on the stem and leaves which botanists term "*stomata.*" The fungi at first make their appearance in little cavities seated immediately beneath these pores, which certainly looks very much as if the sporules entered there. The stomata are naturally exhaling organs, continually discharging, under the influence of light, a large proportion of the water imbibed by the root. But in moist weather, this function is impeded, if, in some cases, it be not actually reversed; when it would be easy for the sporules to enter these invisible stomata, with the moisture imbibed by them. The fact, however, stands in need of proof; and hitherto the evidence is more in favour of similar fungi being imbibed by the roots of the plants which they attack. Mr. Knight indeed, who is high authority, particularly insists upon mildew being induced by foggy weather, happening at a time when the ground is particularly dry: circumstances which we may readily understand as likely to convert the stomata

(or even the whole superficial tissue of plants) into imbibing organs. If the autumnal fogs really pre-dispose wheat to the attacks of the mildew-fungus, we must agree with those who recommend the growth of early varieties in places subject to these fogs. It seems to be pretty generally admitted that spring-wheats are less liable to mildew than winter-wheats; and that heavy soils are less subject to it than light ones. But, at present, the information on these points is very vague and unsatisfactory. We may safely conclude, that a generally healthy state of the plant, without any over-luxuriance of vegetation, is most likely to secure a crop against the attacks of the rust and mildew fungi; but, that whatever tends to render the plant sickly, whether it be excess of heat or cold, draught or wet, sudden changes of temperature, poverty of soil, over-manuring, shade, &c. &c., must be considered as a pre-disposing cause to these diseases. Supposing it were clearly ascertained that a corn-crop had imbibed the sporules of the mildew-fungus early in the season, might it not be advisable to feed it down by sheep? I ask the question in perfect ignorance of the propriety or practicability of such a course. The rust, and mildew-fungi attack many grasses, and I have this year found the latter in great perfection in the Common Reed. It is evident, therefore, that we can never expect to exterminate these fungi; but that their sporules will always be found in our fields, ready to attack the corn-crops whenever these are brought into a state adapted to receive their influence. Whether remedial or palliative measures may not be discovered is an enquiry well worthy the attention of agriculturists.

Section VIII.—*On the supposed influence of the Berberry in blighting corn.*

A notion has long prevailed, not only in England, but on the continent, that the berberry-bush (*Berberis vulgaris*) is in some way or other frequently connected with the production of mildew in wheat. Sensible observers, among practical agriculturists, have persuaded themselves that this is really the case; and they have asserted that their conviction of the truth of this hypothesis rests upon the effects which they have themselves witnessed. I should have considered such testimony of far greater value, if I had found it opposed only by the contradictory convictions of scientific inquirers; for however unlikely it may seem to the latter, that the berberry could in any way produce the ill effects ascribed to its influence, there are too many mysteries in the works of nature hitherto unravelled, not to induce us to pause before we decide a thing to be impossible, merely because we can see no reason for considering it to be at all probable. But in the present case, even practical men are by no means

unanimous in denouncing the berberry. L. A. Staudinger, an experienced and enlightened cultivator, at Flotbeck, near Hamburgh, has published his observations on Ergot and Mildew, made between 1799 and 1830; and, according to a review of them in the Archives de Botanique, vol. ii. p. 285, he expressly contradicts the commonly received opinion. He also refers to some experiments of Hornemann, which were made in the Botanic Garden at Copenhagen, who planted wheat, and surrounded it with berberry-bushes, and repeated the experiment several times, without obtaining any mildew. A similar experiment was made, (if I recollect rightly) by Jussieu in the garden of Trianon, with a like result. Mr. Knight also obtained only a negative result in experiments of the same kind; though in this instance he would have been misled (mildew having attacked the wheat), if he had not instituted a series of comparative experiments, which satisfied him that no just inferences could be drawn from what had happened to the wheat planted near the berberry. I have not had any opportunity of seeing more than a solitary case of berberry-bushes growing in the hedges of a wheat-field; which was in one of the fields already noticed at Audley-End. The wheat was certainly more mildewed in their vicinity than elsewhere; but then, the bushes were precisely in that corner of the field where the soil was decidedly the worst, and which was also sheltered by lofty trees; so that here, at least, there was no positive testimony that the berberry was a pre-disposing, or assisting cause; since the effect might equally be ascribed to the worse condition of the soil or to the shade of the trees. To those who feel as interested as myself in having this question settled beyond dispute, and who may possess the opportunity for doing so, I would suggest the following experiment. Let berberry-bushes be planted in the middle of some fields, and protected by fences. Let it be observed whether the corn grown in those fields is mildewed, and the circumstances under which this happens accurately noted; let all failures be equally recorded. If the results of these experiments should tell to the prejudice of the berberry, I would willingly travel many miles to be convinced, by personal inspection, that this pretty and botanically interesting shrub had really caused the evil imputed to it.

Section IX.—*On Ergot.*

Of all the diseases to which corn, or indeed any other plant is subject, this is certainly the most extraordinary, from the strange effects it produces on the animal economy. It is well known that the punctures which certain insects make in the vegetable tissue, for the purpose of depositing their eggs beneath the epidermis of the living plant, induce a morbid action in those parts, which gives

rise to the production of peculiar excrescences termed galls. The oak apple is an example; so is the useful and important article of commerce, the common nut-galls, which are also obtained from oaks. It has been supposed that the Ergot might be a production of a similar kind; or else, that it may be occasioned by the action of a parasitic fungus; or even, that it was itself a fungus; and it has, accordingly, been sometimes classed in systematic works with true fungi. Mr. Bauer, in the 18th vol. of the Linnean Transactions, fully confirms the opinion of those who consider the Ergot to be a monstrous development of the seed of corn, and other species of the grass tribe; and he has given most accurate drawings of this singular production, in all its stages of growth. He objects, as I conceive rightly, to the idea of its being produced by the action of a certain minute fungus, which is found equally on plants not producing the Ergot, as on those that do so; but an opposite opinion is maintained by high authorities. Be the cause of its production what it may, the Ergot is a monstrous state of the seed, in which the embryo, and particularly one part of it, is preternaturally enlarged, protrudes beyond the chaff, and often assumes a curved form somewhat resembling a cock's-spur (from whence the name of Ergot, which is of French extraction). It is black superficially, and of a spongy texture internally: containing much oily matter, so that it will burn like an almond when lighted at a candle. This production affords us a remarkable, but not uncommon example, of how slight an alteration in the proportions in which certain elements are combined, may make a material difference in the properties of the same body. The few elementary principles which form flour, the very staff of life, are in some way so differently combined in this particular state of the grain from whence flour is obtained, that certain animals cannot continue to eat it for many days together, even in comparatively small quantities, without becoming diseased, and probably dying from its effects. The experiments which have been undertaken in order to prove this are unexceptionable of their kind, but painful to read; and having once been made, with the care and caution detailed by the Abbé Tessier, and others, we may hope that it will never be considered advisable to repeat them wantonly. They were made upon various animals, ducks, fowls, turkeys, pigs, &c. Such repugnance had these animals to the Ergot, that they preferred starvation to voluntarily partaking of it, even when it was mixed in small proportions only with good flour. When compelled to swallow it, they soon sickened, their limbs became inflamed, and their bodies gangrenous in various parts, and sometimes the flesh sloughed off, and death invariably ensued. In the case of a duck which was forcibly fed with flour mixed with the powder of Ergot, forming a seventeenth portion of the whole compound, drops of blackish blood oozed

from its nostrils at the end of five days; the beak soon afterwards changed colour, and the tongue rotted at the extremity; the animal died in ten days, after having taken, altogether, one ounce and seven grains of Ergot. In a turkey, the ill effects began to show themselves in seven days, and it died at the end of twenty-two days, having eaten eight ounces and four grains of Ergot. A pig died in twenty-three days, having eaten one pound two ounces of Ergot, which it was found very difficult to disguise in its food sufficiently to induce it to eat. With another pig the experiment lasted for sixty-eight days, and the animal had eaten twenty-two pounds six ounces of Ergot in that time: this formed about one-eighth the whole quantity of food with which it had been supplied. The effects produced in this last case were very decided; the joints of the legs became gangrenous, as well as the ears, and the flesh from the tail sloughed off. The importance, and propriety of making these experiments, will be readily admitted, when it is known that they were undertaken expressly to test the probability of ergotted rye-bread being the cause of dangerous gangrenous epidemics among the poor, in certain districts of France. The details of the sufferings to which these persons are occasionally subjected are shocking to humanity. Their extremities rot off; and some have been known to lose all their limbs, which, in the progress of the disorder fell off at the joints, before the shapeless trunk was released from its torment. In one instance recorded by Tessier, a poor man, whose family were in a state of starvation, ventured to make bread of some ergotted rye which he had begged of a farmer, but had been cautioned by him against using it. It killed himself, his wife and five out of seven of his children. Of the two which recovered from the effects of the Ergot, one became deaf and dumb, and had one of its legs drop off. I felt interested, whilst pursuing these researches, with an account preserved in the register of a neighbouring parish, Wattisham, which I shall venture to transcribe into this report; because it seemed to me probable, as soon as I first heard of the circumstance, that the effects there recorded may have been due to the presence of Ergot.

"*Extract from the parish register of Wattisham, Suffolk.*"

"The following is a circumstantial narrative of a very extraordinary and singular case that happened in this parish, A.D. 1762:—

"On Sunday, January 10, 1762, Mary, daughter of John Weatherset, alias Downing, aged 16 years, was taken with a pain in her left leg, which in an hour or two sunk into her foot and toes; the next day her toes were much swelled, and black spots appeared upon them. By degrees the whole foot became swelled and black; the pain, which was now chiefly in her toes, was, she said, as if dogs were gnawing them; the blackness and swelling increased upwards, by slow degrees, till it

came near the knee, when the flesh of her leg putrefied and came off at the ankle with the foot, leaving the leg-bones bare. Her other foot and leg were affected in a few days, and decayed nearly by the same degrees and manner. Her thighs both swelled, and under her ham an abscess formed. The surgeon, seeing no perfect separation, did, on the 17th of April following, attempt to take off one of the limbs, near the knee, just above the corrupted flesh, but such an effusion of blood issued, as to stop his attempt; he afterwards took off both her legs near the knee. She lived many weeks, and then died.

"Mary, the mother, was taken, very soon after her daughter, with the same kind of pain under her left foot, or, as she sometimes said, in her left leg; her toes, foot, and leg were affected in the same manner as her daughter's, and in a few days her other foot and leg also. Both her feet came off at the ankles, and the flesh rotted from the leg-bones, which continued bare about three months, and then rotted off. Her hands and arms are benumbed, and her fingers contracted, but not black; she is now almost well, and likely to live many years.

"Elizabeth, the next daughter, aged 14 years, was on the next day, viz. Monday, January 11, 1762, seized only in one leg and foot, which she could not set on the floor for three weeks, but stood all that time upon the other, leaning against the chimney; after which, being taken in the same manner in her other foot, she lay down; one foot mortified and came off at the ankle, the other leg near the knee.

"Sarah, the next child, aged 10 years, was taken on the same day as her sister Elizabeth, in one foot, which mortified and came off about the ankle. The toes of the other were affected, and broke, but healed again.

"Robert, aged 7 years, was taken on the Tuesday or Wednesday following, in both legs, which came off at the knees.

"Edward, aged 4 years, was at the same time taken in both feet, which rotted off a little below the ankles.

"An infant, aged two months, was taken from the mother's breast as soon as she was seized with the disorder. It was put out to nurse, and died within two months; when dead, its feet and hands turned black.

"John, the father of this unhappy family, was seized with the same disorder, about three weeks after the first was taken, in both his hands. His fingers became benumbed, contracted, and black. The nails of some came off, and two of them broke, but healed again. He complained much of darting pains in his hands, arms, legs, and back."

The popular belief in the neighbourhood, to this very day, supposes these unfortunate people to have been bewitched; and that they were thus visited as a judgment for their mal-practices!

In addition to the above, the event is commemorated on a tablet, let into the wall of the church, containing the following inscription:—

"This inscription serves to authenticate the truth of a singular calamity which suddenly happened to a poor family in this parish, of which six persons lost their feet by a mortification not to be accounted for. A full narrative of their case is recorded in the parish register, and Philosophical Transactions for 1762."

Guided by this reference, I find the case excited at the time great attention, both here and abroad; and that the symptoms were considered to be precisely similar to those which the ergot of rye produces in France. But it appears from an accurate inquiry which was instituted at the time, into all the circumstances which might in any way be supposed to have brought on the disorder, that no rye had been used by this family. Rye was, I understand, very commonly the food of the poor, about that time: none, however, is now used here, and it is not grown in the neighbourhood. The circumstance which seems to have struck the persons who investigated this case as most likely to have been the cause of the misfortune, was the family having lived for some time on bad wheat. They were in the habit of using about two bushels of Revet-wheat weekly; and since Christmas, this had been supplied them by a farmer from the produce of a crop which had been laid, and which he had kept apart from the rest of his stock. The grain was discoloured: it made bad bread, and worse puddings. But it did not disagree with any one of the farmer's family, or others who used it, except one man in the village, who was affected by a numbness in both his hands for about four weeks, and whose fingers' ends peeled at the time the unfortunate family lost their limbs. There is no evidence that the presence of ergot was suspected in this wheat. Indeed, the ergot is seldom met with in any other corn than rye; and Tessier says, he never saw but one example of it in wheat, of which he gives a figure. Bauer also mentions having never found more than two ears of wheat infected by it. I have, however, found it this autumn in four different fields of wheat, and gathered more than a dozen specimens; and I find that some of the farmers here are sufficiently acquainted with it to satisfy me that it must be more common in wheat than has hitherto been suspected. Upon asking my miller to search for me, he very soon picked out about three dozen ergots from two bushels of Revet-wheat, which had been sent to be ground at his mill; and he said that he had left at least as many more in the sample. This wheat was grown in the next parish to Wattisham. A very cursory look into the mouth of a sack of gleaned wheat, then at the mill, also furnished me with three or four more specimens. Should the ergot ever prove abundant in any particular crop, it may be worth while to have it picked out,—both for the sake of purifying the sample, and also as a source of profit; for it is a highly esteemed and valuable medicine in skilful hands, but much too dangerous in its application to be trifled with by ignorant practitioners. I am, however, speaking of the wheat-ergot, as though it were an equally efficacious medicine with the rye-ergot; but I am not aware whether this is really the case.

I would wish to invite agriculturists to make enquiry in their several districts, whether the ergot does not sometimes prevail to an extent sufficient to induce a belief that it may be injurious to the health of the poorer classes, whose food is little varied, and who might thus be subjected to whatever evil influence a certain admixture of the ergot in their flour may be capable of producing. It may also be suggested to such medical men as have opportunities of witnessing those disorders to which the poor are more particularly liable, and which are generally ascribed to poverty of diet, whether these complaints may not sometimes be induced or fostered by the presence of this deleterious ingredient in the flour. Tessier states, that some humane proprietors in those districts of France where the gangrenous epidemic was prevalent, were in the habit of furnishing their labourers with rye that had been picked free from ergot, in exchange for any infected samples they might themselves have grown; and that after they had adopted this practice, their labourers were no longer attacked by the epidemic.

Section X.—*On the prevention of the Ergot.*

As the ergot is not known to prevail to an injurious extent in any other corn than rye, nothing has been said of the mode of preventing it in wheat. In rye, it is said to prevail most in wet and stiff land; and draining has been consequently suggested, as the obvious mode of diminishing the evil. The direct experiments which have been made with this view seem to have been sufficiently conclusive; and to have proved that more seeds become ergoted in proportion as the plants are kept wet at the roots, and grown in a clay soil. Perhaps it might be worth while to cultivate rye on this principle, for the sake of supplying the demand for ergot.

Section XI.—*On the Ear-cockle, Purples, or Peppercorn. (Vibrio Tritici.)*

It is now just a century since Needham first made known an extraordinary fact concerning the blighted grains found in the ears of wheat infected by a disease known under the name of the ear-cockle, purples, or, as I find it called in this part of Suffolk, the peppercorn. The grains which are thus infected turn dark green at first, and ultimately nearly black; and they become rounded, somewhat resembling a small peppercorn, but with one or more deep furrows on their surface. The husks of the chaff spread open, and the awns are twisted, by which means the infected ears are readily observable among the standing corn. Upon opening the blighted grains, they are found to be filled with a moist white cottony substance; but to contain no flour.

When Needham placed this cottony mass in a drop of water, under his microscope, he perceived to his surprise (as I did lately to mine, before I was aware that the fact had been previously noticed) that it was composed of a multitude of minute eel-shaped animalcules, which were in active movement, twisting and wriggling to and fro, like so many eels or snakes. The announcement of Needham's discovery summoned several observers into the field, of whom no one was more persevering or intelligent than Roffredi. His papers, in the fifth and seventh volumes of the "Journal de Physique," contain the results of more than five years' patient investigation into the economy of these minute creatures. In the "Philosophical Transactions" for the year 1823, Mr. Bauer has also given the result of his personal observations and experiments, carried through an equally long period, and without his having any knowledge of what Roffredi or others had already done so long before him. He has given faultless drawings of the animalcule (*Vibrio tritici*, as it is systematically named) from the state of the egg to its full growth, and as it is seen under the highest powers of the microscope. The disease which it occasions is said to be sometimes very injurious to the wheat-crop; but I presume it must be very local, for it was unknown to some of the earlier writers on the diseases of corn, who sought for it without success; and I could not learn, upon a limited enquiry, that it was known to the farmers near Cambridge, or at Saffron Walden. In this parish, however, it is well known, and my miller informs me that he often has samples of wheat much infested with it; and among what he calls the tail-corn (the last portions of a particular batch), he has found as much as half a peck in the bushel. He says, also, that when the cottony mass composed of the animalcules, is extracted from the grain in the process of grinding, it does not pass through the cloth with the fine flour in the beating, but remains behind with the bran. When a sound grain of wheat is sown by the side of one infested with the *vibrio*, the young plant which springs from the former is not infected before March; but then the animalcules begin to find their way from the blighted grain into the earth, and thence into the young corn. They gradually ascend within the stem till they reach the ovule (or young state of the seed) in the flower-bud, even before the ear has shown itself. Roffredi believed that they do not increase in size till they have reached the young seed, but that after this they grow very rapidly, soon deposit a large number of eggs, and then die. Mr. Bauer has questioned the accuracy of Roffredi's observation, and supposes the specimens found in the stem to belong to another species. The young are hatched in about eight or ten days after the eggs are laid, and speedily attain to about the $\frac{1}{33}$ of an inch in length, and the $\frac{1}{1200}$

of an inch in diameter. When full grown, the vibrio acquires a monstrous size compared with one of the multitude which composes the cottony mass in the blighted grains, becoming a quarter of an inch long, and the $\frac{1}{80}$ of an inch in diameter. I am not aware whether any precise estimate of the numbers actually found in a single grain has ever been made, but a slight calculation will show us that not less than fifty thousand of the young *might* be packed in a moderately sized grain of wheat. Mr. Bauer seems to think that more than one generation are produced in the course of a season. The most curious circumstance which observers have noticed in the economy of this animal, and which I have had an opportunity of fully verifying, is the wonderful property it possesses of retaining its vitality under circumstances in which we should have supposed it impossible that it could have lived. If a mass of them is suffered to become so perfectly dry that the slight touch of a hair might reduce them to powder, and they are again moistened in a drop of water, they will speedily revive, and become as active as before. They may thus be dried and revived many times before they are killed. Mr. Bauer states the limit to such revivals to lie between six and seven years. I happened to possess an ear of wheat infected with this disease, which had been sent me (I think) at least six years ago, but which I had not minutely examined before; and upon soaking some of the blighted grains in water for a few hours, the animalcules revived, and were quite as active as those I had found in the first fresh grains which I had been examining only two days previously. If the eggs are once dried, or even the young animalcules themselves before they have attained a certain size, they will not revive on being moistened. It does not appear that the vibrio naturally attacks any other corn than wheat; at least, it has not been observed to do so. But barley, rye, and oats may become infected by sowing them in the same hole with the grains of wheat which are filled with the vibrio. The experiment, however, succeeds with difficulty, and only to a small extent.

Section XII.—*On the prevention of the Ear-Cockle.*

When the infected grains are thrown into water, they float for a short time, but on becoming saturated with moisture, they sink; so that merely immersing the seed-sample in water would hardly suffice as a method for getting rid of the bad grains. I have observed that scalding water kills the vibrio; and this may suggest the possibility of exposing infected samples to a temperature that might be sufficiently high to kill these animalcules, without being so hot as to destroy the germinating powers of the corn. Perhaps the suggestion already thrown out, to grow seed-wheat apart from the general crop, may be here repeated.

SECTION XIII.—*On the Wheat-Midge.* (*Cecidomyia tritici.*)

Nothing is more common in wheat-fields, than to find one, two, or more of the flowers, in many ripe ears, defective in the grain; even though the parts of the flower had been well formed. This effect may be owing to a variety of causes; and among others, is frequently occasioned by a minute two-winged fly called the wheat-midge, (*Cecidomyia tritici.*) This fly may be seen in myriads, in the early part of June, between seven and nine o'clock in the evening, flying about the wheat, for the purpose of depositing its eggs within the blossoms. From these eggs are hatched small yellow maggots, which are the caterpillars (*larvæ*) of this fly; and by these the mischief is occasioned. Mr. Kirby, the now venerable patriarch of Entomologists, so long ago as 1798, gave an interesting account of the habits of this insect, to which the attention of naturalists had been directed by Mr. Marsham about two years before. These accounts will be found in the third, fourth, and fifth volumes of the "Linnean Transactions." It has been supposed that the wheat-midge caterpillars feed on the pollen after it has been shed from the anthers, and thus prevent the fertilization of the ovules, or young seeds; but it seems hardly likely that the pollen of one flower should be sufficient to support a single caterpillar, much less several, for a month or more. Mr. Kirby has suggested, what I should consider a much more plausible theory, that the caterpillars, with their heads immersed in the stigmata, live upon the juices secreted by the ovary, and thus obstruct its growth, whether it may have been fertilized or not. Be this as it may, these caterpillars are certainly, in some way, the cause of the non-development, or abortion of the ovary, so that the grain never advances beyond the state in which it appears at the time the flower first expands. A figure of the fly and its caterpillar is given in the "Linnean Transactions;" and likewise in the "Magazine of Natural History," vol. i. p. 227, where Mr. Kirby has also given another figure, and a short notice of a different species of the same genus, called the Hessian fly (*Cecidomyia destructor*), which is particularly injurious to wheat in North America. This latter, however, does not deposit its eggs in the flower, like our own wheat-midge, but near the base of the straw, within which the caterpillars are hatched, and these devouring its substance cause it to break off near the root. The caterpillars of the wheat-midge are about the 12th of an inch in length, without legs, and of a citron-yellow colour; and when they are about to pass into the chrysalis (*pupa*) state, they spin themselves up in a very thin and transparent web, which is often attached to a sound grain, or to the inside of one of the chaff-scales. The chrysalis is of a reddish orange colour.

Section XIV.—*On precautions to be taken against the Wheat-Midge.*

Perhaps it may be thought unnecessary to take any precautionary measures against so insignificant an enemy as the wheat-midge; and possibly the actual damage which it occasions may generally be too trifling to make it worth the farmer's while to trouble himself about it. Mr. Kirby calculated that in a certain piece of wheat, of 15 acres, the loss would amount to about 5 coombs, or a twentieth part of the crop. Whether such a loss may be worth thinking about I am not sufficiently aware; but there is a strange economy in the insect tribe, by which particular species, in certain seasons favourable to their production, are enormously multiplied, and are then capable of producing very extensive havoc, though in most years their attacks are comparatively insignificant. I should therefore presume that any simple method which might be devised for continually checking the increase of the wheat-midge, must be decidedly beneficial in the long run. Since the chrysalides of this insect lie secreted during the winter among the chaff, and the fly does not make its appearance till June, multitudes of them might easily be destroyed by burning or scalding the chaff after the grain has been threshed out. It has however been asserted, and I have myself observed the fact, that many of the caterpillars quit the ears and fall to the ground, where (it has been supposed) they change to chrysalides, and remain buried till their final metamorphosis takes place. It seems extraordinary that different individuals, of the same species of insect, should have habits so distinct as these—that whilst some spin a web within the chaff, others should bury themselves in the ground. I suspect (but have not fully verified the fact) that all those caterpillars which enter the ground have been ichneumonized, as entomologists term it. As it may be an object of some importance to ascertain whether this is really the case, (if ever agriculturists should think it worth while to attempt any remedial measures against the attacks of the wheat-midge,) perhaps I may be allowed to make a few remarks on this curious department of the insect economy. There is an extensive group of insects, collectively called ichneumons, though subdivided into many genera, which lay their eggs in the bodies of other insects, generally whilst these are in the caterpillar state. When these eggs are hatched, the young maggots which they produce (and which are the caterpillars of the ichneumons) feed upon the fleshy or muscular parts of the caterpillar they are attacking, carefully avoiding the vital parts. At length, the caterpillar they have thus been devouring alive, dies; or, as frequently happens, it changes to the state of a chrysalis before it is destroyed. The ichneumon caterpillars also pass to the chrysalis state, and either remain within the body

of the dead caterpillar, or come out of it, before they assume the fly-state.

Each species of Ichneumon is restricted in its attacks to one, or at most to a few, particular species of caterpillar; and the females instinctively proportion the number of eggs they deposit in each individual to the relative size of their own offspring, and that of the insect on which it is destined to prey. In some cases, a single egg is laid in a caterpillar; in others, some dozens. These ichneumons are obviously destined to restrain within due limits certain species of insects, which would otherwise inconveniently increase. Our wheat-midge has certainly one, and probably not less than three distinct species of these ichneumons appointed to keep it in check. One of these *(Platygaster tipulæ)* may be seen in July and August, actively engaged in examining the ears of wheat infested by the caterpillars of the wheat-midge. It is a minute black four-winged fly, with a sharp point at the tail, which it insinuates between the chaff-scales, and then pierces the caterpillars, depositing a single egg in every one it is able to reach. One ichneumon, therefore, destroys many caterpillars; and it is clear, if it were not for their friendly interference, our wheat crops would in a few years run a fair chance of being utterly destroyed. If my conjecture is correct, that it is only those caterpillars of the wheat-midge which have been punctured by the ichneumons, which quit the ears and bury themselves in the earth, there is thus a very effectual provision made for the preservation of the ichneumons; whilst, on the other hand, many of the midge chrysalides must necessarily be destroyed during the process of threshing the corn, and more might easily be got rid of with proper precaution. My conjecture is founded on the following observations made this autumn. I had observed no ichneumons about any of the ears of some wheat which had been attacked by the wheat-midge, and in the specimens which I brought home, many if not all of the caterpillars have spun up in the chaff-scales. But, in some other specimens, obtained later in the season, and on which I had seen the ichneumons busily employed, I found that many of the caterpillars came out of the ears, and buried themselves in some sand placed at the bottom of the vessel in which I had put them. At present they have neither spun nor changed to chrysalides. In the second volume of the "Magazine of Natural History," p. 292, is a notice by Mr. Gorrie on the effects produced by the wheat-midge; and he estimates the loss in the late-sown wheats, in Perthshire in 1828, to have amounted to one-third of the crop! and again, at p. 324, he says they destroy from three to five bolls per acre. He asserts that all the maggots had descended into the earth by the 1st of August, and advises their destruction in

that situation; but if (as I suppose) it is the ichneumonized caterpillars only which enter the earth, this would be destroying the farmers' best friends. A little closer attention to the habits of these insects another year, may enable some one to solve the doubt.

I am aware that in this imperfect report, I have not noticed all the diseases to which corn is subject; and among them, a certain semi-abortion of all, or most of the grains in the same ear; of which I have seen some examples in this neighbourhood, and have been favoured, by Mr. Pusey and Dr. Buckland, with other specimens from the neighbourhood of Oxford. In the latter situation, a whole crop was very much injured in this way. When this is the case, the entire plant (but more especially the ears) is covered with a minute blackish fungus, as though it had been powdered with soot. I do not believe, however, that this fungus (*Cladosporium herbarum*) is the original cause of the evil, but that it merely attaches itself, superficially, to these and many other plants after they have been brought into a state of decay. I had supposed this kind of blight, in some of the localities where I noticed it, to have been owing to draught, the crops growing in a stiff clay which had become thoroughly hardened; and Dr. Buckland formed the same opinion of the case which came under his notice. In other cases, I considered it was owing to the injury which had been done to the straw by high winds, which had much bent and bruised them. Such effects as these are hardly to be classed among the diseases of corn, and they are entirely a subject for the enquiry of the agriculturist. The attacks, also, of many insects and other animals, however injurious to the crops, are unaccompanied by any morbid affection of the plant, which might induce us to class such effects with those we have been considering; and it falls rather to the Zoologist than to the Botanist to notice them.

In concluding this report, I must express a hope that the reasons already adduced will be considered sufficient excuse for any inaccuracies. I have not written it as a scientific communication, but solely with the desire of directing the attention of practical agriculturists to what has already been done on the subject, and to point out what they themselves are required to do towards advancing our knowledge of the Diseases in Corn, and the modes of providing remedies against them.

J. S. Henslow.

Hitcham, Bildeston, Suffolk,
September 14, 1840.

In the observations I this year made upon the apparent diseases infecting my wheat-crop, I find that at one period, about the middle of July,

the rust was prevalent in a piece of golden-drop wheat sown the first week of November, 1839; but more especially in the headlands near a hedge on one side of the ground. The weather, however, appeared afterwards to be against the advance of the disease, but still my interest was excited, and I frequently inspected this particular headland. The fence was low about three parts of the way down, but thick and of a considerable height in the remaining part. About the latter end of July I perceived the wheat in this portion of the field, immediately within the influence of the hedge, assume a dark colour, speckled about the ear, and by about the 14th of August, when the field was reaped, it had the appearance of being infected by this fungus: may not, then, this disease have been superinduced upon the rust, owing to the want of a free circulation of air, which the remaining parts of the field enjoyed?

W. Miles.

II.—*On Subsoil-Ploughing.* By H. S. Thompson, Esq.

[*Taken, by permission, from the Transactions of the Yorkshire Agricultural Society.*]

Public opinion is still much divided on the subject of subsoil-ploughing. Some very eminent farmers maintain that it is lost labour; while others, equally eminent, think no system of husbandry complete without it. When men of sense and experience differ respecting matters of fact which have come under their own observation, it will generally be found that, like the travellers disputing about the colour of a chameleon, neither would be wrong if he would only allow his opponent to be right. To take a case in point;—one farmer of my acquaintance drained deep, and used the subsoil-plough with every precaution and care, yet found it fail; another, following precisely the same plan, permanently improved the texture of the soil: both were anxious that their friends should profit by either the example or the warning, and lost no opportunity of making the result public. For want of a better term, both experiments were said to have been made on *stiff* soils: both are credible men; and the natural result of such conflicting testimonies is, that the question remains undecided. Here we feel the want of some acknowledged classification of soils founded on chemical analysis. No two witnesses could be more directly at issue than those alluded to above: and very possibly, both one and the other may have been quoted by the supporters or opposers of the subsoil-plough as triumphantly establishing their position. The moment, however, that the two experiments are referred to their place in the geological map the

whole difficulty vanishes. One was made in a stiff marly clay, on the new red sandstone formation; the other on that most tenacious of soils, the lias clay; the one was permanently improved; the other ran together again almost as soon as done.

It would be but waste of time to give any additional proof of what has already been fully established, viz.—that on some soils the subsoil-plough has been eminently useful; that on others it has signally failed. The grand desideratum, at present, is the discovery of some test which shall enable us, on the examination of any given soil, to pronounce tolerably confidently that it would be advisable or useless to subsoil it. I feel fully persuaded that the per centage of alumina, or pure clay, in any soil furnishes the required criterion. In the two instances quoted above I procured an analysis of the soils, and found that, in the one on which subsoiling was of no use, the proportion of alumina was twice as great as in the other: this most unexpected result first suggested the rule above stated; and in all the cases which I have since had an opportunity of examining it has been fully confirmed. A rule of this kind can only be established by numerous experiments on various soils; but if those gentlemen who are anxious to promote agricultural improvement would kindly forward to the Secretary of the Yorkshire Agricultural Society the result of their own experiments with the subsoil-plough, accompanied by either an analysis of the subsoil on which it was tried, or even a specimen of the subsoil for analysis, the question of subsoil-ploughing would very soon be set at rest; and it would be as easy to point out the soils which would be benefited by it as it is now to distinguish turnip and barley soils from those adapted for wheat and beans. I am aware that chemical analysis has hitherto been unattainable without so much trouble and expense as to put it out of the reach of most practical farmers; but I am happy to be able to state that Mr. Spence, chemist and druggist, Pavement, York, whose chemical attainments are beyond dispute, has kindly offered to furnish an analysis of any soil sent him, on very moderate terms. A list of charges, for a partial or complete analysis, will be found at the end of this article.

I will now state the steps taken to test the truth of the rule above mentioned; viz.—that the per centage of alumina ought to guide us in the selection of soils for subsoiling. I wrote to several gentlemen whom I knew to have used the subsoil-plough, and on whose accuracy I could rely, and begged that they would furnish me with some account of their experiments, and send me a specimen of the subsoil for analysis. I have, wherever practicable, given the account in the words of the writer; and can only regret that the shortness of the time has prevented my collecting more evidence on the subject. The following Essay was sent me by

that very intelligent farmer, Mr. Black, land-agent to the Earl of Zetland, at Marske, in Cleveland.

"There is probably no agricultural operation that has been so strongly recommended by some, and so much censured by others, as subsoil-ploughing. Its advocates have represented it as the great *panacea* for all soils and situations; and its introduction, they say, will form a new epoch in agriculture. Believing that neither party have viewed the subject properly in all its bearings, I beg leave humbly to offer a few remarks, first, on the soil that will receive the most permanent improvement from subsoil-ploughing; and, second, where it can be of no utility. The soil that I believe will receive the most permanent improvement from subsoil-ploughing is one in which silica predominates; indeed all shallow soils, of the lighter kinds, will be improved by it; and particularly so if there is any moorland pan, or indurated incrustations, formed by the weight of the plough going for a number of years at the same depth, or from other causes. If the subsoil is of good quality, and a greater depth of furrow is wished for, the subsoil-plough may be used with advantage; the percolation of water prepares the subsoil for amalgamation with the surface. Strong clayey land cannot be permanently improved by subsoil-ploughing. Alumina is a tenacious, compact, adhesive substance; its parts are in minute divisions, and have great affinity for each other. In September, 1838, I subsoiled two fields of 10 acres each, which had been previously drained, and as the *nomenclature* of soils is not at all intelligible, and has led to much mischief in detailing experiments, I send you the analysis of 300 grains of the field since ploughed.

300 grains consisted of—

	Grains.
Moisture	61
Soluble matter, principally vegetable	3
Lime, in the state of carbonate	2
Peroxide of iron	50
Alumina	130
Silica, or fine land	20
Vegetable matter	33
Loss	1
	300

"One of these subsoiled fields produced 35, and the other 27½ bushels of wheat per acre; the field that produced the greatest number of quarters per acre was subsoiled across the drains; the other parallel with them. I do not attribute this great fall-

ing off per acre altogether to the parallel subsoiling, although I think the other is decidedly the best method. In December, 1839, one of the fields was ploughed, but no traces remained of the subsoil-plough having been used. I expected, from the complete breaking up of the subsoil, that the parts would have remained distinct for years; but such was not the case: they had all run together, and were as compact as when first moved by the plough, without *even* the appearance of a water-shake or fissure. This I was not prepared to expect. Separated by a fence only is another field of a similar description, which was fallow at the same time, but not subsoiled; the crop on this field was quite equal to the other. A neighbour subsoiled one acre of a field which was sown with beans: this field I frequently saw through the summer, and during that period the part subsoiled was by no means superior to the other."

On reading this account my attention was naturally arrested by the great difference between the produce of the two fields subsoiled by Mr. Black; and as it was important to ascertain whether any sufficient cause could be assigned independent of the different methods adopted in subsoil-ploughing them, I addressed him the following questions:—Is the field which produced 35 bushels per acre of better quality than the one which produced 27½; or was it better manured, or the seed-time more favourable? His answer was as follows:—"The land (viz., that which produced 35 bushels) is much inferior. I ascribe the superior crop to the field having been more recently drained than the other. I have always found the first crop after draining above an average. Lime, too, was applied to this field two years before, which did not appear to have acted until the water was taken off: and last, although not least, it was subsoiled across the drains. As regards manure, I consider the fields alike in that respect. Both fields were sown under favourable circumstances." Draining after lime appears quite adequate to account for this increased produce; but even should we attribute a portion of it to subsoiling across instead of parallel to the drains, the whole effect seems to have vanished before the next ploughing, as we read in Mr. Black's account. In confirmation of Mr. Black's views, I will quote the opinion of Mr. Vansittart, of Kirkleatham, whose experiments I had an opportunity of observing whilst in progress. I need hardly add that they were made in the most judicious and effectual manner. "Upon subsoiling I have nearly made up my mind, and am satisfied that it is not of permanent use on this soil." We have here the experience of Mr. Vansittart, Mr. Black, and a neighbouring farmer, all of whom agree in thinking

that subsoiling is of no use on their land. The quality of land is the same in all; consisting of a level and uniform tract of that peculiarly tenacious soil, the lias clay, containing, as we see by the analysis furnished by Mr. Black (made at Edinburgh), no less than 43 per cent. of alumina or pure clay. The next evidence I shall adduce is that of Mr. Stevenson, of Rainton, near Boroughbridge, a very enterprising and judicious tenant-farmer; whose farm chiefly consists of a stiff red clay, on the red sandstone formation. He began by subsoiling 17 acres in the winter of 1835-6: the summer following, these 17 acres grew a remarkable crop of turnips, though the year was in general a failing one for that crop. The turnips were followed by barley, seeds, wheat, —all good crops. When ploughed deep again for turnips, at the end of the course, it was found to work much lighter than the land not subsoiled. The man who held the plough in both instances found a great difference in the mellowness of the soil turned up, and consequently in the labour of the horses. The subsoil, on analysis, showed 24 per cent. of alumina. The exact analysis is as follows:—

Specific Gravity, 2·070.
100 Parts contain—

Of water of absorption	7
Silica	55
Alumina	24
Oxide iron	7½
Soluble matter	2
Loss	4½
	100

Mr. Stevenson found so much benefit from the operation, that he has since subsoiled 27 acres, and means to continue it on a large scale. A glance at the experiments above described enables us to make a first approximation to the solution of this much debated question. It appears probable that a soil containing not more than 24 per cent. of alumina may be subsoiled with advantage, but that when it exceeds 40 per cent. no permanent improvement is derived from the operation. Many more experiments must be made before this approximation can be so modified as to make it of general application: and I would beg to suggest to those gentlemen who may feel disposed to assist in the inquiry, that any account of the use of the subsoil-plough on land containing more than 24 and less than 40 per cent. of alumina would be particularly valuable, as the first point to ascertain is, the maximum quantity of alumina which may exist in land without making it unfit for subsoiling. From what has been stated

above, there is reason to suppose that this maximum point lies between 24 and 43 per cent.; every experiment, therefore, made on soil containing more than the one and less than the other, reduces the doubtful soils within narrower limits. It would also be advisable to try the effect of subsoiling on two soils containing equal quantities of alumina, but otherwise differing in their composition, as it is possible that other substances, in combination with alumina, may in some degree affect the result.

I have thus far confined myself to stiff soils; but as the subsoil-plough has been little used on light land, and its effect therefore is little known, the following paper from Mr. Denison, of Kilnwick Percy, will be read with great interest.

"That much good is effected upon strong land by draining and subsoil-ploughing is a fact that is generally considered to be incontrovertible: but few have been hitherto met with who would not ridicule the idea of applying the same operation to light blow-away sand: and as it is to this latter description of land that I have chiefly turned my attention and experiments, I will confine myself to what I really know and have experienced.

"In the year 1837 I purchased a considerable tract of sandy land, and I will now mention the mode by which it was brought into cultivation; and I feel so thoroughly grateful to the subsoil-plough for the share it has had in my success, that I cannot do sufficient justice to it without fully explaining the system upon which I worked;—and then I will leave it to my readers to judge whether I can say too much in its praise.

"The tract of land upon which I began was in extent about 400 acres, the principal part of which was rabbit-warren. The general character of this tract was, that, although upon the whole it was nearly a level, yet the surface was undulating; the sandy swells being covered with heather, and the hollows a bed of aquatic plants, being for many months in winter entirely covered with water. Of the sandy hills, the soil, as far as I am able to judge, was a sterile, impalpable sand, having been heretofore cultivated, and again abandoned. About 6 or 8 inches below the surface this sandy soil seemed to become hardened into almost a sandstone, with the occurrence occasionally of an impervious bed of ironstone; presenting, wherever it did occur, a complete obstacle to the entrance of the ploughshare: generally speaking, however, these nodules, or beds of ironstone, lay at a depth somewhat below the ordinary ploughings. The marshy hollows were of a totally different nature, and their cultivation had never been attempted; an idea apparently having prevailed that they were below the reach of drainage. When become dry, the soil of these

hollows appeared to be a black vegetable mould, extending to a considerable depth; in some places peaty, in all containing a large proportion of inert vegetable matter.

"Upon considering the character of this tract of land, I thought that the principle of subsoiling would be equally applicable to the light sandy hillocks and the marshy levels. Upon the higher grounds it was obvious that, when under cultivation, the sun had very great power over the 6 or 8 inches of stirred soil, and that thus vegetation was either burnt up, or, if a strong ground-wind came, there was danger of the contents of one field being blown into another. If, therefore, by stirring to the depth of 16 instead of 6 inches, a greater volume of soil could be obtained, the power of retaining moisture would be proportionally increased, although the constituent parts of the surface remained unaltered; for I never contemplated that which by some is confounded with, and by others preferred to, subsoiling; I mean trench-ploughing. I am of opinion that, in very few cases, if any, is the soil underneath more fitted for vegetation than that of the surface; least of all in a case like the present: a hungry ferruginous subsoil could be no amendment upon a surface however sterile. Experience has shown that this theory is correct, and that on sandy soils the advantage to be derived from subsoiling is from obtaining a greater depth, and consequently a greater power to absorb moisture. On the level marshy portions of this tract the benefits, though not so obvious in theory, have proved equally clear in practice. The subsoil-plough has broken through the mass of tough vegetable matter, tearing up the roots of rushes and other fen weeds, which were beyond the reach of the common plough.

"My first operation was to carry a main drain through the whole estate, and this was not only an expensive job, but one also which required considerable precision; for upon the accuracy of its level depended the success of the whole drainage. Nor, when the drain was made and the surface water conveyed away, was half the requisite treatment effected; for it proved that the sandy elevations, of which I have so often spoken, were the receptacles of springs, so that in the whole of the estate I purchased, though termed a sandy waste, there was hardly a single acre which did not require draining previous to subsoiling.

"The main open drain being carried through, the next thing was to make main hollow drains leading into it, bottomed with tiles, of the width and height of 6 inches, and covered with a sod 4 inches thick, taken from the nearest hedge-side. I prefer sod to sticks, ling, or straw, for it allows the water to percolate freely and does not shrink. The depth of these leading tiled drains varies much, according to the undulations of the surface. In some cases it was necessary to cut them between 6 and 7 feet deep,—

altogether at an average of 4 feet: into these drains were brought the smaller ones, laid with tiles of the width and height of 3½ inches, placed at every 12 yards apart, and of the same average depth as the others. I consider it prudent to have in every 5 acres one leading drain with an outlet into the main open one: the mouths of the outlets should be of kyanised wood, with a swing-door, for the sake of preventing the possibility of the outlet being trodden up or destroyed by frost acting upon the tiles.

"The expence of the main open drain depends upon so many circumstances that no accurate estimate can be given.

"An acre of the tiled drainage, laid out as above, will cost—

	£.	s.	d.
Cutting and putting in tiles	1	11	6
Large and small tiles	2	2	8
	3	14	2
Leading do. from the kiln	0	4	6
	£3	18	8

"The above particulars have been given somewhat at length, from the conviction of the great importance of effectual drainage; and that without it subsoil-ploughing will do more harm than good.

"The first process after the drains were complete was in the months of March and April to pare and burn; and to sow rape and turnips, drilled with half-inch bones and soot in the following month. The crop was not at all regular; being good where the soil was deep and black, but very bad where it was sandy: the sole being hard and the action of the sun having great power to the very roots of the plants.

"In the winter of the same year, after the turnips and rape were consumed, I ploughed the land in the direction of the old furrows, and *the subsoil-plough followed*, worked by two oxen and four horses; loosening the hard sandy sole on the higher ground, and tearing up the roots of the rushes, &c., on the low. In this state the land lay till the month of April following, when Finlayson's drag-harrow was applied across the ploughings, which brought up all the roots and rubbish to the surface; these were then raked off and burnt. I then sowed the black Tartarian oats, and ploughed them in: the ground was then harrowed and pressed down with a clod-crushing roller, made by Mr. Croskill, of Beverley, which implement has been of the greatest service to me in almost every stage and crop. It has been the means of consolidating the earth, which would otherwise have been too light, and it has kept the moisture in also. It has a decided advantage

over every other kind of roller in this respect, because it leaves an uneven surface instead of a flat one, from which the rain, in sandy land especially, is apt to run off without nourishing or re-reshing the crop.

"The oats came out very healthy, and had no check: in sixteen weeks from the time of sowing they were reaped, and when thrashed yielded 10½ quarters per acre, which were sold at 26*s.* per quarter, and this from land that was let two years before at 2*s.* 6*d.* per acre.

"I calculate the expence of subsoil-ploughing, according to my mode of using it, at 26*s.* per acre, thus:—

Four horses and two men, per day .	14*s.*
Two beasts and one man . . .	5*s.*
	19*s.*

These will do 3 roods per day. The oxen are yoked to the plough, and the four horses precede. I sowed 40 acres with oats, of the same flat of land that had been pared and burnt, but not subsoil-ploughed, from want of time. The produce of this was not more than 3 qrs. per acre, and straw small and short; a very fair proof of the advantage of subsoiling.

"I have now 100 acres of wheat and oats growing on what was the very worst part of the whole property, and considered perfectly useless. It has been drained, pared, and burnt, and subsoiled exactly after the mode above detailed; and it looks as promising as what was so good last year. The land upon which I had potatoes exhibits as decided a superiority; and I shall in another year be able to state what effect subsoiling has upon the turnip-crop as upon the produce of the wheat. The ploughs weigh 16 st., being the lightest and easiest to work of any I have yet seen: they were made by Messrs. Walker, ironfounders, York.

"R. Denison."

The only other case I shall bring forward is one in which the subsoil-plough was used in breaking up moor-pan. The Rev. Mr. Croft, of Hutton-Bushel, who occupies some moorland, lying on the calc-grit, thus describes the effect of subsoiling:—

"The surface-soil is little more than half a spade deep, not positively peat, but next akin to it; at this time of year (November) it was always fetlock-deep: under this is the pan, about two inches thick and as hard as iron. We broke a pick-axe in getting a specimen for you. Below the pan is the rubbly soil, of which I also send you a specimen for analysis. On this land nothing would grow. In summer the crops would appear healthy and good, but before harvest always dwindled away. I found it

impossible to use the subsoil-plough with four horses, but by fixing a wheel to it (which made it work much steadier), and using six horses, we got on tolerably well: though it was very hard work for both horses and man. Immediately after subsoiling I sowed oats with Sinclair's grass-seeds. I had a full crop of oats, so heavy, indeed, that they were all flat on the ground, and not ripe till November: the seeds have been hard stocked all this year with sheep and *young horses*, which, as you know, are the worst of all stock for year-old seeds; but the herbage is good, and the land quite firm under you. Before subsoiling, the land was not worth 5*s.* an acre: it is now let at a guinea."

In this case the advantages of subsoiling were great and immediate, and evidently arose from the drainage effected by breaking up the pan, which was impervious to water; whilst the rubble below was highly porous, and afforded a ready passage to the stagnant water, which caused the previous sterility. I was therefore anxious to have an analysis of the pan and rubble below, in the hope of discovering some marked difference in their composition, which would account for the hardness of the pan. On analysis, they proved so very nearly identical in their nature that I could not help suspecting some inaccuracy in the operation. To prevent all doubt on the subject, Mr. Spence furnished me with a second analysis of both, made with great care; and I subjoin the average result, which makes it very clear that the pan is only hardened rubble: how it became so hardened remains a problem for future solution.

Moor-pan.	Average.
Specific gravity	2·204
Water of absorption	5½
Silica	75
Alumina	10½
Oxide of iron	6¾
Soluble matter, consisting of sulphate lime and chloride sodium	½
Loss	1¾
	100

Rubble below the Pan.	Average.
Specific gravity	2·2505
Water of absorption	5
Silica	77½
Alumina	8¾
Oxide of iron	6¼
Soluble matter, consisting of sulphate lime and chloride sodium	½
Loss	2
	100

I have now exhausted all the materials at present in my possession which bear upon the subject before us: and, by way of recapitulation, beg to express my entire concurrence with Mr. Black's opinion, that for moor-pan or sandy soils, where any incrustation has been formed at the depth of the ordinary furrow, the subsoil-plough cannot be too highly appreciated. I am even inclined to go further, and to think, with Mr. Denison, that on deep sands, or even sandy loams, the depth of soil stirred is of great importance to vegetation. To test this opinion, I have had a very light subsoil-plough made by Mr. Buxton, of Malton, which, with four horses, stirs 12, or even 14, inches of the light loam on which it has been tried; and the effect of this ploughing on turnips and other root-crops I hope to give to the public in some future Number of "The Transactions." With respect to stiff soils, I must repeat my conviction that, by trials on clays of various degrees of stiffness—the stiffness of the soil not being guessed at, but ascertained by careful analysis—we may soon discover the average per centage of pure clay which will justify a prudent farmer in incurring the expence and labour of subsoil-ploughing.

Kirby-Hall, Dec., 1840.

The following directions and list of charges have been furnished, at my request, by Mr. Spence, Pavement, York.

Any soil collected for analysis should be supplied to the chemist in quantity of about one pound.

From some part of the field where it appears to be of an average quality several spadesful should be taken; when this has been thoroughly mixed, a quantity of it should be placed under a shed, upon a clean board, and spread into a thin layer. Upon being turned over frequently, during three or four days, it will have become of a proper dryness. It should then be folded in stiff paper, upon which the name of the occupier of the land, with his place of residence, and the designation, if any, (or otherwise a number,) of the field from which it has been taken, should be distinctly inscribed.

The following scale of charges has been drawn up in order to facilitate the obtaining of information on any particular point without incurring needless expence.

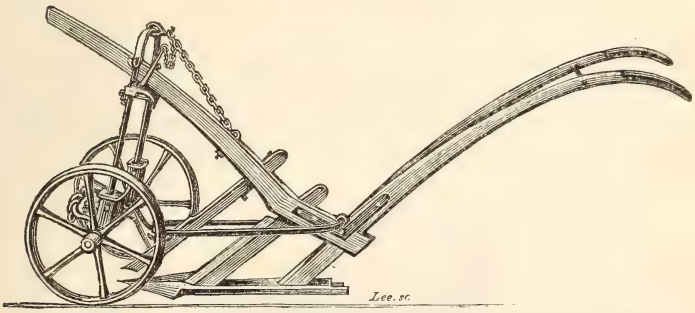
For finding in any Specimen of Soil the Quantity—

		s.	*d.*
1st.	Of vegetable and animal matter	5	0
2nd.	Of calcareous earth	5	0
3rd.	Of matter soluble in water	5	0

		s.	d.
4th.	Of carbonate of lime and carbonate of magnesia	10	0
5th.	Of alumina	10	0
6th.	Of gypsum (sulphate of lime)	10	0
7th.	Of gypsum and phosphate of lime	12	6
8th.	Of alumina and oxide of iron	12	6
9th.	Of silica, alumina, oxide of iron, and vegetable matter	15	0
	A statement of the quantity of water of absorption and of soluble matter, as also of the specific gravity, will be supplied in addition to any of the above, at a further charge of 2*s.* 6*d.* each.		
10th.	Of silica, alumina, oxide of iron, carbonate of lime, carbonate of magnesia, vegetable, animal, and soluble matter, and of water of absorption, and the specific gravity . . .	21	0

Accuracy may be equally relied upon whether one or more particulars are required. No. 9 would frequently exhibit all the essential constituents of the soil. No. 10 would supply (except in some unusual cases) abundant information for any practical purpose. In any analysis of a more complicated kind, as where separate statements of the composition of the sand, of the minutely divided matter, and of the soluble contents, are required, the cost will be increased in proportion.

III.—*On the Rackheath Sub-Turf Plough.* By Sir Edward Stracey, Bart., F.R.S.



The Rackheath Sub-Turf Plough: invented by Sir Edward Stracey.*

To the Secretary.

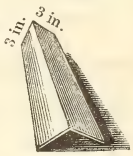
Sir,

In consequence of the applications of many of my friends for a sketch of my Sub-Turf Plough I send you herewith such sketch.

* Manufactured by Barnard and Joy, Norwich.

I have had it made as plain and as clear as I possibly could: I trust therefore that there will be no difficulty attending the making of other ploughs from it, if required. From the above sketch of the Sub-Turf Plough it will easily be seen that it differs but little from the plough commonly in use in this county. The chief difference consists in the share having two wings instead of one wing, and in the absence of the mould-board or breast. Very little have I to add respecting the method of using, or the advantages derived from the use of the plough to those which I stated in my letter to the Royal Agricultural Society (see Third Part of the Journal, p. 256), excepting that after an experience of nearly two years it has fully answered my expectations; and I can give no better proofs of its merits than by the extensive adoption of it by my neighbours, in subsoiling their meadows and pastures; and so perfectly satisfied am I with the results arising from the use of the plough, that I have despatched one of the ploughs to subturf some meadow and marsh lands about twelve miles from this place; and hope to have about 120 acres subturfed between this time and the ensuing spring.

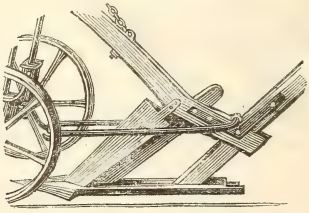
I send you also two sketches; one of an implement which I call the Pig's Head (from its shape being similar to the head of



18 inches.

Pig's-Head.

that animal), for the purpose, when attached to the plough, of throwing potatoes out of the ground, instead of forking; and when attached to the plough for that purpose, the coulter must, in the first place, be removed: and the plough with the coulter



Sub-Turf Plough with the Pig's-Head attached.

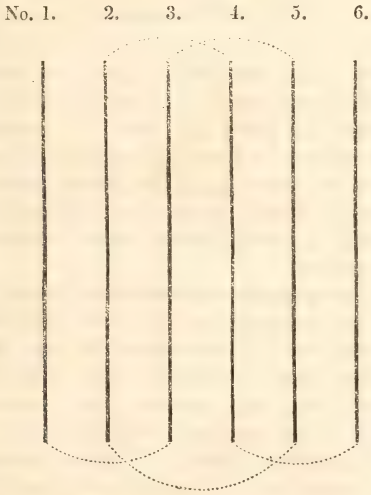
thus removed, and the pig's-head attached, will, with two horses and the driver, if properly worked ten inches deep, employ eight

women or lads in gathering an average crop of potatoes:—and the other is a sketch of the Iron Hands for finding the potatoes

Iron Hand.

when turned out by the plough.

The pig's-head plough, with the coulter removed from the sub-turf plough, and the pig's head attached, is worked by two horses abreast, and one man conducting it. No two adjoining rows of potatoes should be ploughed consecutively, lest the pickers should not have sufficient time allowed them to remove the potatoes thrown out (by the plough) of the preceding adjoining row, before they are covered by the potatoes and soil of the succeeding row. The ploughing, therefore, should be thus conducted; the perpendicular lines represent the rows of potatoes:—



Go down row 1, up 3, down 5, up 2, down 4, and up 6, and so on through the field. The eight women or lads are so placed in four divisions on the most convenient parts of the two rows to be next ploughed, one in each division carrying an iron hand to scratch out the potatoes removed by the plough, and the other carrying a basket into which they are to be gathered. Two men

are also to be employed, each with a basket, to take away the filled baskets, to replace those filled with empty baskets, and to carry the filled baskets to the carts prepared for their reception.

Hard frosts have commenced very early this season; but by this plough, and the gatherers above stated, I have been enabled to clear 1½ acre of land each day, and to secure the potatoes from the effects of the frost; of the great saving in the expense of getting I say nothing, as every potato-grower can calculate that.

I am, Sir, yours, &c.

E. Stracey.

Rackheath Hall, near Norwich,
30*th Nov.*, 1840.

IV.—*On the White or Belgian Carrot.* By John C. Morton, Esq.

To Ph. Pusey, Esq., M.P.

Sir,

I am desired by my father to send to you the particulars of the crop of white or Belgian carrots on Lord Ducie's farm at Whitfield. The extent of the piece is 1 acre, 36 perches, from which 64 cart-loads of roots were taken. The average weight of a cart-load was found to be 10 cwt. This gives 32 tons as the total weight of the crop, which is at the rate of 26 tons 3 cwt. per acre. The soil is a deep, sandy loam, belonging to the new red sandstone formation.

This is a heavier crop than any other on the farm. The seed was sown in the second week in April, on land which had been ploughed 10 inches deep. It was sown on the flat, in rows 18 inches apart, by the common Suffolk drill. The seed had been mingled with damp sand for several days previous, as well to sprout it partially, as to render it capable of being drilled, as carrot-seed clings so much together. They are singled out when a fortnight old to intervals of 6 inches in the row, and two horse-hoeings, with a hand-hoeing whenever the weeds made their appearance, was all the cultivation they received.

The result is a crop not only much more valuable per ton than any other green crop we have, but also heavier per acre, and raised at an expense less by at least one-half than that attending the cultivation of the turnip.

The crop on the land the year before was Swedes, which were

carried off the land and sold. No dung of any kind was put to the carrots.

I am, Sir,
Your most obedient servant,

JOHN C. MORTON.

Chester Hill, Nov. 18, 1840.

(Note by Mr. Pusey.)

This carrot, though it has been long grown as a field-root in Flanders, has been but very lately introduced into England: it is, however, much liked by those who have tried it in my own neighbourhood. A farmer, Mr. W. B. Harris, who has grown it for two years on a good free loam, gives me the following account of it:—" On taking up my carrots and weighing them, I find they fall short of the quantity I grew last year. Instead of the white carrots weighing nearly 32 tons per acre, they will only weigh 20 tons this year; and instead of the red ones weighing about 16 tons, they only weigh 12 tons this year. I have generally found the difference between the red and white carrot to be as follows (in all cases where I have weighed them and in all cases of inquiry):—The white generally exceed the red ones in weight from 8 to 9 tons per acre, when you take the average of the field as I have done now. I attribute the failure in my crop this year to two or three things. In the first place, the land was not subsoiled; in the second, they were planted late, and the weather too dry; and in the third place, they were hoed too thin—they were hoed the last time with a bean-hoe."—Even the diminished crop of Mr. Harris, however, is very considerable, as it is equal in weight to an excellent crop of swedes, and is twice as valuable. On some lighter land 16 tons of the white carrot were grown last year, where the red field-carrot gave a very poor crop. I ought to add that I have not succeeded in raising more than eight or nine tons myself; but this new root has in its favour the high practical authority of the Yoxford Farming Club, who " recommend strongly the cultivation of the long white carrot, as it produces a heavy crop of good quality, and adapted to strong as well as mixed-soil lands, will keep well, and is excellent food for cart-horses." It has been stated to me that there are two varieties, and that the best of the two is that which makes a large portion of its root above ground. Sir C. Burrell has grown it in Sussex, and has found it very productive. Colonel Le Couteur informs me " that in Jersey the prize-crop of parsnips this year afforded 318 lbs. to the perch, or 23 tons to the acre, while the white carrot, a

prize-crop also, which he had cultivated experimentally, gave him 524 lbs. to the perch, or nearly 38 tons to the acre—an enormous crop," he adds, "which, if equally valuable for butter as the parsnip, will of course supersede it, as his parsnip-crop in the same field, cultivated alike, only produced 16½ tons, which, nevertheless, was a very fair crop."

PH. PUSEY.

V.—*On the Early Horn-Carrot.* By Lord DUCIE.

MY DEAR PUSEY,

I SEND you, as you desired, an account of the early horn-carrots grown on my Hill Farm, at Woodchester. The land on which they were grown is a stone brach, on the table-land at the top of Frocester Hill, and certainly not land apparently likely to grow carrots of any sort.

I should first state that the early horn-carrots are about five or six inches long, and as thick as a man's fist; and have been generally grown only as garden carrots.

The field in which they were grown was a clean wheat-stubble, which was ploughed 5 inches deep (the full depth of the soil), in December; a Biddle's scarifier was put over the land twice previous to the seed being sown on the 22nd of March, *without any manure.* The seed was well-mixed with 2 or 3 bushels of ashes; and sown with a Suffolk drill, with 12 inches between the rows.

The quantity produced was 263 lbs. a perch; or 18 tons 15 cwt. per acre. The expense of cultivation and harvesting amounted to about 6*l.* per acre.

The land on which these carrots were grown will not, with the best cultivation, bear on an average so much as 14 ton of Swedes to the acre.

Carrots are this year worth more than 3*l.* a load in this neighbourhood: 2*l.* is their general price. They are undoubtedly an excellent food for fatting sheep, particularly when used with bean-meal. I am therefore so satisfied with the early horn-carrots that I shall grow them more extensively next year.

I should add, that a few drills of Altringhams were sown, which broke in the harvesting, and did not produce so much by 7 lbs. a perch.

Believe me yours truly,

DUCIE.

Ampney, Dec. 4, 1840.

VI.—*On the Agriculture of the Netherlands.* By the Rev. W. L. Rham, A.M., Vicar of Winkfield, Berks.—Part I.

Having been requested by the President and the Journal Committee to communicate the result of my observations on the present state of agriculture in the Netherlands, I shall endeavour to comprise, in a short essay, those peculiar modes of cultivation which have made that portion of the continent of Europe so superior to the surrounding countries in an agricultural point of view, and which throw considerable light on the true principles of practical husbandry. Some of the details have been laid before the public in the "*Farmer's Series of the Library of Useful Knowledge,*" under the title of "*Outlines of Flemish Husbandry.*" I shall take the liberty of quoting largely from this little work, which, having been written on the spot, and referring to particular farms, of which the names are given, may be relied upon as giving a correct account of the modes of cultivation, and of the details of the practice generally adopted there.

The climate of the Netherlands, from the borders of France to the northern part of Holland, along the coast of the North Sea, and for 50 or 60 miles inland, differs little from that of Kent or Essex, in England. From its geographical position, forming a part of the continent of Europe, it is warmer in summer and colder in winter than the central part of England. The quantity of rain which falls there is not so great, especially in winter, as in those parts of England which lie on the opposite coast; but the snow covers the ground for a much longer time. This causes a material difference in the time of ploughing the land and sowing the seed in spring.

The quality of the soil is various.. Towards the northern part of Flanders and Antwerp, and the southern part of Holland, it is a poor loose sand, almost as barren as that which is found on the sea-shore blown into hillocks and only kept together by the roots of the sea-bent (*Arundo Arenaria*). If it were not for a small portion of mud occasionally mixed with this soil the water would freely percolate through it, and no vegetation could be supported. In proportion to the quantity of the mud, which is a very fine clay with a portion of decayed shells and organic matter, the soil is more or less fertile; and when the mud enters into it in a considerable proportion, it forms a rich, compact loam. In many places there are alternate narrow strata of sand and loam, which, being mixed together, form a very productive soil. A small portion of carbonate of lime, produced from the decomposition of sea-shells, is found in the mud, when it is analysed; but there is no limestone, chalk, or marl, in any portion of this coast.

When the sand is of considerable depth, and little or no loam is found near the surface, it becomes a difficult and tedious process to bring it into a state of productive cultivation. The sandy heaths which lie between Antwerp and the Maese are of the most unpromising kind; and with all the industry of the Flemings and Dutch, a great portion is still in a state of nature, producing nothing but scanty tufts of heath, interspersed with a few very coarse grasses. But even in these barren sands there are many green spots, which have been forced into cultivation. The following passage in the "Outlines" is a faithful representation of such improvements:—

"The poor sandy heaths, which have been converted into productive farms, evince the indefatigable industry and perseverance of the Flemings. They seem to want nothing but a space to work upon; whatever be the quality or texture of the soil, in time they will make it produce something. The sand in the Campine can be compared to nothing but the sands on the sea-shore, which they probably were originally. It is highly interesting to follow step by step the progress of improvement. Here you see a cottage and rude cow-shed erected on a spot of the most unpromising aspect. The loose white sand blown into irregular mounds is only kept together by the roots of the heath: a small spot only is levelled and surrounded by a ditch; part of this is covered with young broom, part is planted with potatoes, and perhaps a small patch of diminutive clover may show itself; but there is a heap of dung and compost forming. The urine of the cow is collected in a small tank, or perhaps in a cask sunk in the earth; and this is the nucleus from which, in a few years, a little farm will spread around.

"In another spot more extensive improvements are going on; a wealthy proprietor or lessee is trenching and levelling the surface, sowing broom-seed, and planting young fir-trees, which are to be cut down in a few years. In another, the process has gone on further: the firs or the broom are already cut down; a vein of loam has been found, and is dug out to be spread over the sandy surface; the cart with liquid manure is preparing the surface for the reception of seed, or the same, diluted with water, is poured over the young blade just appearing above ground. The soil is created, and, if the cost and labour were reckoned, is paid for at a dear rate: but perseverance insures success, and there are few instances of improvements being abandoned, after they are fairly begun, unless they were undertaken on too large a scale; but then the land is soon divided into smaller portions, and improvements go on from different centres, and with more certainty."—pp. 11, 12.

Trenching and levelling the surface is always the first operation in bringing a barren soil into cultivation. The Flemings and Dutch are very expert in this operation:—

"The instrument they use is a light wooden trenching-spade, the end of the blade only being shod with iron: the handle of this spade is about 2 feet long, the blade from 12 to 15 inches. A light pick-axe is used to break the pan where it appears. A ditch is dug with the trenching-

spade 2 or 3 feet wide, and as deep as the trenching is intended, generally 2 feet, or at least 20 inches ; this ditch is filled with the earth which is taken in long thin slices from the edge of the solid side of the ditch. Every slice is distributed carefully, so as to mix the whole, and keep the best soil at top, and likewise to fill up hollows and level eminences. If there is more than can conveniently be spread level, little heaps are made of the superfluous earth, which are afterwards carried, in an ingenious manner, to fill up more distant hollows, by means of horses and an instrument which is called a *mollebart*. Wherever there is a pan, it is carefully broken, and the loam, which is always found under it, is mixed with the sand dug out. Draining is seldom required here, except that which is effected by making deep ditches to carry off the superfluous rain-water, which, in a country almost as level as a lake, is no great difficulty. . . . .

"If there is no manure at hand, the only thing that can be sown on poor sand, at first, is broom : this grows in the most barren soils ; in three years it is fit to cut, and produces some return in fagots for the bakers and brickmakers. The leaves which have fallen have somewhat enriched the soil, and the fibres of the roots have given a certain degree of compactness. It may now be ploughed and sown with buckwheat, or even with rye, without manure. By the time this is reaped some manure may have been collected, and a regular course of cropping may begin. As soon as clover and potatoes enable the farmer to keep cows and make manure, the improvement goes on rapidly ; in a few years the soil undergoes a complete change : it becomes mellow and retentive of moisture, and enriched by the vegetable matter afforded by the decomposition of the roots of clover and other plants. . . . .

" If about 20 small cart-loads of dung can be brought on each acre of the newly trenched ground, the progress is much more rapid. Potatoes are then the first crop, and generally give a good return. The same quantity of dung is required for the next crop, which is rye, in which clover is sown in the succeeding spring ; and a small portion is sown with carrots, of which they have a white sort, which is very productive and large in good ground, and which, even in this poor soil, gives a tolerable supply of food to the cows in winter. Should the clover fail, which sometimes happens, the ground is ploughed in spring, and sown with oats and clover again. But if the clover comes up well amongst the rye stubble, it is cut twice, after having been dressed with Dutch ashes early in spring. It is mostly consumed in the green state. The cloverley is manured with 10 cart-loads of dung to the acre, and rye sown again, but not clover. After the rye comes buckwheat without any manure ; then potatoes again, manured as at first, and the same rotation of crops follows. It is found that the poor land gradually improves at each rotation from the quantity of dung used. . . . .

" For want of sufficient manure, broom-seed is sometimes sown with the rye after the clover. The rye is reaped, and the broom continues in the ground two years longer. It is then cut for fuel. The green tops are sometimes used for litter for the cows, and thus converted into manure. It is also occasionally ploughed in, when young and green, to enrich the land. Oats, clover, and broom are occasionally sown to-

gether. The oats are reaped the first year, the clover and young broom-tops the next, and the broom cut in the third. This is a curious practice, and its advantage appears rather problematical. All these various methods of bringing poor sands into cultivation show that no device is omitted which ingenuity can suggest to supply the want of manure.

"After the land has been gradually brought into a good state, and is cultivated in a regular manner, there appears much less difference between the soils which have been originally good and those which have been made so by labour and industry. At least the crops in both appear more nearly alike at harvest than is the case in soils of different qualities in other countries. This is a great proof of the excellency of the Flemish system; for it shows that the land is in a constant state of improvement, and that the deficiency of the soil is compensated by greater attention to tillage and manuring, especially the latter. The maxim of the Flemish farmer is, that 'without manure there is no corn; without cattle there is no manure; and without green crops and roots cattle cannot be kept.' Every farmer calculates how much manure he requires for his land every year. If it can be bought at a reasonable rate, he never grudges the outlay. If it cannot be purchased, it must be made on the farm. A portion of land must be devoted to feed stock, which will make sufficient manure for the remainder: for he thinks it better to keep half the farm only in productive crops well manured, than double the amount of acres sown on badly prepared land. Hence also he does not reckon what the value would be of the food given to the cattle, if sold in the market, but how much labour it costs him to raise it, and what will be the increase of his crops from the manure collected. The land is never allowed to be idle so long as the season will permit anything to grow. If it is not stirred by the plough and harrows to clear it of weeds, some useful crop or other is growing in it. Hence the practice of sowing different seeds amongst growing crops, such as clover and carrots amongst corn or flax; and those which grow rapidly between the reaping of one crop and the sowing of another, such as spurrey or turnips, immediately after the rye is cut, to be taken off before wheat-sowing. These crops seem sometimes scarcely worth the labour of ploughing and sowing; but the ploughing is useful to the next crop, so that the seed and sowing are the only expense; and while a useful crop is growing, weeds are kept down."—pp. 12, 13, 14.

The process here described is the only one, which, allowing for difference of soil and other circumstances, can bring very poor land into a state of profitable cultivation. In the neighbourhood of Aberdeen, in Scotland, on a very different, but still very poor soil, deep trenching with the spade, and judiciously mixing the different earths which are dispersed through the soil, have been found the most efficacious, and, in the end, the cheapest mode of transforming large tracts of peaty moor, full of granite rocks and stones of all sizes, into cultivated fields. The change produced in the aspect of the country is no less striking here, after a few

years, than that of the improved heaths of the provinces of Antwerp and Guelderland.

The most rapid improver of loose sands is rich liquid manure, affording immediate nourishment to plants, which otherwise, for want of moisture, would languish, even with an abundance of solid dung; for this last remains altogether inert, until it be moistened and partly dissolved. When the fibres of the roots spread, they bind the loose sand, and prevent the too rapid evaporation and percolation of the moisture. These roots remain in the soil when the crop is reaped, and by their decay afford organic matter for the nourishment of the next crop. Hence it is evident that the plants which have long spreading roots, if they can be made to vegetate vigorously by an ample supply of liquid manure, greatly improve very light sands, and, in process of time, by the decay of the vegetable fibres, produce such an increase of humus as entirely to change the quality of the soil.

The collection and preparation of liquid manure is an object of primary importance with the Flemish farmer: every farm has, near or under the stables and cow-houses, one or more capacious tanks, into which the urine of the animals and the washings of the stables flow; and every exertion is made to increase the quantity and improve the quality of the tank liquor.

"The tanks are generally sunk below the level of the ground, and have the sides built of brick, and the bottom paved: they are of various dimensions, according to the number of cows and horses on the farm. Attached to the distilleries, where many beasts are constantly kept to consume the refuse wash, there are very large urine-tanks, of an oblong shape, divided by partitions into different chambers, so that the liquor may be of the proper age when it is used, which some farmers think ought to be six months.* Each chamber is about 8 feet square and 6 or 8 feet deep: these are sometimes vaulted over, but frequently only covered with loose boards. As urine and the emptyings of privies are sold wholesale and retail, there are many large tanks near the rivers and canals, where the dealers have sometimes great quantities in store. Some of these consist of many square pits like tan-pits, bricked round, and the inside covered with a cement, which prevents loss by filtration. There is generally in a corner of each pit a graduated scale, by which the number of barrels, or tons of liquid in the tank may be ascertained, by observing the height of the surface. These tanks are gradually filled by boat-loads brought from the large towns; and when the season arrives for sowing, in spring and autumn, the farmers come with their carts and tubs, and purchase as much as they may want. The price varies from three to five francs (2*s.* 6*d.* to 4*s.*) per hogshead, according to the quality. In a small farm of 30 to 40 acres the tank is generally about 20 feet long, 12 wide, and 6 deep, with a partition in the middle,

* But this depends on the season of the year and other circumstances, as will be seen below.

and arched over, leaving a small round opening for the pump, and another sufficient to allow a man to go in to empty out the earthy deposit which accumulates at the bottom. A trap-door shuts over this last aperture to prevent accidents. Sometimes the tank is round like a well, with a dome top, and so deep in the ground, that it has a foot or two of earth over it. The situation of the tank is either in the farm-yard near the entrance of the cow-house, or immediately behind it: sometimes it is like a cellar under the building; but this is apt to cause a disagreeable smell in the cow-house. We here describe those tanks which we consider the most convenient: the form and capacity of them vary greatly, according to the means and notions of the proprietors of the farms; but a tank of some kind or other is considered as indispensable an appendage to a farm as a barn or a cow-house. The farmer would as soon think of dispensing with his plough as with his tank: and no expense or trouble is spared to keep it well supplied.

"The numerous towns and villages in Flanders afford great help in the way of manure. The thrifty housewife and her active substitute the maid know the value of what in our households is thrown away, or wasted and lost. A small tank, or a tub sunk in the ground, in some corner, contains all the liquid which can in any way be useful; soap-suds, washings of dishes, &c., are carefully kept in this reservoir until, once a week, the farmer or contractor calls with his tub on a cart; and this, mixed with the contents of privies, which are frequently emptied, he keeps in large cisterns for use or sale.

"But this supply is not always adequate to the wants of the farmer; and then he has recourse to rape-cakes dissolved in water, or in the tank liquor, which is expensive, and can only be profitable when flax bears a good price, this being the crop for which rape-cakes are chiefly used as manure. Every means, therefore, of augmenting the supply of urine is had recourse to, and the most efficacious is the establishment of distilleries. These answer the double purpose of consuming produce and increasing manure by the number of beasts which are fattened on the refuse wash. It is calculated that every beast produces at the rate of 10 or 12 tons of dung and 26 hogsheads of urine in the year. A moderate distillery has 50 or 60 head of cattle constantly stalled. Here then is a supply of manure for several hundred acres of land every year. Formerly there were a great many distilleries in Flanders, but the duty on spirits and the interference of the government has much reduced their number; so that the farmers complain of the loss of this manure, and the consequent deficiency of their crops. . . . .

"Liquid manure is carried to the fields in common water-carts, which consist of two wheels and shafts, carrying a cask containing from 60 to 120 gallons of liquid. The cask has in the under part a hole, 2 or 3 inches in diameter, secured inside by a valve; under this is a board a little slanting, to spread the liquid as it flows out of the cask. A man usually rides on the horse which draws the cart, and holds in his hand a string, which passes through a hole in the cask and opens the valve when required. There is an advantage in riding on the horse, as it does not add to the weight of the load on the wheels, which in light soils would be apt to sink deep. In a momentary exertion it assists the horse

by the weight on his back; and the heavy Flanders horses are well able to carry a man and draw a light load at the same time. When the cask is empty the horse trots home for another load, and no time is lost. It is astonishing what advantage there is in accustoming horses to trot when they have no load; it actually fatigues them less than the continued sleepy walk. Who would suppose that the Flemish and Dutch farmers surpassed us in activity? but whoever has been in the Netherlands in hay-time or harvest must acknowledge it."—pp. 21, 22, 24.

The value of cows' urine with other animal substances dissolved in it is universally admitted by all the farmers of sandy soils in the Netherlands: the theory of its preparation and application to the soil remains, however, yet involved in some degree of obscurity; and some eminent chemists have doubted whether the collection of it in a tank is the most economical mode of preparing it for the soil.

In the fourth number of this Journal there is a translation of a very valuable Treatise on Animal Manures, by Sprengel, in which (p. 474) it is more than insinuated, that the advantages of the urine-tank are much over-rated; and that it is better to mix the solid and liquid parts of dung together, and form them into composts with rich earth, as is often done in England and other countries, than to preserve the fluid portion by itself in a tank, to be used separately on the land, after it has gone through a certain stage of decomposition. Without disputing the correctness of the chemical principles on which this opinion is founded, we may hesitate before we condemn or undervalue a practice which has produced such wonderful effects in the improvement of the poor sands in the Netherlands.

Liquid manure may be applied to plants in every stage of their growth, if it be judiciously diluted so as not to injure the young and delicate roots by its caustic nature. It invigorates their growth more than we could anticipate from a knowledge of its solid component parts. It is no doubt sooner exhausted; because it is rapidly absorbed by the roots, and its elements enter into new combinations. If some of the more volatile parts, as ammonia, fly off in the process of decomposition which goes on in the tank, it is probable that a much greater portion of these elements fly off from the solid dung, while it remains in the ground and before it is in a fit state to be taken up by the roots, which can only happen when rain renders it liquid. All those who have had long experience of the good effects of liquid manure on light soils persevere in its use, whatever objections may be urged theoretically to its being preserved separately.

On stiff, impervious soils the use of liquid manure may not be so advantageous, and the reasonings of chemists may be correct. On these soils it is seldom used, except when they are in grass,

or when cabbages are planted; and composts prepared with straw, earth, and dung, with the liquid portions occasionally poured over them, are found to be a more effectual and lasting manure. The Swiss, whose principal object is to have a supply of food for their cattle in winter, when the mountain pastures are covered with snow, and who devote much of their attention to the cultivation of roots and artificial grasses, use the liquid manure in a very condensed state, collecting the water which has been poured over their heaps of dung, after it has filtered through them and been saturated with all the soluble portions of the dung. This, which they call *lizier*, in French, and *mist-wasser*, or *gülle*, in German, is carried on the land immediately after the grass, sainfoin, or lucern has been mown, and produces a second and third crop in a very short time. Cabbages, potatoes, and the varieties of the beet are invigorated in the same manner; and thus, in the short summers of the high mountain valleys, crops are brought to maturity, which, without the use of liquid manure, would never have had time to ripen. But let it not be imagined that either the Flemings or the Swiss undervalue the solid manure which is produced by the mixture of litter with the dung of animals, collected in heaps, where it heats and decomposes. They are as careful of this, and as anxious to increase it, by every means in their power, as the best English farmer can be:—

"In order to increase as much as possible the quantity of solid manure, there is in most farms a place for the general reception of every kind of vegetable matter which can be collected; this is a shallow excavation, of a square or oblong form, of which the bottom has a gentle slope towards one end. It is generally lined on three sides with a wall of brick, to keep the earth from falling in; and this wall sometimes rises a foot or more above the level of the ground. In this pit are collected parings of grass sods from the sides of roads and ditches, weeds taken out of the fields or canals, and every kind of refuse from the gardens: all this is occasionally moistened with the washings of the stables, or any other rich liquid; a small portion of dung and urine is added, if necessary, and when it has been accumulating for some time it is taken out, a portion of lime is added, and the whole is well mixed together; thus it forms the beginning of a heap, which rises gradually, and in due time gives a very good supply of rich vegetable mould or compost, well adapted to every purpose to which manure is applied."—p. 22.

It will be seen hereafter that, in the preparation of the land for the different crops, the Flemings and Dutch do not use less solid manure than we do, and that the liquid is an additional means of producing a certain and abundant crop, and not merely a substitute for the dung-heap.

The great secret in the improvement of poor land is to increase

its fertility by judiciously stirring, pulverising, and mixing together the different earths of which it may be composed; adding those which are deficient—where it can be done without too great expense of labour or capital—and, above all, impregnating it throughout with portions of humus, that is, organic matter in a state of decomposition.

The mechanical texture of the soil is of the first importance; for on this depends the proper retention of moisture, without superabundance or stagnation, which implies that the subsoil is naturally porous, or made so artificially; especially in northern climates, where the evaporation is slow, and much rain falls throughout the year.

The roots of plants, in their tender state, must find pores in which they can shoot and increase in bulk, for which the air and water are indispensable. They must also find substances which can yield them carbon, in a soluble state, as carbonic acid, which is produced in all vegetable fermentation. In water and air are contained all the other elements of vegetables, and even carbon in a small proportion. If the pores are so large as to let the moisture through, or allow it to evaporate readily, the vegetation ceases, and the plant soon dies: if they are filled with water, so as to exclude air, the same result follows. Hence it is evident that by altering the mechanical texture of a soil, without any chemical change in its component parts, it may be made much more capable of supporting vegetation than it was before. The quantity of organic matter, or humus, which will sustain vegetable life is extremely small, when other circumstances are favourable. Hence in the improvement of barren soils the most essential process is to alter the mechanical texture. In clays this is effected by repeated tillage, when the situation allows the superfluous moisture to run off. This is the reason why good clays are in all countries looked upon as the best soils, and sands as comparatively inferior. A soil which contains but little argillaceous or calcareous earth in its composition was long considered as irreclaimably barren: but when the alternative presents itself of starving, or making poor sands productive, means are soon found to correct their barrenness.

As pure siliceous sand is too porous, the first thing is to add substances which will readily fill up some of the pores. Fine clay diffused through water does so most effectually; and it is astonishing how small a portion of pure alumina will consolidate a loose sand, and convert it into a good loam, the parts of which, when moistened, will adhere and form a clod in drying. Whenever this is the case, the soil can no longer be considered as barren; but it may not yet be fertile, however its porosity may be corrected; for this purpose it requires organic matter already so

far decomposed as to be readily assimilated to the substance of the plants. When vegetation is active, and the organs of plants vigorous, there is every reason to suppose that water is decomposed by the action of the leaves; but this does not take place in the infancy of the plant. The roots must find some nourishment, ready prepared and easily assimilated. This has a strict analogy with animal life. The infant finds its earliest nourishment in its mother's milk, or, by the admirable contrivance of nature, in some similar substance. The body of a young chicken is formed from the white of the egg in which it was enclosed; and the yolk is a provision for the period which intervenes between its being hatched and the time when its little bill is so hardened as to enable it to peck and take up insects or small seeds. The seed committed to the ground may be compared to an egg: the first expansion of the embryo is entirely from the substance of the seed; and, until the seed-leaves are fully formed, it takes little or nothing from the soil, except pure water. But after the real leaves expand, it requires more nourishment, and if this is not found in the pores of the soil, or if the roots cannot penetrate to it, the plant languishes and dies. It is of no use that plenty of rich manure is somewhere in the soil, if it be not accessible, or if it be not in a proper state to be absorbed by the tender fibres of the roots. The plant will die, as an animal would by the side of a chest full of provisions, which are locked up, or unfit for his organs of digestion. These principles lead naturally to the best practice in improving or cultivating the soil; and we shall find that the mode pursued by the Flemings admirably accords with the theory.

The trenching and mixing prepares the soil for receiving the additions of organic matter. The roots are fed with a liquid manure readily taken up, and greatly invigorating, until a sufficient portion of humus is formed, which gives the most gradual and regular supply of nourishment. At the same time solid particles are deposited which fill some of the pores, and begin that accumulation of humus which in time will convert the whole into a rich and fertile soil.

It must be observed, that the smaller the particles of sand the better the soil will be after being improved. Coarse sand, each particle of which is a visible crystal, allows the humus to be readily washed out. It must be mixed with clay or marl to fill up some of its pores; and if this is not already done by nature, it must be done by art, or all the labour bestowed on the cultivation, and all the manure expended, will never be repaid by the produce. It is, therefore, of the greatest consequence to all improvers of barren lands to know, not only what proportion of silicious and argillaceous earths there is in the soil, but also what is the actual

size of the particles. This is very easily ascertained by means of the simple instrument, consisting of metallic sieves, which is described in the *Essay on the Analysis of Soils*, in the first number of this Journal. When a considerable proportion of the dry pulverised earth passes through the finest sieve, it is a sure sign that the soil, if not already fertile, can be easily made so. That which is most readily improved consists of a small portion of coarse sand, mixed with a larger portion of finer, and with a considerable portion of impalpable earth, partly silicious, and partly argillaceous and calcareous, so that, when it is moistened, it does not form a tough paste, but dries into clods easily pulverised between the fingers. The degree of fertility will depend altogether on the quantity of humus which is incorporated with this loam, and which the specific gravity readily discovers; the richer soils being the lighest; for humus is much lighter than any of the simple earths.

Keeping this in view, it is easy to show the advantage or disadvantage of different modes of proceeding, which should vary with the nature of the original soil. In the natural earth, which has never been cultivated, or which is dug up from a considerable depth below the surface, portions of different kinds of earth are found in thin layers, or in separate pieces, which, being pulverised and mixed together, want nothing but the addition of humus to make them a fertile soil. Here the use of the trenching-spade is evident. No other instrument could so well divide the earths, and mix them in due proportions. The more the ground is stirred, the better it becomes; and by a course of cultivation which, instead of exhausting the humus, gradually increases its quantity, it becomes at last a rich mould, like that of a garden, in which all plants suited to the climate thrive luxuriantly. In the progress to this state of fertility the soil must have passed through every intermediate state; and the same process which at any one period effected the improvement must be judicious, if applied to any soil similar in its nature. In agriculture, as well as in most arts and sciences, to stand still is the prelude to going back. The soil, under the hands of a skilful agriculturist, must not only be made to produce all that it is capable of producing, but its capacity for production must be continually increasing, until it arrives at that state, when a further increase of humus would loosen its texture too much to produce many of the most valuable plants, which are the chief objects of cultivation; for, beyond a certain proportion, the increase of humus does not always increase the produce.

These preliminary observations appear necessary to enable those who may not have paid much attention to the theory of vegetation to trace their accordance with the practice which ex-

perience and observation alone have suggested and confirmed. They may also be useful in suggesting to those who would imitate any particular system of husbandry the modifications which are necessary, where the soil, climate, and other circumstances are different.

The advantages of stirring the soil to a considerable depth by trenching and deep ploughing, which only now begin to be generally appreciated in England, and the intimate union of the manure with every portion of the soil, have long been practically acknowledged by the farmers in the Netherlands. The quality and value of flax, of all their crops the most profitable, has been found by experience to depend chiefly on the care with which the soil is loosened, and the manure intimately incorporated with it. Great attention is paid to ploughing and cross ploughing. The harrows are used much more frequently than with us, and the surface is laid level and thoroughly pulverised to receive the seed. The stitches, where there are any, are not generally in a convex form, but have a flat surface; and the spade deepens the intervals to twice the depth of a common furrow. The earth dug out is spread evenly over the seed which has been previously sown, and is pulverised by the harrows or by a flat instrument called a *traineau,* which is drawn over it, and breaks all the clods, while it compresses and levels the surface.

The rounded form of the stitches in England throws the water into the interfurrows, but at the same time tends to soak the lower portions on each side in wet, if the subsoil is at all retentive of moisture; hence the plants which grow there are often sickly and unproductive. In Flanders, even in the most tenacious soils, this rounded form is unnecessary; for there is an open drain between every two stitches. The soil, having been well pulverised, allows the superfluous water to sink, and it runs slowly into the deepened furrows, without injuring the plants at the edge of the stitch. When the crop is reaped, the edges of the stitch are broken down and drawn into the deepened furrow by means of a large hoe or hack, and the plough completes the filling up and lays the land level again. When next the stitches are made, care is taken that the intervals are a foot to one side or other of the lines where they were before, and again dug out 8 or 9 inches below the bottom of the furrows. Thus in a few years the whole field will have been dug 16 or 18 inches deep, and the soil and subsoil, to that depth, completely incorporated and enriched with manure; for, after the seed is sown, the tank liquor is invariably poured over the surface, or into the intervals before they are deepened, that it may soak in and mix with the earth which is about to be spread over the seed. Although this is a longer process than that of trenching the whole ground with

the spade at once, it is much more effectual and less expensive. About an inch only of the subsoil, whatever be its nature—if it be not an indurated clay or gault, as it is in many places in England, but nowhere in the Netherlands—is put on the surface to cover the seed. It produces no weeds, and being soaked with liquid manure, and exposed to the action of the atmosphere for many months, it is mellowed aud assimilated to the soil before it is ploughed in. An inch of earth thus improved every year, and mixed with the soil, soon renders the whole of a uniform quality to the depth of 16 or 18 inches; after which every subsequent spreading tends to increase the uniformity in texture and richness.

Some plants do not require a great depth of soil, their roots spreading near the surface. In this case the manure is ploughed in with a shallow furrow, and none of it is buried below the reach of the roots. But the most profitable crops, such as clover, wheat, cole, and especially flax, thrive best in a deep soil: the roots of this last will strike down several feet into the ground, if it meets with a very mellow soil; and the crop will not only be more abundant, but of a better quality, than it would in a soil, however rich, which had but little depth. Potatoes also, which are cultivated to a considerable extent in every farm, thrive better in a deep soil of moderate quality, than they do in a richer soil of small depth on a barren subsoil.

Another mode of deepening the soil and mellowing it at the same time is worthy of notice. When the harvest is over the land is immediately ploughed, and, where labourers are to be found in sufficient numbers, several are stationed, with spades in their hands, at regular distances along the line of ploughing. The plough makes a furrow about 10 inches wide and 6 deep. As soon as it has passed the first man, he begins to take solid spits of earth out of the bottom of the furrow and places them on the land to the right side. These spits are not taken in continuation, but with a small interval between them, leaving so many square holes. The number of labourers is proportioned to the length of the furrow, so that each shall have finished his portion by the time the next furrow is made, which fills up the holes in the preceding furrow; and the whole field is laid in an extremely rough state: thus it remains for a considerable time, sometimes all the winter, and the rain and frost pulverise the clods which lie all over it. In spring the whole is repeatedly harrowed to make it level, and is then ploughed flat, or in stitches to prepare for sowing, the manuring being a matter of course. This will give some idea of the importance attached to deepening and mixing the soil, and will account for the uniform appearance of the crops on soils of very different qualities. The worst soils require more

labour and manure, and consequently are less valuable; but every deficiency is made up by additional industry. But it may be asked, where can a farmer find manure, solid and liquid, to manure nearly all his land every year? for of all the crops cultivated buckwheat is the only one which is sown without some manure, at least by all good farmers. This is the great point to which the attention of the farmer is constantly directed. The collecting and preparing of manure is a profession of itself. The poor in towns sweep the streets, and make composts of all refuse matter in some spot given to them for that purpose without the gates. They reduce it to a fine powder, and dry it in the sun. What will chemists say to this? Will not all the volatile parts fly off, and the best portions of the manure be lost! We will not pretend to give an answer to this objection: but the fact is, that this dry manure is most highly prized by the growers of flax, and is supposed more efficacious than any other, night-soil excepted. This last is the *ne plus ultra* of manure for light soils. It is conveyed in boats from the different towns, and deposited in pits, where it is collected and kept for sale by measure. In a very dense population this resource is considerable, and no one would be so wasteful as to allow the common sewers to carry off a substance which is regularly sold and obtains a good price.

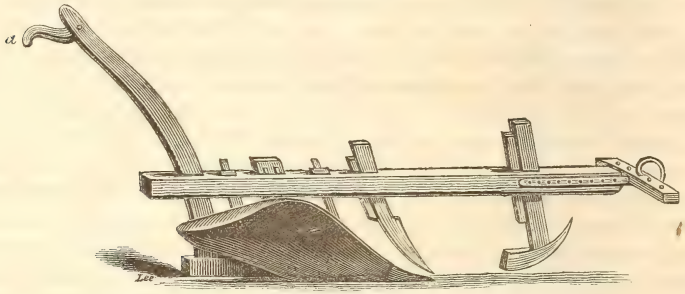
These are adventitious resources, and can only be depended on in certain localities. The only certain means of obtaining manure is by feeding cattle, which in the Netherlands are chiefly milch cows. No meadows are required in the light lands of Flanders for the cattle to graze in: and where there are meadows along the banks of the rivers, they are mown to feed the cows with grass in the stalls, or to make hay for winter fodder. The whole system of husbandry is founded on the supply of manure, and a considerable portion of the crops are merely subservient to this purpose. The immediate profit on the cattle is trifling, if they do not even cost more to feed than their produce will repay: but the manure must be had; and he who can procure manure at the least cost is the best farmer. Keeping this in view, all the cattle are kept in stables, that none of the manure may be lost; and every mode of feeding has been tried which will increase the manure at the cheapest rate. Meadows being scarce, and hay dear in those parts of the Netherlands where the soil is sandy, the chief food of cows in summer is grass, barley or oats, cut in a green state, clover, tares, and spurrey; and in winter cabbages, beans, and roots. These last are not given in their natural state, but soaked in warm water, or boiled into a mess, which is given milk-warm to the cows in troughs; so that it may be truly said, that the cows are fed like pigs. The straw is used chiefly as litter for the horses. The cows often lie on smooth bricks,

which are washed clean twice a day, for which purpose a pump is an essential appendage to a cow-house, There is generally a deep gutter along the wall behind the cows, into which the water and urine drain, the ground sloping gently towards it. The tank is either immediately under the stable, well vaulted over, or it is so near that all the liquid readily runs into it through a covered drain. The heads of the cows are towards the middle of the stable, and their tails over the gutter along the wall. The width of the building admits of two rows of cows, facing each other, with a space between them sufficiently wide to admit a small cart to bring the food to them. This is universally the form of a cow-house in Holland. The liquid in the tank is allowed to go through the first stages of fermentation, during which the caustic portion of the urine is rendered mild, and the liquor is better adapted to be taken up by the fibres of the roots. In order that there may be a regular succession of liquid, in a proper state for use, there are partitions in the tanks, and, by means of small flood-gates in the drain which leads to it, the fresh accumulation may be directed to any one of the pits thus formed, while the ripe liquor may be pumped up into tubs or barrels set on wheels, to be conveyed to the land. There are means of accelerating or retarding the fermentation, according to the time when the liquor is wanted. Stirring and admitting the air assist the process, while the addition of earth, peat, or ashes, and keeping out the air, retard it. The efficacy of the liquid is much increased by adding oil-cake, the residue of rape-seed when the oil has been pressed out, and other vegetable substances. This is usually done a short time before it is put on the land, as it would otherwise ferment too much.

We have already mentioned the Compost-Heaps. These are chiefly made of the dung and litter of the horses and pigs, kept moderately moist, and mixed with every kind of refuse vegetable matter, with the addition of mould from ditches and the sods taken from open drains in pastures. This is generally put on the land in an active state of fermentation, and immediately ploughed in; sometimes the small heaps laid out of the carts at regular distances in the field are moistened with liquid manure, to excite a fresh action; and, as soon as they begin to heat, the dung is spread and ploughed in. It would appear from this, that it has been found to decay more rapidly in the earth, when put in hot, than when the fermentation is already subdued, which might be anticipated in the sandy soils.

The Instruments of Tillage are few and simple.—The Plough in the first cut is short, with a straight horizontal beam, and a single stilt or horn placed nearly upright. Near the end of this stilt a small piece projects (*a*), which, taken in the hand, enables the

ploughman to draw the plough out of the furrow on turning, and to direct it into the next. The sole is 10 inches broad, of an equal width from the fin of the share to the heel. The turn-furrow is made of sheet iron, $\frac{1}{4}$ or $\frac{1}{2}$ an inch thick, and bent as if it had been rolled obliquely round a cylinder of about 2 feet diameter; the concave side is outward. It is nearly horizontal at the fin, and its inclination increased till its upper edge is

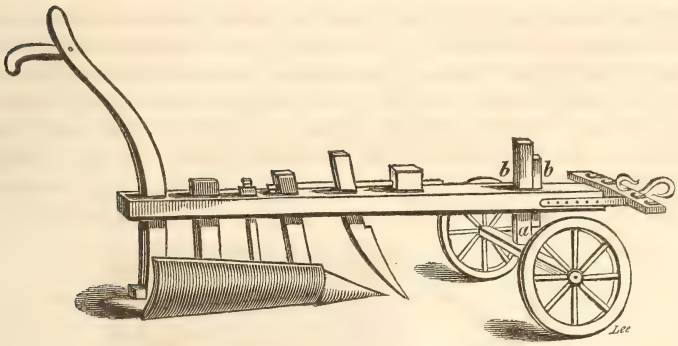


Old Flemish Plough.

considerably to the right of the line of the furrow. This raises the furrow-slice, and turns the earth over, crumbling it at the same time. There are no wheels, but a piece of wood with part of it shaped like a club-foot or inverted hammer projects downwards from near the end of the beam: it can be moved up or down in a mortice, so that the foot shall graze the ground when the plough is at work. This serves to regulate the depth of the furrow, and prevents the points of the share from striking too deep. This simple plough has been adopted or imitated in most countries, and for light soils without stones none can surpass it. The old Rotheram plough, which was improved by Small, was only a copy of it. In France and Switzerland it has almost superseded the old ploughs of the country wherever improvements have been introduced, and, with a few modifications, to adapt it to different soils, it has re-appeared in England as an improved plough.

Besides the old Walloon plough, which is the same as the Kentish turnwrest-plough, and is used in the stiffer soils of Holland and Belgium, there is a lighter Turnwrest-Plough with two small wheels attached to the beam, on the principle of Ransome's Rutland and Bedford ploughs: it answers very well to plough up clover-ley or grass-land; but it is inferior to the foot-plough in light soils.

There is a Double-breasted Plough, without a coulter, usually made entirely of wood, with which the inter-furrows between the stitches are sometimes smoothed out; and, in particular cultivations where ridges are formed, it is very useful to make them

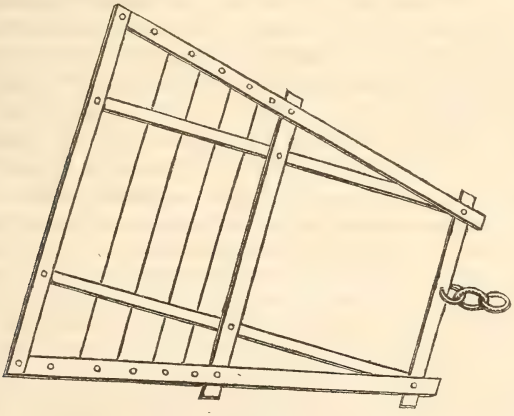


Double-breasted Plough.

straight, and throw the earth sideways, as our double-moulding plough does between rows of turnips or potatoes.

The Harrows are mostly triangular, with wooden teeth set at an acute angle forwards: they would be of no use if the soil had not been previously pulverised and loosened, for a very slight obstruction would break the teeth; they are, however, very useful to cover the seed and finish the pulverising of the soil: one horse draws them easily.

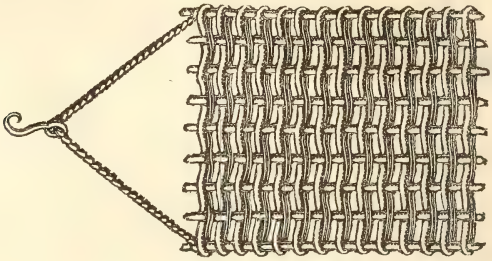
The Traineau, which has been mentioned before, is an instrument peculiarly Belgian: the use of it is to level the surface of



Traineau.

light soils without too much compressing them. If a door were taken off the hinges and dragged over a field it would become a traineau. It has been found convenient to make a stronger frame, and to cover it with stouter boards than those of a door. The trapezium shape also is found more convenient than the rectangular; and as the part nearest to where the horses are attached

does not press much on the land, the hinder part only is boarded. This traineau is loaded with stones, if its own weight is not sufficient to break the clods. The stone roller, which is also generally used to compress the surface, does not grind the small clods so well as the traineau; rather pressing them in: but both these instruments are used according to circumstances, and their united effect is to produce a very fine surface, and give the seed sown every advantage in shooting up through it. A rodded hurdle is



Rodded Hurdle.

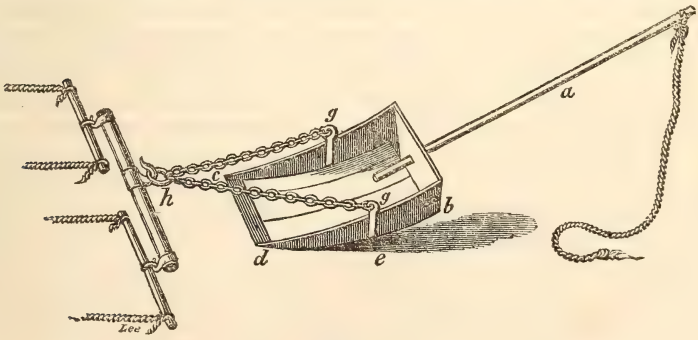
also used for the same purpose.

Threshing-machines are of little use where the farms are, in general, so small in extent as they are in the Netherlands. The labour required for a garden cultivation, as it may be very properly called, requires many hands, which are usefully employed in winter in threshing out the corn. A threshing-machine would be no saving there, and the cost of it would absorb too great a portion of the capital. Much of the corn is winnowed with the shovel and fan, as it has been from the earliest days of agriculture; but they occasionally use a winnowing-machine, which blows off the chaff, like that which is in common use in England, and which is said to have been originally invented in Switzerland.

"Besides the common scythes, hoes, and rakes, there is a peculiar instrument for cutting corn, called the Hainault scythe, of which notice has been taken in many agricultural publications. It is a very useful instrument, and in the hands of an experienced person will cut a third more corn, in the same time, than can be done with the reaping-hook. It is a short scythe, of which the blade is broad and about 20 inches long. The handle is about the same length, and fixed so as to form an acute angle with the blade when in the act of cutting: it is bent outward at the end where it is held, at an angle of about 120°, and is there shaped like the stout handle of a knife or turning tool. It should be so constructed that, when the blade lies flat on the ground, the man's hand is nearly perpendicularly over the centre of the curve of the blade, so that he can swing the instrument, by a motion of the wrist, without stooping. A leathern strap doubled and nailed on the handle, in which he puts the fore finger, prevents its slipping from his grasp. In the left hand he holds a light stick 3 or 4 feet long, having an iron hook fixed at the end, bent into a semicircle of about 8 inches diameter. With

this hook he collects the standing corn, and lays it towards the left, while the right hand cuts it close to the ground. The cut corn leans against that which is standing; and when as much has been cut as will make half a sheaf, the workman turns half round, and hooking up part of what is cut with as much of what is standing, he cuts and rolls up the whole in the form of a sheaf, using his leg and foot to keep it in the bend of the blade: the legs are protected by pieces of strong leather over the shins. Thus it is laid down for the binders. Those who are accustomed to the method of fagging in use in Middlesex, Surrey, and the neighbourhood, where straw is valuable, will readily see that this scythe is only an improved fagging-hook, allowing the reaper to stand upright at his work, and saving that fatigue of the back which is the chief inconvenience of fagging. For women, to whom stooping is not so laborious, the fagging-hook may perhaps do the work as conveniently. But, in Flanders, women only tie up the sheaves, and seldom reap. This instrument has been often recommended for use in England; and we have ourselves made presents of it to reapers who cut by the acre. Very few had the patience to become dexterous in the use of it, and after a few trials returned to the old fagging-hook; although it was evident that it would, if properly managed, cut one-third more corn at least in the same time. It is, however, inferior in expedition to the cradle-scythe in the hands of a skilful mower. This last is also used in Flanders, but not so commonly as the foregoing.

"The Mollebart, the use of which in the levelling of newly-trenched land has been before mentioned, is an instrument peculiarly Flemish or Dutch. It is simply a very large wooden shovel, in form like the tin dustpans used by housemaids, with a stout long handle. The bottom, which is convex, is covered all over with thin iron plates; and a stronger piece of iron (*c d*) forms the edge. The handle (*a*) is 6 or 7 feet long, firmly fixed to the shovel, and so placed that, when the end is raised 5 or 6 feet high, the only part of the instrument which touches the ground is the edge (*c d*). When it is held 3 feet from the ground the shovel rests on the convex bottom (as at *e*), with the edge rising a few inches above the ground; and when it is pushed quite down, and it drags on the ground, the instrument rests on the hinder part of the bottom (*b*). The width of this shovel is about 3 feet, and



Mollebart.

the length from the insertion of the handle to the sharp edge is nearly the same. Sometimes it is wider than it is long. In the middle of the border on each side are strong iron hooks (*gg*), which are connected with the iron on the bottom. It is drawn by chains fixed to these hooks and united into a large link (*h*) a little before the edge of the instrument. To this link are attached a common whipple-tree and bars, to which two horses are yoked abreast. Attached to the end of the handle is a strong rope of the size of a man's little finger, 14 or 15 feet long. This the driver holds coiled in the same hand which holds the handle, the reins being in the other. It is now ready to begin its operations. The man depresses the handle so that the edge of the shovel rises upwards, and directs the horses towards a heap or an eminence to be removed. As soon as they reach it the handle is raised, the edge of the instrument enters the ground or the bottom of the heap, and it is soon filled with loose earth. The handle is immediately depressed, and the whole load slides on the bottom of the shovel over the sandy surface, until it arrives at the hollow which is to be filled. The handle is then raised suddenly as high as the man can reach; the edge catches the ground, and the whole machine is overturned forwards, the handle striking on the whipple-tree; the load is thus left behind. The rope, of which the workman kept the end fast in his hand, now comes into use, and by pulling it the instrument is again reversed, and proceeds empty for a fresh load. All this is done without the horses being stopped for a moment. A skilful person will spread the earth at the same time that he deposits it: this is done by holding the rope so that the handle shall not fall over at once, but remain for a short time in an erect position. The earth is thus delivered gradually, and laid level by the edge of the instrument scraping over it. It is astonishing how much labour and time are saved by using this instrument instead of carts. It takes up about 500 cwt. or more of earth each time, and this load slides along with the greatest ease to the horses: in returning they generally trot. More complex instruments have been invented to answer the same purpose, some of which are extremely ingenious, but the simplicity of this, and the small expense at which it may be made by any common wheelwright or carpenter, or even by the farmer himself, strongly recommend it; and we do not hesitate to assert that, with a very little practice, any common labourer who can manage horses will do as much work with this simple instrument as he would with the more perfect and ingenious machine which obtained a prize from the Highland Society some years ago."—pp. 17, 18.

With these instruments, materially assisted by the spade and shovel, the whole of the tillage in the Netherlands is performed.

"In ploughing the land, in some districts, they lay it flat, without divisions. In others, as the Waes district, the fields are all laid in a convex form when they are trenched, and kept so by ploughing round in a circle upwards towards the centre. Where the loam is not very pervious to water they lay the land in stitches 7 or 8 feet wide, as is usual with us. They plough across the stitches occasionally, and reverse the crown and furrow, or change the interval so as to be in a different line every year, which in the end tends to deepen the whole soil. The

depth of the furrow varies according to seasons and circumstances, and there is much skill and ingenuity displayed in doing this, so as to divide the ground well, and lay the dung where it is most effective. When weeds are to be destroyed a very shallow skimming is thought sufficient. In autumn the dung is ploughed in a few inches deep only, to allow the access of air to decompose it. In the following spring the furrow is made several inches deeper, to bring fresh earth to the surface without uncovering the dung. When a first ploughing has been very deep to bury weeds, the next is often shallow to divide the slice first turned over, without bringing up the seeds again within the influence of the atmosphere, which would cause them to spring up (the furrow-slice must, in this case, be turned quite over and laid flat, and not leaning on the preceding, as in ordinary ploughing). In all this there is a great attention paid to every operation, so that it may be performed most effectually. No more ploughings are given than are thought necessary to each particular crop. A great object is to have an early harvest, both because the weather is generally driest and best early in summer, and because a second crop may be sown before the midsummer showers. Winter barley is on this account preferred to spring barley; and rye is sown early, that turnips may be sown with some chance of success immediately after it is reaped. Summer stirring and liquid manure keep the land in a clean and rich state, and it is not allowed to remain idle. The heavier soils are laid up high before winter; the intervals between the stitches are well dug out with the spade, and numerous water-furrows are dug across them that no water may stand anywhere after rains. The winters are more severe on the continent than in Britain; and even in Flanders, which is so near to us, the frost is much longer and more intense: but this is taken advantage of to expose stiff soils to its influence."—pp. 19, 20.

VII.—*On the Flax-Dodder.* By Charles C. Babington, M.A., F.L.S., F.G.S., &c.

To the Secretary.

Sir,

Although the culture of flax is not of common occurrence in England, yet, as it is a valuable product in several parts of this country and also of the sister kingdoms, I conceive that a very short notice of the parasitical weed which peculiarly infests it, and in Germany often quite destroys the crop, may be interesting to the Agricultural Society.

A few years since, Mr. J. E. Bowman noticed that the *Cuscuta epilinum* (Weihe), or *flax-dodder,* was a frequent inhabitant of the flax-fields in Shropshire and the neighbouring counties of Wales; and during the late summer, in a visit to the West of Ireland, and also to Argyleshire, I observed it amongst the flax

in both those countries. In a recent letter, Mr. T. B. Flower informs me that it is very prevalent in Somersetshire; and my friend Sir W. Jardine, Bart., states that it is also frequent in Dumfriesshire.

I need scarcely inform the Agricultural Society that the dodder is a parasitical weed, growing from seed deposited in the ground but taking hold as soon as it can of the stem of the plant (in this instance flax), upon which it is parasitical, when, its root immediately decaying, it draws all its nourishment by means of short suckers which penetrate the bark of its unfortunate victim, and, by abstracting its juices, gradually weaken and ultimately destroy it.

In Somersetshire this weed is known by the name of the "mulberry," derived probably from the form and appearance of its bunches of pale-pinkish flowers; in the west of Ireland it is denominated the "parasite-plant." Mr. Thompson, a highly respectable merchant of Westport, in the county of Mayo, states that a small consignment of Odessa flax-seed was received at that port in 1836, that it was the first ever imported there, and that "*sore* complaints, on account of the weed," dodder, "growing up with it, and *quite destroying* the flax," were made by the purchasers. He adds that, "on particular inquiry, he is satisfied that this weed is *never* found in American nor yet in Riga seed; and equally satisfied that it is in seed from Odessa and parts of the north of Europe." The seed used in Somersetshire is imported at Bristol, and comes, as does that at Liverpool, from some of the Russian ports—but I have been unable to ascertain which, although Odessa is certainly one of them—and is full of the dodder. The seed used in Ireland, being imported from America, is free from the dodder, although a little of the weed still remains, owing to the above-mentioned cargo of Odessa seed.

It is therefore manifest that the almost certain way of avoiding this troublesome weed is by obtaining American or Riga seed; and not purchasing the cheaper but dirty seed from Odessa.

CHARLES C. BABINGTON.

St. John's College, Cambridge,
Nov. 19th, 1840.

VIII.—*On the Productiveness of certain Wheats.* By C. Hillyard, Esq.

To the President.

Dear Sir,—As you think that an account of the experiment I have been making as to the productiveness of 7 different kinds of wheat will be of sufficient value for insertion in the Society's Journal, I will here state the particulars of the experiment, give the result, and make a few observations on the growth and value of that most important of all grain, wheat.

Mr. Sewell, of Bookham, Surrey, who gained at Oxford the first prize for white wheat, and Mr. William Fisher Hobbs, of Mark's Hall, Essex, who gained the prize for brown, having each been kind enough to give me a bushel of their wheat, I had these, and five other bushels, of different sorts, dibbled into 7 half-acres of land, after Mangel Wurzel, in the three last days of November. They were numbered thus :—

No. 1. Mr. Hobbs' brown.
2. Mr. Sewell's white.
3. Clover, a brown wheat distinguished here by that name.
4. A white wheat, which I have called Snowdrop, it having been given me some years ago without a name.
5. Burwell, a brown wheat much sown in this country, and procured from Burwell, Cambridgeshire.
6. The Golden Drop.
7. Whittington White Wheat.

These have all been thrashed out, except the Golden Drop, which was not a full crop, arising I have no doubt from defect in the seed, but it is well known here that this wheat will produce more than any other kind, and that it is about six-pence per bushel of less value.

Underneath is an account of the produce of each kind, and from a miller's estimate of the value per bushel, the value per acre.

Produce of each half-acre :—

No.	NAME.	Bush.	Good	Inferior.	Weight per Bushel.	Value per Quarter.	Per Acre. Quantity.		Per Acre. Value.		
					lbs.		Qrs.	Bush.	£.	s.	d.
1	Essex Brown .	20	19	1	64	64*s.*	5	0	15	17	0
2	Surrey White .	18	17	1	64	66*s.*	4	4	14	14	0
3	Brown, called Clover	20	19½	½	63½	63*s.*	5	0	15	13	6
4	Snowdrop White	19½	18½	1	63	64*s.*	4	7	15	9	0
5	Burwell Brown .	22½	22	½	63	63*s.*	5	5	17	12	0
7	Whitington White	18	17	1	62	62*s.*	4	4	13	16	9

*** A great deal more straw than either of the other kinds.

Although I do not approve of dibbling for general practice, as I have said in my book on Practical Farming and Grazing, still in order to sow exactly the small quantity of two bushels per acre, I had the seed dibbled into holes 8 inches asunder. The winter was favourable for late sown wheat on dry land, still if my experiment had been made on a clover ley, and the sowing 6 weeks earlier, each kind would probably have produced more, and although the quantity of each was good, it possibly might have been better. I cannot conveniently sow this year more than 4 of the sorts; for further proof of produce, those will be Nos. 1, 2, 5, and 3 or 7.

The result of this experiment strengthens the opinion I have long entertained, that the brown Lammas wheats are best suited to loamy soils, and for general growth in this county; besides which, in every market in the county it will always fetch a higher price than the white.

In Mark Lane it is the reverse of this, therefore the white may answer best to those growers whose grain is sold there, and more likely so if their soil is a strong clay or chalk.

A greater quantity of wheat is now produced per acre than formerly, by greater attention being paid in selecting seed from the best and most prolific kinds; and by close examination into growing crops many new and valuable varieties are likely to be obtained, and thus there will be wheat best suited for every description of soil. The public are greatly indebted to Col. Le Couteur for giving the result of his experiments made as to the produce and value of many varieties of wheat; but these experiments carried on in the Isle of Jersey, cannot be satisfactorily conclusive for the midland or northern counties of England; at the same time I beg leave to remark that in the account of profit, straw ought not to be included; it may be said to belong to the landlord, for if he allows it to be sold he has a right to expect that the amount it sells for should be expended in manure. It does not, in my idea, add to the value of any kind of wheat that it produces an extra quantity of straw, and thus takes an extra quantity of nourishment from the land; besides this a greater price must be given for the thrashing, and there is a less chance of its being cleanly done.

I remain,

Your's, truly,

C. Hillyard.

Thorpelands, Northampton, Sept. 25, 1840.

IX.—*An account of the Transposition and Admixture of Soils, as in the application of a Clay dressing to a light Sand, stating the result of actual Experiments.* By William Linton.

PRIZE-ESSAY.

Having had several years' experience in marling, or the admixture of clay with sand, I venture to give a practical account and a detail of my method, in doing which I shall notice,—

First. The description of the land clayed over.

Secondly. The kind of clay or marl used.

Thirdly. State of the land and season of the year when done.

Fourthly. Quantity laid on, the way of doing it, and the expense per acre.

Fifthly. The result.

1st. The description of land clayed over was a very light barren sand, so barren that it never had been cultivated to profit, but had proved a losing concern to all that had engaged in it, both landlord and tenant. About one-fifth part was entirely out of cultivation and grown over with ling, gorse, &c. The substratum is a white sand, varying in depth from 1 to 4 feet. The surface was of the same texture but darker in its colour, through the decomposition of vegetable matter upon it. Beneath the bed of sand lay a yellowish kind of clay, about 1 foot thick, under it a rich marl about 18 feet deep. The land generally being very wet, my first object was to underdrain it thoroughly with tiles; unless this is first done where necessary, marling is a waste of capital. I cut my drains about 24 inches deep and 9 yards apart.

2ndly. The kind of clay used.—This being plentiful in nearly all parts of the farm, but varying in depth from the surface, was more or less difficult to get. The first 12 inches under the sand was an inferior yellowish clay, under it a bed about 18 feet, as already stated of rich dark-coloured marly clay, having in it a soft stone which had the appearance of lime, and also a quantity of cobble-stones. This clay and soft stone when dissolved in vinegar and water, effervesced nearly as tartaric acid and carbonate of soda do when mixed together in water: this was my test that it contained a quantity of alkali which rendered it fit for my purpose and worthy the name of marl. The top or yellow clay dissolved without effervescing. I consider that on the proper testing and selection of the clay or marl chiefly depends the success of marling operations. All clay will do good there is no doubt, but on the quality used must rest the amount of benefit obtained.

3rdly. The state of the land and season of the year when done.

—I have alreadys tated that the land was first drained; in the next place it was made completely level by the plough, harrows, and in some places spade, after which it was ready for the marl being laid on, which was done at all times of the year. For the first two years I made naked summer fallows, and laid the clay on in July and August: but after getting the land into a regular course of crops (viz., the four-course system), I then did the work when in seeds in the same months, which I continued to do as much as possible afterwards, for the following reasons:—First, To avoid the great injury done to the land by such heavy carting when in fallow, which was visible in some places the two or three succeeding crops. Secondly, from the loss sustained in having a fallow instead of a crop of turnips: and Thirdly, from the cartage being so much easier when in seeds than when in fallow.

The land which was out of cultivation was pared and burnt with a hope of getting a crop of turnips, but in this I was disappointed. It was also drained and levelled before marling.

4thly. The quantity laid on, the way in which it was done, and the expense per acre.—The quantity laid on depended upon the quality of the land, and varied from 100 to 200 cubic yards per acre; the average was 150 yards. Where the land was very light and barren (which was mostly the case on elevated parts) a larger quantity was laid on, but where it was a better soil a much less quantity answered the same purpose; my object being to lay just as much on as would grow wheat after seeds. To do more than this would not only have been an injury to the land for eating turnips upon it with sheep and for the barley crop, but also a waste of money in extra expense. When sufficiently clayed to grow wheat after seeds, a point requiring close attention, I always found it effectually done for any other crop.

The way in which it was done.—It was necessary in the first place to fix upon the most favourable situation for the pit, keeping three objects in view. 1st. The most convenient place for carting to the plot of land intended to be marled. 2ndly. The best situation for a pond to answer for a permanent watering-place, cutting if possible across a fence so as to water two fields, one from each mouth of the pit. 3rdly. Where the clay could be got with the least difficulty. After the place was fixed upon the work was carried on by five diggers, a driver, four horses or beasts, and two carts (which are of the Scotch kind, with short bodies and broad wheels). The pit was dug with a gradual descent, so that three horses could draw out about a ton, which was shot out where wanted, the cart returning by the time the other was loaded; thus three horses were always ready for the loaded cart. The clay was spread by the diggers at broken times after being exposed to the action of the air; rain, after

either frosty or droughty weather, would cause it to fall to pieces sufficiently for harrowing and ploughing in. The expense I paid for digging, filling the carts, and spreading, was from 4*d.* to 5*d.* per cubic yard (full 1 ton), varying according to the quantity of stones imbedded in the clay as before noticed.

The total expense upon an acre having 150 yards laid upon it was as follows:—

	£	*s.*	*d.*
Digging and spreading 150 yards, at 4½*d.* per yard . .	2	16	3
Four horses four days, at 2*s.* 6*d.* each, 10*s.* per day . .	2	0	0
Driver four days, at 2*s.* 6*d.* per day	0	10	0
Other expenses (wear and tear)	0	3	0
Total expenses in marling one acre	5	9	3

In this way I marled 80 acres, but afterwards hit upon another plan in which I found a great saving to my horses, as in the wet season of the year it was heavy work for them to draw the carts out of the pits. I got a windlass made on the same principle as the one used for the draining-plough, which I fixed upon a platform 10 yards from the centre of the mouth of the pit; the platform was formed of the sand taken from above the marl, and was elevated 2 feet above the surface of the ground.

The expense per acre when the windlass was used was—

	£.	*s.*	*d.*
Digging and spreading 150 yards, at 4½*d.* per yard . .	2	16	3
*Three Horses 4 days, at 2*s.* 6*d.* each, 7*s.* 6*d.* per day .	1	10	0
Lad to drive horse in windlass, 4 days, at 1*s.* . . .	0	4	0
Driver for Carts, 4 days, at 2*s.* 6*d.*	0	10	0
Wear and tear	0	2	0
Total expense per acre when windlass was used . .	5	2	3
Total expense per acre when common carts are used . .	5	9	3
Saving . . .	0	7	0

The advantage is not pecuniary alone, but the heavy drag and difficulty in getting out of the pit is also avoided; and one-third less land is taken up by the pit, as it can be dug much steeper, and to any depth, whilst no difficulty arises in getting out with the loads, even with an inferior horse. The same number of diggers are required.

5thly. The result.—I have already described the land as being light, and of a very inferior kind; this the crops went to prove, which were generally overgrown with the greatest variety of annual weeds, the growth of which apparently no culture could

* One horse was used for the windlass, and the other two for taking away the loaded carts.

prevent; but in no instance have they ever made their appearance after the land was clayed over. I cannot give an account of the rotation of crops; previous to marling no regular system could be adopted. It was usual to allow the seeds to remain four or five years unploughed, for the sake of ridding the land of the weeds, after which a crop of oats was taken, which would not average more than 3½ quarters per acre. Then followed a fallow, which was sown with rye, and sometimes with turnips, but the land being generally undrained, the latter crop often proved a failure. Barley was sown after the turnips, also grass or clover seeds.

The produce in four years could not be stated at more per acre than—

	£.	s.	d.
First year—Turnip fallow . .	4	0	0
Second year—Barley or Rye . .	4	0	0
Third year—Seeds depastured . .	2	12	0
Fourth year—Oats, Barley, or Rye .	3	15	0
	14	7	0

The same land is now cultivated to the best advantage under the four-course system or rotation of crops. All the fallows are sown with turnips, after which follow barley, seeds which are depastured, and then wheat, which finishes the course of crops. I will here give the produce of four years, after marling upon fallow, and four years after marling upon seeds :—

	£.	s.	d.
First year—Fallow	0	0	0
Second year—Wheat, 29 bus., at 7*s.* per bus. . .	10	3	0
Third year—Seeds depastured	4	4	0
Fourth year—Wheat, 24 bus. at 7*s.* per bus. . . .	8	8	0
Produce in four years when marled upon fallow . .	22	15	0
First year—Wheat, 24 bus. per acre, at 7*s.* per bus. .	8	8	0
Second year—Fallow, Turnips	4	15	0
Third year—Oats, 52 bus., at 23*s.* per qr. . . .	7	9	6
Fourth year—Seeds depastured	4	4	0
Produce when marled upon seeds	24	16	6
	22	15	0
Balance in favour of marling upon seeds . . .	2	1	6
The produce after marling in four years . . .	24	16	6
The produce before marling in four years . . .	14	7	0
	10	9	6

The balance of 2*l.* 1*s.* 6*d.* in favour of marling upon seeds does not show that there is any advantage in it over that of making a naked fallow for that purpose, as more than that ought to be deducted for the cultivation of the turnip crop, which would not occur in a naked fallow. But when a naked fallow is made for the purpose of marling the land, then two wheat crops occur in four years, which, notwithstanding it here makes the produce run much higher in the four years than it otherwise would do, could not be long practised with any advantage whatever to the farmer.

The balance of 10*l.* 9*s.* 6*d.* in favour of marling needs no comment.

But in stating these results, I must refer to the comparative merits of the two different kinds of clay used, not by any chemical definition, but from actual experience. The clay, whether laid upon seeds or fallow, was shot out in loads as already stated, then spread as equally as possible; but, on account of the large size of the pieces of clay, the land could neither be ploughed nor harrowed until it had been first dried, had then become wet, or frozen, and had afterwards thawed. After this it was harrowed. The best or dark-coloured clay will fall long before the top or yellow sort, which is not so easily pulverised. The first named is very productive of itself, but the other requires some stimulant to produce a crop.

If laid upon seeds the land was only ploughed once in October, and drilled in the same month with wheat. When upon fallow it was ploughed two or three times, and well mixed up with the sand, and also sown with wheat. In this way a good crop was realised without any other manures, but wherever fold yard manure was applied, the crop was very abundant.

On parts of the farm turnips were frequently destroyed by grubs before the land was clayed over, but in no instance have they since, neither have they been destroyed by any other insect, except in 1836, when a few black caterpillars were upon them. A moiety of the Swedes are drawn off, but the whole of the white turnips are eaten upon the land with sheep. I find no manures to surpass that from the fold-yard. I tried, by way of experiment, rape-dust, bones, and fold-yard manure. The turnips sown with bones and fold-yard manure were equally good, but those with rape-dust were decidedly the worst.

The land is never so productive the first two years, or until the clay has got well pulverised and mixed with the sand, as it is afterwards, and will not grow a good crop or a fine sample of barley for five or six years after the clay is laid on; I have therefore sown oats instead.

It is thought by some people that the clay will waste away,

and require to be renewed in the course of fifty years, or perhaps sooner. On this head I have no apprehensions, but am confident that, if after the lapse of twenty or thirty years there were not a particle of clay remaining, the land will have acquired sufficient quality and strength in itself, to produce a crop of any kind of grain.

I am led to this conclusion from my own observations, and think it one which may readily be come to by others on referring to the statement made of the produce, which is considerably within what I might have stated, had I selected the leading or best crops. This increase in the produce (which is double to what it was) returns in part to the land under the four-course system.

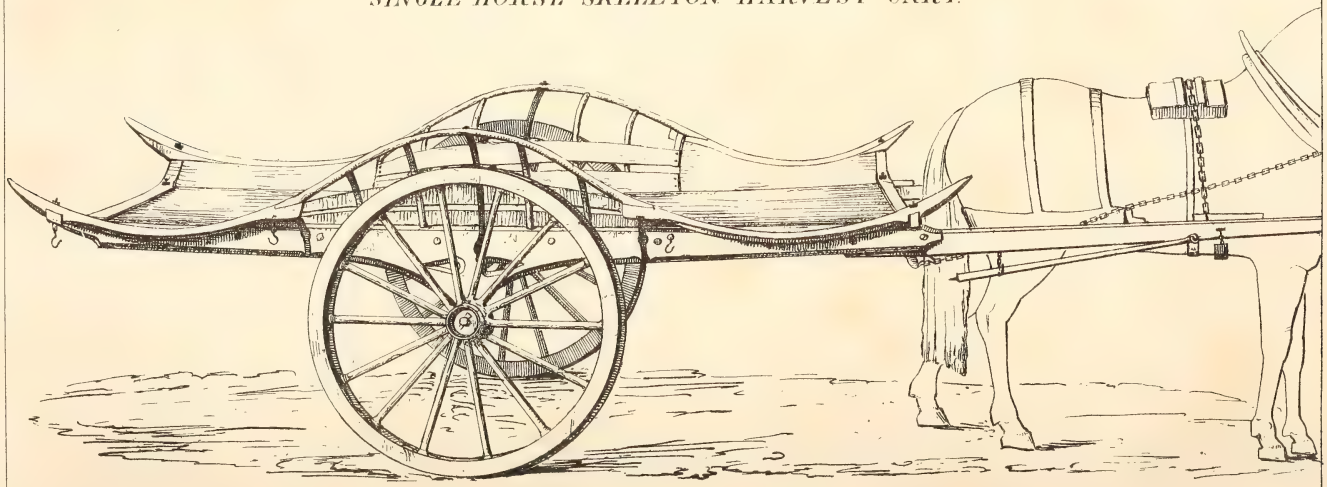
It may not be necessary for me to add more, as enough already has been adduced to increase exertion in making such improvements upon light sands. I have to regret that I did not commence the above improvements with greater determination, and to a greater extent from the first, but being inexperienced in the business, and having but little information on the subject, I was desirous of finding out the best way of doing the work and of trying the result before I went to any extent. If people would improve the land they have, particularly light land, by draining, marling, &c., they would realise a far greater return for the outlay than by purchasing more. It is a great national loss, and much to be regretted, that so much land, capable of being made really good, should lie waste, having a good drainage, and a plentiful supply of excellent clay underneath, which is generally the case when there is a white sandy surface.

Having the sanction of my landlord, who is anxious to see this system spread, I may be excused for stating that the whole of the above improvements have been carried on at his expense, for which I pay a rent which yields him a clear 4 per cent. on his purchase and other monies expended on a farm originally of the most barren quality.

Inferior land, and especially light sands, ought not to remain untilled; but for the common benefit of the owner, the occupier, and the consumer of the produce, they should be brought into cultivation.

Sheriff Hutton, near York.

SINGLE HORSE SKELETON HARVEST CART.



Length 12ft 2in Width 6ft 7in Weight 6¼cwt. Scale, ⅜ inch to a Foot.

Standidge & Co. Litho London

X.—*On the Reduction of Horse Labour by single Carts, detailing some years' experience of their economy.* By Henry J. Hannam, Esq.

To Philip Pusey, Esq. M.P.

Sir,

I have much pleasure in complying with your request for an account of my experience in the use of single-horse carts, because the Society, keeping in view the important subject of economy in horse-labour, appears desirous of having this system tested, as one of its material branches; and because I think I am able to show that by this practice something like one-half of the number of horses employed in the labour of carting may be saved, and consequently that there can be shown so much saving of individual capital, so much of national produce, and of course a proportionate ability to give additional employment to the agricultural labourer.

The question is not, as is frequently supposed, whether one horse single can draw more in proportion than any number harnessed together—which, I believe, is generally admitted—it is not, altogether, which will move the greatest weight; but the question is, which will transport in the most ready and economical manner the materials required to be passed between the field and the homestead, or between one field and another. For in the carrying operations of a farm, with the exception of drawing corn to market, a certain bulk has to be transferred from one point to another, not by one effort, but by a continuous succession of them. Practically speaking, the loading and unloading have to be kept in constant activity by a chain of carriages passing between them. What, then, is the best and most economical intermediate conveyance is not an easy matter for consideration. The best implement and best moving power have to be ascertained; and, among known methods, the selection ranges widely between the barrow or pack-saddle and the eight-horse waggon. Our present consideration, however, is whether one-horse carts are more ready and economical for the purpose than the methods now generally in use. And to assist in determining the matter I will give you as briefly as possible an account of my experience.

I. *By details of my practice.*
II. *By a statement of the saving apparently effected.*

1. *Details.*—I will first give my motives for adopting the system, and then some account of the principles with which I set about it, before I proceed to practical details.

The counties of Cumberland and Westmorland have universally and immemorially used the one-horse cart. They have no

other carriage for any kind of agricultural produce; and never is the addition of another horse on any occasion seen. The practice, apparently originating in economy, has long since spread into the neighbouring Scotch county of Dumfries; and I have the authority of Mr. Wilkie, the well-known implement maker of Uddingston, near Glasgow, for sayiug that it is all but universal at the present moment throughout the west of Scotland.

Having had during visits to the above English counties good opportunities of observing the apparent economy of the practice, I determined, about the year 1828, on endeavouring to economise my horses by trying the system on a farm of 370 acres in Burcott, near Dorchester, Oxon, conceiving that what was practised on the mountain sides of Cumberland, would not fail on the easy slopes near my own residence, and I procured two improved carts from the neighbourhood of Carlisle. In 1831 I sold the whole of my Berkshire waggons and three-horse dung-carts, having in the mean time had a set of carts made from the above pattern. But while I conceived, and by long experience have proved it to be a most complete implement for the carriage of heavy materials, I was not satisfied with its native plan of a simple frame fitted upon it when the hay and harvest-corn were required to be taken home. It loaded high, was somewhat liable to upset, did not take the utmost load that one horse might manage on a tolerably level surface; and, moreover, the tendency of its elevated load was to incommode the horse up and down hill. To obviate these disadvantages, I constructed a cart of the length and breadth of a Berkshire waggon, and for the following objects:—1. Lightness, suited to one horse. 2. Capaciousness, to carry a full weight of the lightest material, for instance, loose straw. 3. Lowness, for expeditious loading. 4. Compactness and steadiness of load, with little liability to overturn. 5. A long and consequently low-seated load, to relieve any undue pressure on the horse's back or breastbone in going down or up hill.

1. To insure *lightness,* I dispensed with a body, which moreover is perfectly unnecessary for harvest-work; and discarded every ounce-weight of material that could be spared consistently with strength and durability. For lightness I chiefly used the best thoroughly-seasoned ash, though for the two principal longitudinal bearers (provincially "beds") my carpenter strongly recommends oak as more trustworthy and lasting. These cut $2\frac{1}{2}$ in. $\times$ 5, and a little more than 12 ft. long, were placed for their greatest resistance edgeways, and the 5 inches at the centre bevelled underneath to 3 inches at the extremities, and they were strengthened on the axletree by a block of the same width, giving a bearing of not less than 2 ft. 9 in., and the depth of which (about 6 in.) enables the cart to stand on a perfect level when the horse

is properly attached. The 8 traverse oak "shoots" (or shuts) connecting these two principal pieces and supporting the floor, were also on the same principle of resistance cut 3 in. × 1, and placed edgeways; the fore and hind "shutlocks" are 3 in. deep × 2½ wide, and spring 3½ in. in the width of the rail to meet the "pannel" (or concave part of the rail) which is rested upon them. This outer rail thus resting at each extremity on the shutlocks is supported along the middle by three iron stays, viz., a tall one 1½ in. × ½ in., bent over the wheel, edgeways to the resistance, and on which the hoop (a 1½-inch square elm stick) is turned; and 2 shorter, on which the other end of the pannel (cut 2¼ in. wide × 2 in. deep, but much shaved underneath), and both ends of the hoop, are pinned down. Besides these 3 iron stays, which attach the rail to the bed, there are 10 wooden pins, at the requisite distances apart, for the same object; and on which are fitted thin elm boards to prevent grain from falling through. The longer pins over the wheel are bent to the same form as the centre iron stay. The space between the wheels (which are 4 ft. 6 in. high) and the rail should not be less than 5 in. The distance of the wheels apart where they rest on the ground was accommodated to the cart-ruts of the district; and of course the space on the axletree regulates the width between the two "beds." The axletree is of iron, and is the same as that used in stage-coaches, and lightly cased with wood. The horse draws by long chain plough-traces attached to a "whipper," the centre of which works on a pin fixed underneath, and behind the fore shutlock, and in a direct line from the middle of the axletree to the point of draught on the shoulder. Three sticks are used for supporting the load when the horse is out—two on the shafts, which are set crossing each other—and one behind. Four pieces of stone or brick are useful in blocking the wheels on a barn-floor, &c., when the horse is taken out.

The weight of the cart with narrow wheels is about 6½ cwt. The average size I made was about 12 ft. long × 6 ft. 6 in. wide. The length of the cart from which the sketch is taken, is from shutlock to shutlock exteriorly 12 ft. 2 in., and the width of the rails at the fore shutlock, 6 ft. 5 in.; at the hind shutlock, 6 ft. 7 in.; and at the top of the hoops, 6 ft. 10 in. The shafts are bolted on to the inside of the beds, and projecting 6 ft. 8 in., their points approach to 22 in., a closeness which is requisite in drawing with long traces.

I have troubled you with all this detail, not with the hope of interesting general readers, but for the benefit of those desirous to know something of the framing of this cart as shown in the sketch, which is on a scale of $\frac{3}{8}$ of an inch to a foot.

2. *Capaciousness.*—Besides the length and breadth that I have

described, I fitted to one of the carts, for the purpose of carrying a large and low load of loose straw, what in the Berkshire waggon are called "ladders," which temporarily fixed before and behind, lengthened the load not quite a yard each way. On this cart I have found my people sending home from a meadow 3 miles distant, over a turf road and a short hill rising 1 in 18, a load of hay measuring 36 cubic yards; and though I do not encourage heavy loading, I have not unfrequently seen on the other carts under the same circumstances, a load of hay 5 yds. long × 3 yds. wide × 2 yds. high = 30 cubic yards, and about a ton weight, drawn by the horse without difficulty.

Our barn-doors form an opening 12 ft. × 12 ft., and sometimes the top and sides are brushed by the loads of loose barley, which placed on a waggon would be too high to enter.

3. Though I have satisfactorily accomplished *low-loading,* and the consequent advantage of increased despatch from the quickness with which a man can pitch at such a height, yet the low carriage is of course a disadvantage at the side of a rick, &c.; nevertheless I have not found this a hindrance to the work, for the labourers at that point being stationary, can perform their portion quicker than those in the field, a part of whose time must necessarily be occupied in moving along rows of shocks, &c.

4. With a view to compactness and steadiness of load, I originally directed my attention to the outrigger, or "copse," supported over the horse by an iron upright from the shafts, together with a corresponding projection from the floor of the cart behind, adapted to the dung-cart in many midland counties, as an improvement on the Cumberland "shelving" or rail, for carrying hay, &c.; but decided ultimately in favour of my present plan (though less economical) on account of its easy and firm loading, together with other supposed advantages. Nor have I been disappointed in its non-liability to upset; for though sheaves may sometimes slip off in dry weather, I do not recollect one instance of an overturn. It has sometimes been suggested that some railing in front, next the horse, would better keep the load in its place, but I believe it would only be an incumbrance, and add to the weight, as we have never discovered any necessity for it. The hind-quarters of the horse form a sufficient guide to load by, and when he moves on the corn does not press on them.

5. *Pressure on the horse.* I think it will be seen by a glance at the figures below that the objection which is urged against two-wheel carriages in harvest, on account of their load bearing injuriously on the horse's back in descending a hill, and tending to weigh him off his legs in going up, is greatly obviated in a low-built carriage of considerable length.

It may be shown, first, that upon an inclined plane the

Fig. 1.

Midland Cart.

$5^{yds} \times 2^{yds} \times 3^{yds} = 30^{yds} = 1$ *ton.*

Pressure on horse 465^{lbs}

Descent 1 in 2.

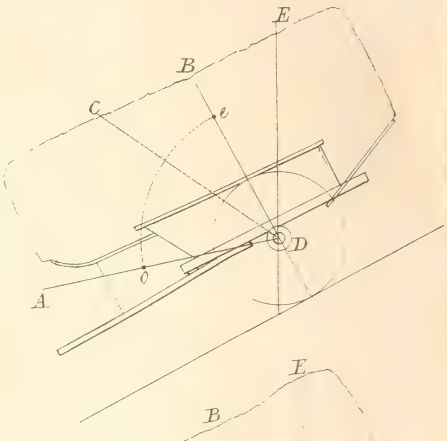


Fig. 2.

Cumberland Cart.

$3\frac{1}{2}^{yds} \times 1\frac{7}{8}^{yds} \times 2\frac{1}{2}^{yds} = 15^{yds} = \frac{1}{2}$ *ton.*

Pressure on horse 401^{lbs}

Descent 1 in 2.

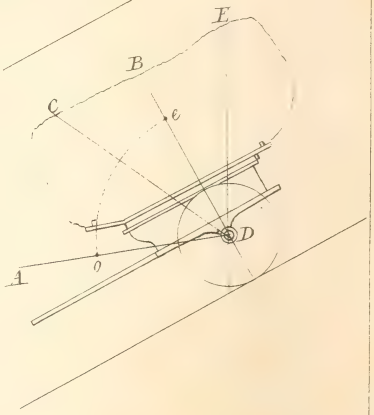


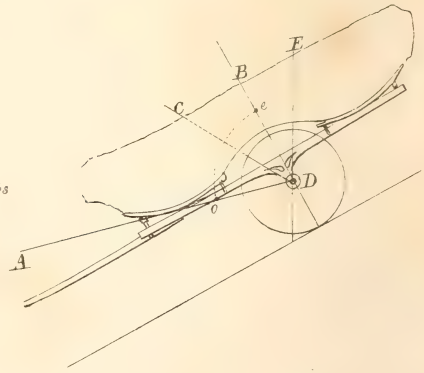
Fig. 3.

Skeleton Cart.

$5^{yds} \times 1^{yd} \times 3^{yds} = 15^{yds} = \frac{3}{4}$ *ton.*

Pressure on horse 62^{lbs}

Descent 1 in 2.



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lower the load, and the more lengthened its base, the less disturbed will be the equilibrium; and that, consequently, the less will be the pressure. And again, that the higher the load in proportion to its base the greater the pressure. To prove this, take a plumb-line, and drop it to the point of the axle; this will divide the load into two unequal parts, the downward side being the greater, and the upward the less: the difference between them is the weight of pressure. To find the amount of it, draw a second line from the axle at right angles with the inclined plane: this will pass through the middle of the overbalance, will determine the position of the pressure, and will divide it into two equal parts: and it will distinctly exhibit one of these half-parts by the angle it forms with the plumb-line. And if on this second line the centre point of weight of pressure be found (and I think it resides in the centre of the area formed by the above angle doubled) and from it an arc be described to the horizontal lever, the shaft, or rather to a line resting on the horse's back at one end, and on the middle of the wheel at the other, there will be seen the exact share of weight that each of these two supporters bears.

To elucidate this, the following figures are represented on the same inclined plane, and supposed to be loaded with hay from the field, in perfect equilibrium on level ground. The moment that a pound weight inclines off the balance it passes the plumb-line *E*, and becomes two pounds of pressure. And the equal division of that pressure is exhibited by *B*, the line at right angles with the inclination; and its position and contents are determined by the triangle *E C D*: *e* is the centre of the weight of pressure, *D A* is the lever borne by the cart-saddle *A*, and the wheel *D*; and *o* the amount of pressure that descends upon it.

I do not vouch for exactness, nor for a correct delineation of the loaded carts, yet I have endeavoured to make the following calculations as fairly as I could, upon a scale of one-eighth of an inch to a foot. For simplicity I have left out the weight of the cart bodies, though I have considered them as bulk where they come within the angles of pressure.

Fig. 1 is a midland county two-horse cart, containing a load of green hay, 5 yards long × 2 high × 3 wide = 30 cubic yards = about 1 ton; and showing by the plumb-line *E* that on the slope on which it is descending there exists in the triangle *E C D* about 747 lbs. of pressure, which falling from the centre of weight, *e*, on the lever *D A* at *o*, gives the horse *A* the burden of $\frac{11}{18}$ of this weight, and the wheel *D* $\frac{7}{18}$; therefore that the horse sustains on his back 456 lbs.

Fig. 2, a Cumberland single-horse cart, with its usual load of the same material, $3\frac{1}{2}$ yards long × $1\frac{2}{3}$ high × $2\frac{1}{2}$ wide = 15

cubic yards = about $\frac{1}{2}$ ton, exhibits by the same lines an amount of 622 lbs. of pressure: on the horse $\frac{11}{17}$ and $\frac{6}{17}$ on the wheel = $401\frac{1}{2}$ lbs. on the horse's back.

Fig. 3 is the skeleton-cart loaded with the same quantity as the Cumberland cart above, viz. $\frac{1}{2}$ ton, which it is enabled to do at so low an elevation from its length and greater width. It measures 5 yards long × 1 high × 3 wide = 15 yards cube = about $\frac{1}{2}$ a ton. The amount of pressure that it exhibits in the same way as the other two, is 238 lbs., $\frac{13}{49}$ of which rest on the horse, and $\frac{36}{49}$ on the centre of the wheel, being a weight on the horse of $62\frac{1}{2}$ lbs.

I will not occupy time by giving the process of my calculations, which I trust will be sufficiently obvious. And I hope I have made it clear that I had good reason for adopting the principle of the cart in *Fig.* 3, which, while the midland cart shows in a ton load a weight of 456 lbs. on the horse, and the Cumberland 401 lbs. in a half-ton, gives him in the same quantity but 62 lbs. to bear. It must not, however, be forgotten that they are represented on an inclination that can scarcely occur, viz., 1 in 2, which I thought it best to use in order to show the principle more distinctly. I trust at least I have made it satisfactory that on an ordinary steep hill, with a moderate load adjusted with common care, my cart can never distress the horse. In my own experience I have never perceived it to do so under the heaviest load. My descents* do not ordinarily exceed 1 in 28.

The French fully carry out the principle of a long load. Their harvest-carts are literally only two very long stout levers (with scarce any other appendage), just so much *over*-balanced on the axle-tree as to leave length enough for the horse to find a pair of shafts. I have discovered lately in the old Agricultural Report for Cornwall that my plan has been anticipated in the Cornish wain,† an implement the reporter speaks most favourably of: its principle appears exactly similar, varying only in structure of parts.‡ It is not mentioned that it is adapted to the draught of one horse.

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* The steepest part of the road over the Henley chalk hills between Oxford and London rises about 1 in 10. On a turnpike 1 in 25 is an easy ascent.

† I do not know to what report Mr. Hannam refers. Frazer's report in 1794 says that no wheel-carriages were used, everything being carried on mules and horses; which is not true. Toupin mentions the Cornish wain sixty years earlier. The wain now in use is commonly for oxen; the platform is 10 ft. long by 3 ft. 5 in. wide; but a rail on each side makes the total width about 5 ft. 3 in.—C. Lemon.

‡ It is perhaps the best carriage in the kingdom for clearing off harvest. The body is open: ladders of five bars before and behind give it great length, and an arch over the hind wheel gives it breadth. The fore wheels turn clear under the body, so that it can sweep round in a very narrow

Fig. 4.

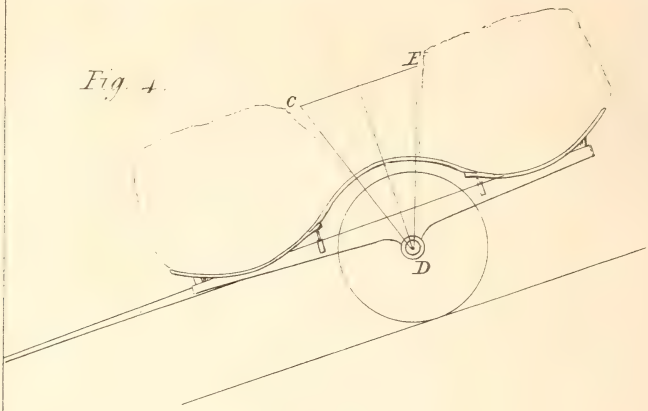


Fig. 5.

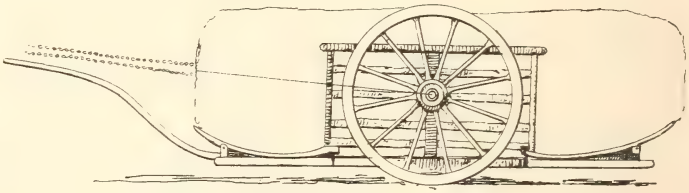
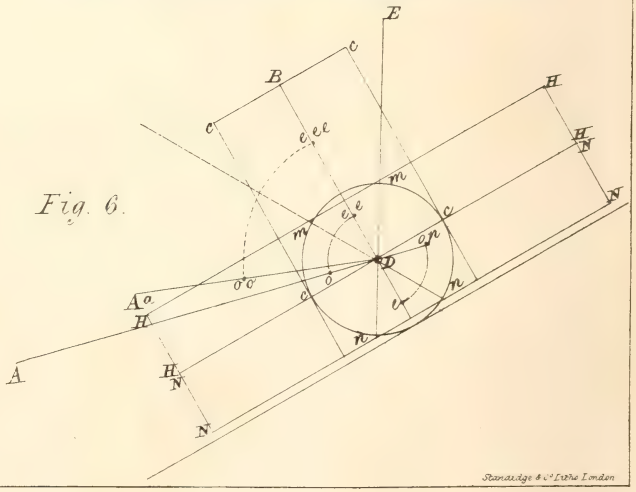


Fig. 6.



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I have now shown how in my situation all inconvenience from pressure is obviated. And for myself I should not fear in any situation the success of this cart with a single horse's draught, and that only by suiting the form and size of the load to circumstances. For it is an almost unanswerable argument that practice sanctions the use of an implement of much greater pressure (*see* Fig. 2) in mountainous counties in England and Scotland; and again in many midland counties farmers do not scruple to put the pressure of a two and three-horse cart load on the back of one shaft horse. Nevertheless, I will offer to those who farm on excessively steep slopes (as well as for the purpose of farther elucidating the principle advocated), two hints, by which I think pressure may be completely remedied; but at the same time undertaking to vouch for nothing more in other respects than their mere feasibility.

The first is by a cart of sufficient length to afford room for the load towards the two extremities, leaving the middle empty, so that at the greatest descent it has to meet with, no portion of the bulk shall pass the plumb-line, consequently, according to what has been before shown, no overbalance can take place—no weight can be thrown forward. This will be best explained by Fig. 4, where the skeleton cart is so loaded as to leave the middle clear, showing that, at the inclination given, the space at the triangle *E C D*, that would otherwise be occupied by the weight of pressure, being void, no weight can be thrown upon the horse till the load meets with a greater slope, and a portion of it passes the plumb-line *E*. But as it would be difficult for labourers so to lay the load as to prevent its slipping out of its place going down hill, I would suggest a framework of very light materials made in the form and fixed in the position of this triangle ; and made to expand to suit any descent.

My second hint is a carriage built below the axle, as near as possible to the ground, as in Fig 5. The object of this is, first, the inversion of the pressure, *i. e.* as all beyond a certain overbalance of load placed above the axle-tree acts injuriously on the horse, the same bulk placed below it might be found beneficial in inverse proportion. The diagram, Fig. 6, (*N N N N*) will show that the pressure will then be upon the horse's back going up hill, which is generally considered desirable, and, in the same degree, that it hangs on the breast-bone in descending; but whether this would tend to "keep him up" I have not proved. But the principal advantage of the carriage in Fig. 5 is, that if

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compass. It may be used with either tongue-tree or shafts, as designed for oxen or horses, and can be made with either two wheels or four. The load is secured by two ropes tightened by a winch or roller, fixed behind; and the waggon carries 300 sheaves with ease.—J. French Burke.

loaded as much above the axle as below, it will equalize itself on every inclination, it will never lose its equilibrium up or down the steepest slope. For this object the wheel should be as high as can be conveniently used. And instead of cranking the axle, which to be sufficiently strong must be heavy and clumsy, I should recommend, as shown in the sketch, the smaller inconvenience of its passing in its ordinary form through the carriage, suspending the body from it. I think the shape presents a difficulty in applying the horse's strength with best advantage, and to overcome it I would boldly propose submitting to another inconvenience in the inside of the carriage, viz., a chain attached to the middle of the axle-tree and to a "whipper," with or without a slight iron support fixed to the centre of the "fore-shutlock." A moveable midland "side-ladder" would be sufficient to protect the wheel when a load was raised above it.

Fig. 6 explains (*see H H N N*) the above position, as well as embodies the principles advocated in regard to pressure. And it is also intended to exhibit in a combined view four methods of carrying a load on two wheels, with the degree of pressure in each. And I trust I may be excused some recapitulation in the description of it.

C C C C is a given bulk on a short cart. *H H H H* is the same quantity on a carriage three times the length. *N N N N* is a carriage of similar length and contents loaded below the axletree. *H H N N* combines the two long loads, and is intended to exhibit the effect of a bulk, equal above and below the axle. *E* the plumb-line to the axle, shows what portion of each bulk has passed off the equilibrium and become pressure. *B* a line through the axle at right angles with the inclined plane, traverses the middle of each portion of pressure; while *e* marks the centre of gravity of each pressure. This centre of pressure is traced on its arc to its resting point at *o*, on the levers *D A*, which point determines what is received respectively by the horse and the wheel; by the rule that the share borne by each is exactly in inverse proportion to their distance from the point of pressure.

In the high, narrow-based bulk *C C C C*, the area of pressure is found in the pentagon *D C C*, the centre of its gravity at *e e e*, and the arc described from thence to the lever *D A a*, at *o o*, determines the point which will give the relative portion of pressure sustained by *D*, and by *A a* the bearing point on the horse's back. This has been elucidated in Figs. 1 and 2.

In the bulk *H H H H* the triangle *D m m* shows the area of pressure, and *e e* its centre, and thence an arc described to *o*, on the lever *D A*, exhibits the share of weight borne respectively by *D* and *A*. This has been practically shown in Fig. 3.

In *N N N N* is seen the same superficies and the same contents

as in *H H H H*, and the area of pressure the triangle *D n n*, together with its centre *e*, is the same quantity, but the bulk being placed below the axle, the pressure is found on the upward side of the plumb-line and reversed, and acts through its arc in inverted proportion, on the underneath side of the continuation of the lever *D A* at *o p*.

In the combined bulk above and below the axle *H H N N* (see Fig. 5) is exhibited an equilibrium which cannot be disturbed, the quantities on each side of the plumb-line are seen to be the same, and will always be so on every inclination, as whatever portion of the bulk above the axle passes the plumb-line with a downward pressure, an equal portion below the axle passes upwards, which is declared by the two equal angles formed by the line perpendicular to the inclined plane intersecting the plumb-line at the axle.

There is a simple remedy for pressure used in the North, and by my own people, and I dare say by all occasionally who are experienced in the use of carts—that of stopping at the top of a hill to raise the shafts by shortening the back-chain and lengthening the breast-band, and returning them to their places at the bottom. The full extent of this may raise the shaft 1 foot at this point. Here the short cart has an advantage over the long one; for its length from the axletree to the back chain not being more than about 9 feet, it might obtain an equilibrium in a descent of 1 in 9, while the harvest cart being 12 feet between the same points, would only obtain it in a descent of 1 in 12.

While so much has been urged on the apparent necessity for an equilibrium, it must not pass unobserved that practice requires the placing a certain portion of weight on the horse. We find cartwrights adjusting their cart-bodies on the axle with some regard to this view; and in the Cumberland cart it occurs to an extent that I cannot fully account for, considering the nature of the country.

Where skidding is necessary, a presser on the principle of the common French plan might be the most desirable. The carriers on the Oxfordshire chalk hills use a flat piece of board 2 or 3 feet square, trailing on the ground behind by a chain or rope from the middle of the axletree; on this they stand, and by their own weight give an effectual check to the load. Tipsticks, on which the load is tilted for this purpose, as well as everything else of the kind that injures a public road, are forbidden by the Turnpike Act.

One more view of this part of my subject must be taken before I proceed to a few practical details. It may be observed that if the adoption of the one-horse system be essential, why not adapt to one animal a light waggon instead of a cart, when the matter

of pressure would be set at rest? In answer to this it appears to me that the complication of the parts of a waggon would render it impossible that it could be made so light as a cart: therefore that the constant misapplication of power by the drawing about an unnecessary weight of material would of itself be a sufficient objection. Beyond, however, the removal of pressure, together with a greater stability when at rest, I am not aware of any material advantage that a waggon possesses for farming objects over a two-wheel carriage. For all purposes of motion, in the field, in the stackyard, and in the interior of barns, I have found it very much inferior.

I found it advisable in parting with waggons and three-horse dung carts, to dispose of the sets of harness with which they were worked. Having already adopted two-horse ploughs there was no farther occasion for trace-horse harness; one set only was reserved for timber drawing, and this was put out of the way; for much progress cannot be made in the system if opportunities are afforded of occasionally adding a trace-horse. Such pretexts must be firmly resisted; and servants used to large implements have to learn the habit of putting up only such a load as one horse can conveniently draw.

There seems a fair *primâ facie* reason for having an extra horse to wait upon a steep pitch and help up the single horse, and return down again for the next; but I believe it to be at variance with the principle of *chain* work, in this as well as every other system. It is not seen in the northern counties. This extra horse should be put into another cart, and with the rest loaded with just so much as will not prevent his surmounting the difficulty in his way.*

I retained but one trace for every purpose, viz., the chain trace used in ploughing, rivetting it fast to the "hames;" thus the horse is equally ready at a moment's warning to shift to any kind of work. In carting it is hooked at full length under the body of the cart in a direct line with the shoulder and the axletree, and is quite independent of the shaft: and this was adopted from a belief that the common short ones, called "tugs," are so attached to the shafts as to feel the swinging of them in such a manner as to operate materially against the draught. I have purposed applying the whipper, described in the structure of the skeleton cart, to my dung-carts: the intention of it is to give free play to a horse's shoulders as they alternately advance; and also to obviate a slight retrograde movement that takes place alternately in each

* It appears, however, that it will be more economical to use the extra horse for an extra pull, when otherwise each single horse must go with an half load, on account of one steep pitch which may happen to occur in the distance to be travelled over.—C. Lefroy.

wheel, when the whole carriage is allowed to move with the working of the animal's limbs.

My dung carts I have stated, are taken from the improved Cumberland cart, which measures 60 inches long × 47½ inches wide × 17 inches deep = 1 cubic yard = 21 bushels, and it tilts with a spring-key stick which adjusts itself as the horse moves forward: the wheels are about 4 feet 6 inches high, and are set so far apart as conveniently to span two 27-inch ridges; yet this distance must again be in some degree subservient to the cart-ruts of a district. Its weight is 8 cwt. I had 7 dung-carts and 6 harvest-carts made; and amongst them four pairs of broad wheels. All the axletrees and boxes being of the same stage-coach pattern, the wheels can be shifted as circumstances require. Fewer pairs might be made than carriages, but it is much more convenient to have them all ready for service. Some of my dung-carts have frames fitted for harvest-work if required. It is very desirable to have as many dung-carts as horses (I mean, of course, on the reduced scale), when every horse can have employment when only carting-work can be carried on. The moderate height and weight, and yet very strong framing of these carts, fit them for dung, mould, market, and every kind of farm work, as well as for any heavy materials. From their reduced height they are filled with greater proportionate dispatch than 3-horse carts. Yard-dung should be thrown into them by a short-handled tool with wide set prongs, better adapted for giving scope to a labourer's powers for raising a larger quantity to a lesser height than the common long-handled dung-fork, which, being merely a three-pronged pitchfork, is best suited for throwing small quantities to the top of a high cart. The Scotch "gripe," and the Kentish dung-fork, are the proper tools, which (particularly the latter) possess the properties of both lever and fulcrum for wrenching up the close trodden litter, while the workman with the common strait long-handled tool is compelled to use his knee for a fulcrum.

I market my corn according to the northern practice, in the dung-cart. It is not so convenient to unload sacks from as a waggon, but the load it carries, viz., 5 qrs. of wheat, 6 qrs. of barley, and other grain in proportion, and in back carriage half a waggon load of ashes, compensates for small inconveniencies: and one horse delivers 10 qrs. of wheat, &c., at two trips when the distance does not exceed 5 or 6 miles. The only objection that I have heard the carters make to the system is thus carrying out the corn: they find themselves singular, and making but a bad figure by the side of a waggon and team of horses: they should be indulged with a reserve of the best carts kept well painted, and washed after being used for manure, and with harness a little ornamented. In going out with a string of carts care should be

taken that the breeching be well tightened, or otherwise when a cart stops suddenly and there is room for the horse behind to thrust his neck over the tail-board, the points of his shafts will be forced through it. The ends of the shafts must be kept as short as possible.

The value of minutiæ to a person disposed to try the system must be my excuse for inserting them.

II. *Saving effected.*—I had no other object in view in entering into this practice than lessening my expenses by reducing the number of my horses, and in this I have succeeded beyond my expectations. My farm of 370 acres, consisting chiefly of gravelly and ferruginous sandy loams, was some years ago under very able management, with a strength of 12 horses and 6 oxen. And just previous to my taking it into my own occupation 16 horses had been employed by another spirited cultivator. I have gradually by the joint operation of two horse-ploughs and single horse-carts, reduced my number to 8 horses. My system notwithstanding, is such as somewhat increases my aggregate amount of horse-labour beyond that of the surrounding district—certainly doing a great deal more carting work—though in a few points of tillage, it is transferred to the manual labour. For instance, I grow annually about 35 acres of mangel and 20 of potatoes, which necessarily cause much carriage, and together with the other ridged crops, also a good deal of horse-hoeing. I cart great quantities of limestone road-scrapings from a distance of 3 or 4 miles. My carriage of coals, bricks, stone, draining-tiles, &c., is extensive. I thresh with a four-horse machine: and soil clover, &c., throughout the summer, with horses, and with cattle or pigs. And I think I do not slight my tillage, being rather particular about a fine tilth, giving most of my barley-ground three furrows; and perhaps I lose more time than many other farmers by being scrupulous about keeping off the land for some time after a considerable fall of rain. On the other hand I expend no horse-labour in cleaning the soil of couch grass, as I commence forking it out of the stubbles as soon as they are cleared of corn, and carry this on through the winter till the whole are broken up; having originally conquered any serious foulness * by one horse ploughing immediately after harvest.

* My method of cleaning a "couchy" piece of land was, immediately after the corn was cut (and that fag-reaped, or mowed close to the ground), and the surface a little moist with rain, to plough it, with one horse, 3 inches deep (this grass seldom spears along beneath the surface at a greater depth), to tear it (across the furrow) out of the mould with a cat's-claw drag, completing the operation with harrow and roll; and, finally, to harrow together the haulm and couch into regular rows, and again into cross-rows, and to collect every bit of couch remaining on the surface by hand-raking and picking. It was then, after carting the stuff home to bottom the yards,

My saving by two-horse ploughs (and I have observed the same on other farms where they have been adopted) I consider about one-fourth of the usual proportion of 4 horses to every 100 acres. If according to this proportion my appropriate number under the general system would be 15, I save $3\frac{3}{4}$ by pair-horse ploughs. My requisite strength then at this reduction is shown to be $11\frac{1}{4}$. The saving, therefore, that I am able to effect by single carts, according to my present reduction to 8, must be $3\frac{1}{4}$, rather more than one-fifth of my original proportion.

I set out by stating my confidence that this system is capable of saving one half of the horses usually employed in the carting-labour of a farm; and therefore it will be necessary to show what proportion carting bears to the rest of the work. Under the ancient low systems of cultivation, this is very small: little manure is carried out, and little produce brought home; and to such the practice under consideration offers no great boon. It is there generally considered greater economy to save manual than horse labour; and as a large number of horses may really be required to combat the usually foul state of the land with tillage implements of faulty construction, there is always a superabundance for carting purposes. To that happily much more numerous body of farmers who have adopted every improvement short of a two-horse plough the same observation in some degree applies: the abundant strength they possess for tillage purposes makes them feel no need of economy in carting operations. But let them once economise their tillage system, they will find some comfort in proceeding another step. Let them take the two-horse plough as a first, and the single cart as a second step, and I have no hesitation in asserting that they will find themselves (gradually as they master the working of the system) able to perform their labour, as I have experienced, with something approaching to half the number of horses that they now use, and with *at least* equal facility and comfort. On the subject of the proportion of carting to the rest of the work, I can, perhaps, best help to the consideration of it by offering a rough calculation of my own operations, which will also show at the same time the degree of saving effected:—

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ploughed again to the same depth; and every operation repeated a second time was generally sufficient to clean my kind of soil. August is the best month for this species of fallowing; after September the soil does not often dry readily enough for separating the mould and roots by the roll, &c. Extra strength may be required (it is here a question whether Biddell's scarifier would economise the above process) to do it extensively, but it will be well repaid; for at no other season of the year is this troublesome weed more easily destroyed. And after having thoroughly done it, I have ever since found the Kentish dung-fork, applied at every opportunity, sufficient to keep it under.

CALCULATIONS of the relative Proportions of Team Labour, and of the saving effected by pair-horse ploughs, single carts, &c.

Expended with 4 horses per 100 acres.		Saving effected.	
In ploughing,	about 50 per cent.	by 2, and (occasionally) 1 horse ploughs, and double-ridging ploughs . . .	27 per cent.
,, horse-hoeing,		by forking couch grass	
,, dragging,		by pair-horse cat's-claw drag	
,, Suffolk drill, &c.			
,, harrowing,	12 per cent.	by 1 horse 6 feet heavy roll, being 33 per cent. in the implement, and 10 or 12 per cent., on the general labour, when heavy rolling is performed . . .	1 per cent.
,, rolling,			
,, carting . . .	38 per cent.	by single-horse carts	19 per cent.
		Total saving . . .	47 per cent.

Calculations on the general system of this district would probably show that carting scarcely bears the proportion of one-fourth to the whole team labour.

Let me now answer the question which will be asked. In what manner is the saving by single carts of about one-fifth of the usual proportion of horses effected? By considering that to move a bulk from one spot to another, in the way that field operations are carried on by a continuous chain of loading at one end and discharging at the other, seldom less than 3 carts are employed, and that in the usual practice of the southern counties, one horse occupies the stand-cart or waggon, and 3 horses each of the other two that are in motion; the work thus going forward with 7 horses. If 2 horses in a cart are used, 5 will be the number engaged; and if 4, the number will be 9. Now, I am prepared to show, not by any series of experiments, but by the routine of my farm for the last ten years, that the same amount of work, when at a moderate distance, may be performed by 3 horses in separate carts; and that it is only at the greatest distance in which 3 three-horse carts are able to keep up the chain, that 4 may be required. And these will keep the same number of (and from low-filling, somewhat fewer) loaders engaged, and consequently accomplish the moving of an equal bulk. As this may seem a little paradoxical, I will enter into the reasons which combine to effect it. 1st. A horse thus harnessed draws more in proportion with equal ease; 2ndly, the misapplication of his strength in the constant draught of a heavy carriage is prevented; 3rdly, he moves more briskly and freely, and turns, &c. with less loss of time, and when any check occurs the loss is saved that takes place by the hinderance of a large number; and, lastly, there is a certain convenience and ready manageableness which can be better felt than calculated or described.

1. Practice and general opinion are agreed in assigning a greater power of draught to a horse working singly than to any

number harnessed together; but the amount of difference I have never proved by actual experiment. Mr. Culley, in his Report of the three English border counties gives an instance (page 192) in which the advantage is as 3 to 4 (see also page 272, and the Middlesex Report, pages 108 and 526); and another, in which, with a horse of 16 hands, 24 cwt. was the load, on the hilly* road from Hexham to Newcastle. I am in the regular practice of sending out to any distance, on a turnpike however hilly, 5 qrs. of wheat, which, with the cart., 8 cwt., seldom amounts to less than 30 cwt. It is also considered universally that the nearer a horse is to his load the easier will be the draught, but to what extent I have also never proved.

2. The misapplication of power caused by a heavy carriage is often enormous, there being sometimes, especially by waggons in harvest, double the weight of timber moved, in going backwards and forwards, to that of produce brought home; for instance, a common harvest load, except at a great distance from the homestead, seldom exceeds 1 ton, and 1 ton more or less is the weight of a waggon: at any rate, 1 to 1 is the common proportion of the carriage to the harvest load.

It is admitted that there is no perceptible difference between the size of my neighbours' loads and my own: the weight of my harvest cart I have stated is about 6½ cwt., therefore my proportion is 1 to 3; and under less favourable circumstances than mine, it need never, with a similar carriage, be less than 1 to 2; and this goes a very considerable way to explain why I am able to perform the same work with half the strength, and without straining the powers of my horses. In the dung-carts the case is not quite so strong in my favour, as there is not so large a disproportion in their weight.

3. It is certain that a horse can exert his powers with greater ease and effect by himself than when incommoded by the diverse pulling of companions, and also that a sluggish animal must draw his own share. In turning, one horse is much more handy than a string; and no comparison can be made between the turning of a two and four wheel carriage. I have never practised trotting.

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* I had occasion to send my skeleton cart with 15 cwt. of hay up the steepest hill (Cuddesden) in this part of the country, and directed a very intelligent labourer to go with it and report; his statement was, that besides observing at a steep descent that the breeching was tightened more than the backchain, on stopping on the sharpest ascent he found the breast-band tolerably slack, and that the horse drew the load up this steep point (1 in 7) without difficulty; and he thought he might have managed a ton. "The horse, however, had a *knack of thwarting the road*,"—a method of easing the ascent horses are very ready at in the north: in a waggon they cannot do it. His opinion also was, that four horses, with 2 tons on a waggon, would have very tight work at this part of the hill.

4. The manageableness of one-horse carts compared with heavier implements is greater than I can describe. Every operation appears facilitated by them. Improvements are more easily carried into execution through their means. I doubt whether I could get through my present work by means of the old implements without an increase of the original number of horses.

On an average three in six are saved, in the proportion of one in the quantity carried, one in the weight of carriage, and one in quick movement, saving loss of time, and manageableness. And that this is not done by over-taxing the powers of my horses may be believed, by five out of my present number of eight averaging somewhere about 20 years old; and they are a light kind of cart-horse, of fair height, without any remarkable qualities. Nor is it done by extra feeding; for most of their carting work falls within the five summer months, in which they live entirely on broad clover, &c., without any portion of corn.

I now come to a very material point,—the expenses of carrying the practice into execution. Though I can with propriety range it under the head of saving, yet it is not of that low scale that will induce a person for its own sake to adopt the system. Were he to follow my steps, it would depend on the goodness of his old implements, whether the disposal of them would repay him for the expense of the change. The fairest view is by a comparison with a new set of each. A full set of implements under the general system of this district for employing the original horse power on my farm to the best advantage, would be 6 dung (3 horse) carts at 14*l.*, two Dutch (mould) carts at 10*l.*, one marketting cart at 16*l.*, and 5 waggons, at 35*l.*; total, 295*l.* Under my present system I require 8 dung-carts at 15*l.*, and 6 skeleton carts at 18*l.*; total, 228*l.*

The advantage of buying second-hand carriages exists under the general system, which is not available in a new one; but my vicinity to the stage-coaches of Oxford enabled me to turn to account their cast off wheels and axletrees—the latter to me are as good as new, and the best of the former last many years in my slow work—so that I had only to furnish myself with new broad wheels. My expense in providing myself with seven dung-carts and six skeleton-carts was 182*l.* A complete and well made skeleton-cart will be about half the cost of the best made Berkshire waggon, and will probably last as long, and perhaps longer, from its not being required for marketing; and a waggon is said to last as many years as it costs pounds. The wear and tear and repairs of a two-wheel carriage of simple frame work must necessarily be much less than one of four with numerous parts, whether it be from the shocks of the road, or the process of natural decay.

It is necessary also to exhibit, as far as they have been disco-

vered, the disadvantages and difficulties of the system. It must first be considered, that whatever reduction of horses may accomplish the carting labour, a certain number is required for tillage, particularly in busy seasons. I have with my reduced number, eight, found myself pressed in the spring, particularly the last. I believe I might have forwarded my work by better arrangement, and by having been less scrupulous in waiting for dry intervals during the winter, but it is essential, particularly throughout barley and turnip sowing, that the work should be "close up." Growing, instead of beans and peas, a large breadth of potatoes and mangel-wurzel, my tillage labour is very severe during April, May, and June, and I have been obliged to go for assistance to my own stable, to an amount equal to one horse for those three months. To meet this difficulty it is my intention first to reduce my number throughout the year to seven, and seven able ones I am satisfied will accomplish my general work satisfactorily, and then in the month of March either purchase two pairs of oxen, and work them till June and graze or sell them, or four aged horses, any moderate loss in the disposal of which at the end of three months would be well repaid in the value of their work. Thus four horses for three months, being equal to one throughout the year, I should not exceed my present cost in the keep of eight.

There are probably few districts that present a greater apparent obstacle to the use of both single carts and two-horse ploughs than that in which I am situated, from the practice which prevails of making up heavy horses for the London market. They are bought in between two and three years old, worked till five or six, and sold fat at the fairs to the London dealers. London must be supplied; and the practice cannot be abandoned. And the question is, how far so young a stock is compatible with the above systems. Those who have experience in the practice are perhaps best able to determine. It strikes me that, as a larger stock than usual must be required to prevent the colts and fatting horses from being overworked, the two systems quoted might still be easily carried into effect, by a larger proportionate stock than they would otherwise require. One advantage, however, the natural working of the practice would give which I am in search of, viz. an increase of strength in the spring; for instance, were young stock to be employed on my farm, nine would probably be required throughout the year, and if the purchase of three colts were made in the winter, there would be twelve for the spring work, and three might be got ready for the London dealers by the beginning of the summer.

It will be seen by all this that my system requires exertion to economise the means of performing spring tillage. I am not,

however, prepared to say how far necessity may not stimulate invention so to economise our tillage management as to do away with the need of the expedient I suggest. Both duty and interest should gradually lead us to avoid wasting our horse-power by implements of defective principle, or extravagant dimensions; and while we improve the old, to satisfy ourselves that the new ones are calculated, not only to expedite but to simplify the old practice; and above all, that they do not demand a number of horses. A farm is not like a factory, concentrating its power unvaryingly at one spot on one object, but its operations are multifarious and scattered, and have frequently to be carried on at many points at the same moment. Large implements, therefore, are opposed to the reduction of horse labour; and I am disposed to look doubtingly on all that require more than two or three horses. And I think the nearer we can bring them within the powers of one the better; for I believe this to be the secret of performing our present labour with a smaller power. And our prejudices in favour of profuse horse labour must gradually give way before the wants of an increasing population. The food will be required, and the labour also. I feel a greater zeal in advocating the one-horse system, because I consider it a boon to the agricultural labourer; for it is more than probable that the greater part of the capital abstracted from the purchase and keep of horses would find its way to him in the form of additional employment.

The saving to the farmer is in the purchase of fewer horses and perhaps of less costly implements in the stocking of his farm; and all the keep, wear, and other expenses annually attendant upon the number of horses, that he may be able to reduce by improving upon the present system. The gain he may possibly spend upon himself, but the greater probability is that he will spend it on the cultivation of his farm.

I have no statistics by me which show the number of acres under cultivation in this kingdom, the number of horses employed in agriculture, &c., but the data which I have supplied may, by the aid of such references, be made to show in what round sum our national resources may be economised by greater frugality in the employment of horses. The saving in my individual instance, reckoning the yearly keep, the wear, and all other expenses incidental to a horse at 30*l.*, and my reduction being seven fifteenths, is about 56*l.* per 100 acres per annum, which puts it in my power to obtain the work of at least one additional good labourer and his family to that same quantity of land. If five men be the average allowance to every such 100 acres of arable land, there exist then in the reduction of the present system of horse labour ample means for the employment of an increase of one-fifth in the present

number of labourers and their families; and of course for the support to a proportionate increase of our agricultural population: whose labour will furnish a supply for an equal augmentation of the population at large.

Believe me to be, Sir,
Your most obedient servant,

HENRY J. HANNAM.

Burcott, Oxfordshire, Sept. 19, 1840.

XI.—*On the Application of Bones to Grass Lands, on Lord Combermere's Estate.* By Mr. EDWARD BILLYSE. Communicated by the MARQUIS OF DOWNSHIRE.

WITHIN the last nine years Lord Combermere has supplied his tenantry (upon the Combermere estate in Cheshire) with bones for upwards of 600 statute acres of their pasture land, at a cost of about 10*l.* an acre. The land before the bones were applied was not worth more than from 10*s.* to 15*s.* an acre; it is now well worth from 30*s.* to 40*s.* His lordship charges the tenantry 7 per cent. upon the outlay; they would gladly pay 10 per cent. rather than not have the bones.

Old sour turf upon a clay subsoil is the land that answers best to manure with bones, though I have seen them used upon a dry, friable soil, and a sandy substratum with success. I have never known them to fail when there is a strong turf and the land free from water.

Upon Lord Combermere's estate bones are not allowed to be put upon land until it has been down in grass at least seven years. I have seen them tried upon clover of the first year, and upon land that has been down in grass two or three years, but in very few instances where land has recently been in tillage have I known bones to answer well.

The end of April I consider the best time to apply bones; no stock ought to be put upon the land before the following spring. If the land is not too poor to produce a crop of hay, I do not object to its being mown the first year, but on no account afterwards.

Thirty to 35 cwt. is the quantity used upon a statute acre, according to the quality of the land; or if bought by the bushel, one bushel of bones to a rood of 64 square yards; if the land is very poor, 90 bushels to a statute acre.

An imperial bushel of bone-dust should weigh from 45 to 47lbs. if ground fine enough. I prefer them ground to about the size of a walnut.

It is now 20 years since I first saw bone-dust applied to pasture land, on a field adjoining Lord Combermere's estate. At the time the bones were put upon the land it certainly was not worth more than 10*s.* an acre, and though so long a period has elapsed since the field was manured with bones, it is now worth 35*s.* per acre, though I think the land is not quite so good as it was five years ago.

I consider bones the cheapest of all manure for mowing-grounds. Eight years ago I manured part of one of my mowing fields with bones 35 cwt. to the acre, the land has produced me a good crop of hay every year since, quite equal to the other part of the field which has been manured with good farm-yard dung every two years. Once in eight or nine years is quite often enough to manure mowing lands with bones; and I am quite certain that pasture land on which bones have been applied never will (so long as it remains in grass) return to the state it was in before the bones were put on.

The price I paid for bones last spring was 2*s.* 8*d.* per bushel; or if by weight, 6*l.* 15*s.* per ton. They are now a little lower; I can purchase them at 2*s.* 6*d.* per bushel, or 6*l.* 6*s.* per ton, that is for the raw bones.

The boiled bones are at 4*l.* 15*s.* per ton, but I do not consider them any cheaper than the raw ones, as being wet they weigh much heavier; 2 tons of boiled bones are not more than equal to 30 cwts. of the raw. I give the preference to the latter, if they can be got pure; but I have not had such long experience as to assert confidently that they are the best as to durability.

In the year 1828 one of Lord Combermere's tenants manured 5 acres of pasture land with boiled bones, and in the same field 2 acres with raw bones; both answered well, and at this moment I do not observe any difference; both still equally retain their fertilizing qualities.

I find a great difficulty in procuring good fresh bones, as the manufacturers buy them up to make size of; old bones (such as the greater part of those are which are imported from Ireland and the continent) will not do for this purpose, and it is my opinion that the fresh bones are not so much deteriorated by boiling, but that they are quite equal as a manure to those we get from the bone-dealers as fine bones, most of which are old, and consequently have lost a great part of their fertilizing powers.

I have the honour to be, my Lord,
Your lordship's most humble and obedient servant,
EDW. BILLYSE.

Haywood Farm, Nantwich, Cheshire,
October 2*d*, 1840.

XII.—*On the Economical Manufacture of Draining-Tiles and Soles.* By Robert Beart, of Godmanchester, Huntingdonshire.

In writing upon this subject, difficulties arise in forming a system generally applicable; if it were only required to meet the wants of one locality, the nature of the clay would point out the peculiar mode of preparing or tempering required. The expence and process of burning must be regulated by the facility of procuring the coals, wood, or peat, made use of; but as my object is more particularly to give a statement of the system and cost of manufacturing draining-tiles, and the prices at which tiles have been sold in this county for the last five years, I shall confine myself as much as possible to these objects. The price of furrow draining tiles has fluctuated here from 20*s.* to 22*s.* per 1000: and that of soles, or bottom tiles, from 8*s.* to 10*s.* per 1000; at these reduced prices, the consumption of tiles has increased greatly: as a proof of that increased consumption, and of the great quantity manufactured, it was publicly stated at a late meeting of agriculturists at Huntingdon, that one tenant farmer last year consumed five hundred and twenty thousand of furrow draining-tiles. I wish to point out to tile-makers, that whether the making of tiles be performed by machinery or by hand-labour only, they may be made at prices much below what they now cost in many parts of the country, and thus enable the makers so to reduce the price of tiles that the consumption will augment as it has in this county. Though the profit on a single thousand of tiles will be less, still the quantity they would sell would be so increased that the profits of their works would be larger; by the introduction of machinery which led to the change of system in this county, a reduction of 15*s.* per 1000 was effected in one season, and during the last five years the number of tile-works has doubled. I will now give a statement of the cost of manufacturing by hand, and likewise by machine, in Huntingdonshire, which is as follows:—

	By hand.		By machine.	
	s.	*d.*	*s.*	*d.*
Removing the earth and raising the clay, per thousand, each tile to contain 100 in. cubic	2	0	2	0
The clay turning once over and covering down	0	6	0	6
Grinding and moulding	4	6	3	0
Sand	1	0	0	0
Setting and unloading the kiln, burning and waste	3	0	3	0
Cost of fuel, one ton of coals, to burn 3,500 draining tiles, 13½ inches long, at 23*s.* per ton	6	6	6	6
	17	6	15	0

This statement shows the actual saving in this county by machinery is two shillings and sixpence per thousand; but a material advantage is felt in the control of the manufacturer over his workmen—common labourers being competent to the working of the machine: besides which a more regular supply of tiles for the kilns may be secured by the adoption of a better division of labour; I shall now proceed to give a description of the kilns, drying sheds, &c., made use of.

1*st. As to the form of the Kiln.*—The form of kiln which has superseded all others in this county, is delineated in figures 2, 3, and 4. This kiln is well adapted for burning tiles with only a single course of bricks set upon the floor of the arches, it can be filled entirely with tiles and is calculated to burn every description of fuel; if wood or peat are burned the furnace bars are removed, and the size of the furnaces regulated by the consumption of such fuel. Constructiug the bottom of the kiln with fire bricks as shown in figure 3, not only saves both time and labour in loading and unloading the kiln, but also simplifies the setting of the kiln. It may be supposed that there is a loss of fuel, inasmuch as, if the flues were built with unburnt bricks these would be burnt without any greater consumption of fuel; but this supposition is erroneous, for were an immaterial consumption of fuel thus saved the time lost in setting and unloading the kiln is equal to the value of the bricks, which are generally of an inferior quality, when burnt in the flues of the kiln.

2*nd. Construction of Drying Sheds and Pug-mill House for grinding the Clay,* as shown in figures 1 and 5.

As the manufactory of a large quantity of tiles depends very much upon the facility of drying them either upon shelves or drying floors, which must be of sufficient extent to allow the uninterrupted moulding of the tiles, I believe the most economical and convenient drying sheds are as shown in figure 1: the four sheds as thus shown are calculuted to contain from 20 to 24,000 draining-tiles, and the method of using them to the greatest advantage is to cover all the shelves with tiles, which when done, those first made may be removed, and set or stacked down the middle of the sheds, as the shelves are required to be refilled—by these means from 40 to 50,000 tiles are made before it is necessary to move any to the kiln. Drying-floors for most descriptions of clay are quite equal to shelves, if the clay is sufficiently strong to bear setting one tile upon the other, 3 or 4 high, as they are produced from the machine or mould; they may, however, be dried without sheds (as great quantities are in this county) and simply protected from the weather by being covered with sedge or straw. If attention is paid to drying them the quality is found to be quite equal to those dried upon shelves or covered floors.

3rd. Machinery.—The only machinery for making draining-tiles in this county is the machine constructed by myself, and which I have patented, and the common hand mould—the mode of working my patent machine is fully described in the explanation appended to the drawings of the machine, Plate, figures 1, 2, 3, 4, and 5. The use and construction of the common hand mould is too well known to require any description.

4th. Best shaped Tile for Draining Land.—I consider the best shaped tiles to be the common draining and sole tile; they are the cheapest, and also the most permanent when laid in a drain. For the manufacturer they are also the most simple and easy to produce in large quantities; they do not take up above half the space in the kiln that winged or other shaped tiles do, and thus they require less fuel to burn them, and the manufacturer is enabled to produce the tile and tile sole (the two to be sold as one) at less money than the winged or other tiles which vary in shape from the common tile.

5th. Cost of erecting Kiln and Hopper (to burn 40 *to* 45,000 *Tiles), with Sheds, Machinery, or Tables and Moulds, &c.*

	£.	s.	d.	£.	s.	d.
Kiln and hopper, as shown by the plans, will require 60,000 bricks, at 30*s.* per thousand	90	0	0			
Labour, lime, and sand	45	0	0			
Fire bricks	10	0	0			
Two tons of furnace-bars and doors, at 12*l.* 12*s.* per ton	25	4	0			
Roof for the kiln and hopper . . .	20	0	0			
				190	4	0
Four drying sheds and pug-mill; house covered with pan or flat tiles; the shelves to be one-inch board; the posts may be fir or other poles set upon a sill on brick-work raised six inches from the ground, the shed being but seven feet wide; the tops of fir-poles will do for the roof; in setting up the shelves, lay the first board on the ground; support the shelves from this; merely attach them to the building to keep them upright				130	0	0
Patent machine	12	12	0			
Pug-mill	12	12	0			
Tools, barrows, and planks	10	0	0			
				35	4	0
				£.355	8	0

N.B. If tables, hand-moulds, &c., are used to make the quantity of tiles above mentioned, the cost of these will be about equal to the machine.

Description of Sheds, Kilns, &c.

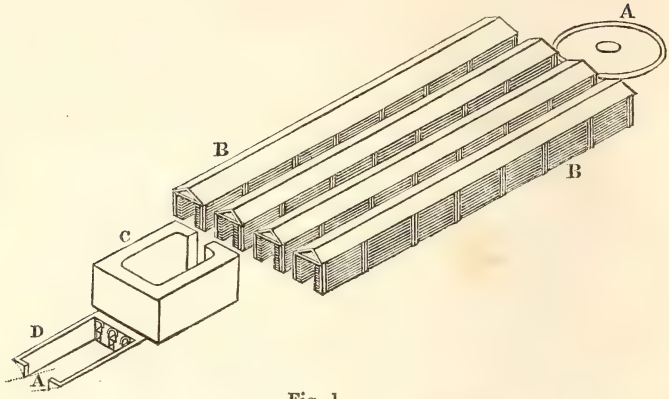


Fig. 1.

Fig. 1. Is an isometrical view of the different departments of a tile work, in the order which is considered advantageous for carrying on the various processes; A, is the position of the pug mill and horse walk; B the drying sheds, in four lines, each 100 feet in length; C the kiln represented without the roof; and D the hopper, also represented without the roof in order to show the mouth of the furnaces.

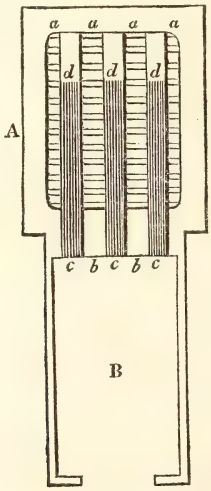


Fig. 2.

Fig. 2. Ground plan of a kiln and hopper, A the kiln and B the hopper. The walls and piers *a* for the furnace arches are

founded at the depth of about five feet under the level of the surface of the ground, and are carried up in solid brick work, the whole length of the kiln, as from *a* to *b*, to the height of two feet six inches, see also fig. 4. The over-all dimensions of the kiln are twenty-four feet in length and twenty feet in width, the height from the floor to the top is twelve feet; it is capable of burning forty-five thousand tiles. The width of the ash pits under the grate bars is fourteen inches and of the furnaces above the grate bars two feet. The height of the ash pit eighteen inches, and of the furnaces to the spring of the arches twelve inches, and the rise of the arch fifteen inches, over which the floor of the kiln is laid. The walls above the level of the floor are carried up at a thickness of two feet six inches. In the piers of the furnaces the shaded parts represent the position of flues formed through the arches, to carry the flame through the openings in the floor—*c d c d c d* are the grate bars; B is the hopper to contain the fuel; and to allow space for the fireman, its dimensions over all are twenty-five feet in length, and sixteen feet six inches in width, the necks of the furnaces projecting into it two feet.

Fig. 3. Is a plan of the kiln taken above the level of the floor; *a a* the walls; *b* the doorway by which the kiln is loaded; and the interior represents the perforated floor, the shaded parts being the perforations or flues, having a width of six inches, crossed occasionally with a brick to bind the arches, the arches themselves being nine inches in breadth. If the sides of the kiln are slightly curved, as shown by the dotted lines *c c*, and embanked with clay on the outside, less thickness of wall will suffice; it will be equally strong and will retain the heat better.

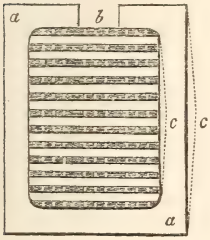


Fig. 3.

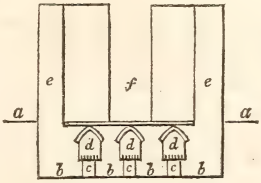


Fig. 4.

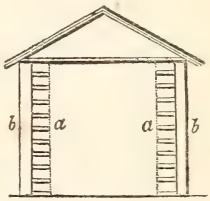


Fig. 5.

Fig. 4. Is a transverse section of the kiln, *a a* the ground line, *b* the piers, *c* the ash pits, *d* the furnace and grate bars, *e* the wall, and *f* the door way.

Fig. 5. Is a cross section of a drying shed upon an enlarged scale, showing the position of the shelving *a* in relation the posts *b*.

Description of Mr. Beart's Patent Machine for making drain-tiles.

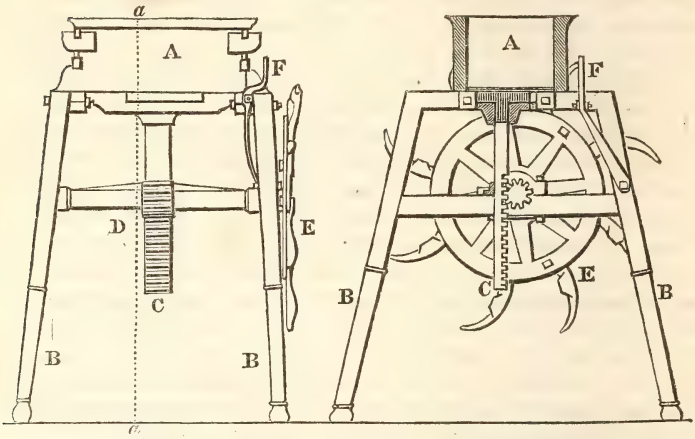


Fig. 1. Fig. 2.

Fig. 1 is an end view of the machine, and fig. 2 a section on the line *a a*. In these figures, the letters refer to the corresponding parts in both figures. A is a box or mould of cast-iron fixed by hook joints at the corners, and bolted to the frame B, also of cast-iron. The box is 13½ inches long, 10 inches wide, and 6 inches deep, but may be varied in size, according to the size of tile wanted. It is fitted with a movable bottom or piston, which, being attached to the rack-bar C, rises and falls with it. The rack-bar is acted upon by a pinion fixed in the shaft D, supported in the frame-work. This shaft D carries also a spoke-wheel E, having eight bent spokes or hands, by which the operator acts upon the machine.

To work this machine properly, one man and two boys are required. The man stands on the side of the machine with his right hand towards the spring-stop F; one boy between the machine and the table on which the bending-blocks or horses are placed, and the other boy behind the table. The man having let down the piston to its lowest point, takes a lump of clay of sufficient size; this he throws with force into the mould; if it does not fill up all the angles, he beats it in with the blow of a mallet, and with the strike or bow, Fig. 3, cuts off any superfluous

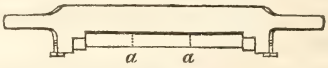


Fig. 3.

clay that may stand above the edges of the mould, smooths the clay with the same, turns the wheel E one spoke round, which,

being provided with a catch on each spoke, on its arriving at the spring F, falls into, and is locked by it. By this motion the piston and clay has been raised about one inch, or the thickness of a tile; the operator then leaves hold of the spoke, and with the strike cuts off a slice of clay, equal in thickness to the space through which the piston and mass of clay has been raised; the strike being guided in passing from front to back of the mould by the edges of the same. The nearest boy now lifts off the slice, lays it upon a tile horse, or bending-block, Figs. 4 and 5,

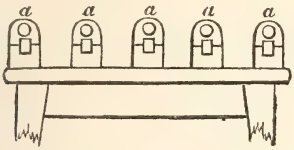


Fig. 4.

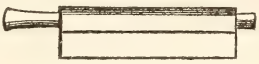


Fig. 5.

where the tile is put into form by bending the slice of clay on the horse. This operation is repeated until the mould is emptied. The boy who removes the slice then moistens the inside of the mould with a wet cloth, or other wet substance; and while the man is refilling the mould, both boys are employed in washing down the bended tiles, and laying them in the drying shelves.

In making soles or flat tiles, the same process is followed, except that in this case the strike is furnished with one or two cross cutters, as shown by the dotted marks *a, a,* in Fig. 3, which, simultaneously with the cutting of the slice, divides it into two or three separate portions. These are taken up by the boys, and removed directly to the shelves.

The table or stool that bears the horses is a very slight fabric, and is furnished with a water trough; but no sand-box, that material not being required in this method of moulding tiles.

The horses, Figs. 4 and 5, are in two parts, the upper or curved part being fitted to the other by means of a groove and feather. They are covered with flannel, which, when moistened, allows the tile to part freely from them. In lifting the tile to the shelf, the upper part only of the horse is lifted with the tile. The strike, Fig. 3, is a piece of hard wood, three-fourths of an inch thick, and shaped as in the figure. A thin brass-wire is stretched between the points *b b,* which forms the cutter for slicing; and in the strike for cutting soles, the cross-cutters *a a* are added; the extremities are formed into handles, by which the operator holds the strike.

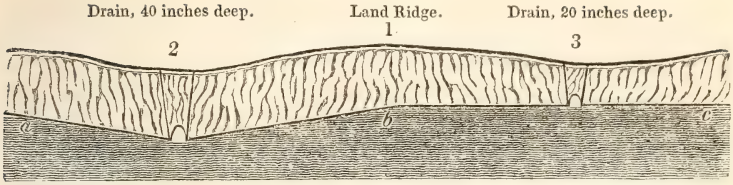
The operations effected by this machine being purely practical, it sometimes happens that the moulder succeeds but indifferently for a week or two at first; but that period will gene-

rally give him sufficient experience to enable him to turn off 3000 tiles per day.

Having now given a detailed statement of the mode of manufacturing and the cost of producing tiles in this county, with a general statement of the construction of a tile work or tile and brick work, it would be useless for me to attempt to give a theoretical direction as to the burning of tiles, this part of the work being purely practical. None but experienced burners can tell from the appearance of the flues and fires of a kiln, how to regulate the heat or management of them with supplies of different sorts of fuel.

I would observe that the clay best adapted for tiles is that which contains a small proportion of sand or marl, or sand may be mixed with the clay when raised in the winter. Clay thus mixed does not contract so much in drying, and the tiles, when burnt, are larger and sounder; but as tiles must be made from clay beds in the locality where they are required for use, it will be expedient to consult practical men acquainted with the soil.

In conclusion, I wish to add a few observations upon furrow draining on tenacious clay soils; the drainage of these soils has generally been done in shallow depths, under the prevailing common opinion that otherwise the water would not get into the drains. The contraction which beds of clay undergo when cut through by parallel drains has thus been entirely overlooked. This contraction, however, is most important, so much so (as I have found by experience) that drains dug from 30 to 40 inches deep have operated to much greater advantage than those of shallower depth. The bed of clay contracts itself near the drains as deep as the drains are made; and the deeper the bed of clay is contracted, the larger will be the fissures for the water to percolate through to the drains. In well-drained land, the water does not enter the drain by the furrow, but percolates through the fissures (formed by contraction) from the ridge to the drains. It is also, I consider, an error to cover tiles with loamy soil or vegetable substances; these have a tendency, after a few years, to choke the drains: the best covering upon them is the clay itself. The action of the atmosphere will always so contract the clay, that there will be sufficient fissures for carrying the water into the drains. This is proved by the system of block-draining, which is sometimes performed on very strong clays in this county. The plan is to dig out the drain, lay a block of wood in the bottom of the drain, then beat the clay firmly upon the block, and after drawing forward the block the same operation is repeated. Now there is no complaint that the water does not enter these drains, for the contraction of the clay which always takes place remedies the supposed obstruction.



The line *a b c* represents the direction of the supposed line of the depth to which the contraction of the clay-bed is available to drainage by the water percolating through the fissures. The dark horizontal shading represents the clay-bed.

This sketch is intended to show the fissures formed by the contraction of the clay-bed, and the advantage of deep draining: by increasing the fall from the ridge to the bottom of the drain, the expansion of the clay in the winter will be less than in shallow draining.

ROBERT BEART.

Godmanchester, Huntingdonshire,
September 18, 1840.

Mr. Beart has omitted to state any charge for royalty or rent, interest of capital, for the erection of furnaces and sheds, as well as for wear and tear of implements. The cost of a kiln of so large a capacity as this seems to be estimated very low, as well as that of the erection of sheds, which must either, I should imagine, be of very small dimensions, or constructed with timber growing upon the estate. The usual amount charged by landlords to their tenants for tiles made upon the estate is from 23*s.* to 25*s.* per thousand at the cost price; and if reference be made to the statement of Mr. Wiggins on tiles in this Journal (vol. i. p. 354), it will be seen that those even so small as 12 inches long, and only 3½ high by 2½ at the opening, cost 19*s.* 6*d.* for labour and materials, exclusive of clay and agency, which are 5*s.* 6*d.* more, thus bringing the price of the very smallest kind to 25*s.* per thousand. However, if Mr. Beart can really manufacture sound well-made tiles of full size, and sell them at the price he mentions, he certainly deserves the encouragement of landowners.

J. FRENCH BURKE.

(*Note by Mr. Pusey.*)

In consequence of the doubts thus expressed by so experienced a writer on agriculture, I thought it my duty to inquire further into this invention, and have found Mr. Beart's statements to be borne out. The secretary of the Huntingdonshire Agricultural Association, Mr. Fox, writes me word that "the farmers of the county value Mr. Beart's services so highly as to have invited that gentleman to a public dinner last summer; that he considers Mr. Beart's tiles quite as good and durable as any tiles made by hand; and that the price of tiles immediately before Mr. Beart invented his machine was 35*s.*, but that for the last five years they have

been sold at from 20*s.* to 22*s.* by all manufacturers in the neighbourhood, whether made by hand or machine." This statement establishes the fact that tiles can be *sold* at the price of 22*s.* per thousand, the price of coals being 23*s.* per ton. The price for which they can be *made* by those who possess kilns and brickyards is stated by Mr. Beart as follows, in answer to my inquiries:—

"The work here is farmed by the foreman: my contract with him is 15*s.* per thousand for all tiles which are returned at my counting-house as delivered. I have nothing to do with waste tiles, nor do I go to my tile-yard ten times a-year. I contract to deliver the coals at 20*s.* per ton. The clay in this county is the most expensive to raise, and requires the most tempering and grinding of any clay that I ever saw (and I have visited yards in most parts of the country), except where the clay requires washing to free it from stones. As to cost of fuel I have had 56,000 tiles burnt in a kiln, with a consumption of 14 tons of coals, but the construction of our kilns is on the best principle and on a large scale."

This saving of fuel, indeed, appears to be a more essential part of Mr. Beart's system than even his machine; for he is able to burn 3500 or even 4000 tiles with 1 ton of coals: but, as Mr. Burke informs me, a ton of coals at least is required on the old system for 2500 tiles, and he has generally found a ton or even 24 cwt. to be employed in burning 2000. It is not, however, the form of the kiln alone that effects this saving of fuel: I find from Sir Harry Verney, who has lately begun to use Beart's machine with his own kiln, that the more accurate shape of the tiles is also a source of great economy in the burning. He writes to me from Buckinghamshire:—

"My kiln contains 34,000 tiles without bricks or soles, being 8000 more than I could pack into it when I made the tiles by hand. Ten tons of hard Derby coals burn my kiln of tiles; of softer Staffordshire coals a couple of tons more would be required. In small fires in a dwelling-house the sea-borne coal would go much further than even the hard Derby, a fourth or a fifth further, but in the large furnace of a kiln we find the hard Derby coal as enduring as the Newcastle coal."

The subject is so important that I must add some calculations with which Mr. Evelyn Denison has furnished me, as applying to the manufacture of tiles in Nottinghamshire:—

"I am afraid the answer, which I now send to your question as to the expense of making draining-tiles in this part of the country, will come too late for one of the objects you had in view, but I have had the calculations carefully gone over as to the cost of those made at my own yard, and I have communicated with several of my neighbours who make tiles, so you may depend on the accuracy of this statement.

"No. 1. Draining-tiles 12½ inches long, 5 deep, 4½ wide, cost me at my yard 17s. 6d. per 1000: which may be divided under the following heads:—

	s.	*d.*
Getting clay in winter, making and burning the tiles . .	10	0
Coals	6	0
Sand	0	6
Horse labour grinding clay	1	0
Total . . .	17	6

You will see that nothing is here charged for the prime cost of the buildings, the kiln, the sheds, &c., or for the clay.

"But the outlay for the buildings is not large; 250*l.* would cover the expense of sheds and a kiln sufficient to make 300,000 tiles in the course of the summer, so if you add 2*s.* per 1000 to the 17*s.* 6*d.* for the interest of the money and the value of the clay, you allow more than is sufficient.

"With this addition the total expense of the tiles would be 19*s.* 6*d.* per 1000. I should say that this is not an estimate, but the actual price paid to my tile-maker.

"I built the kiln and sheds, and the tile-maker delivers the tiles to me at the rate of charge stated above. He is answerable for all accidents by frost or weather, and for all breakage. I pay only for perfect tiles fit for use.

"Throughout this part of the country the actual cost of making tiles varies from 18s. to 20*s.* per 1000. The current price at which they are sold is from 27*s.* to 29*s.* per 1000. Coals costing about 14*s.* a ton.

"The price of coals, you see, forms a very important ingredient in the cost of producing tiles: a ton of coal will burn between 2000 and 3000 tiles, varying with the quantity of the coals and the construction of the kiln.

"Lord Wenlock, who has taken great pains with this branch of rural economy, and who has a very large brick and tile yard admirably conducted, tells us that by a combination of Lord Tweeddale's machine to press the clay, and of Beart's machine to assist in making, he has reduced the cost of tiles to 13*s.* 6*d.* per 1000, —not of course including any interest on buildings or machinery."

Ossington, Dec. 9, 1840.

The variation in the price of draining-tiles certainly proves the necessity of communication among the agricultural body. In parts of Gloucestershire and Somersetshire they cost more than 40*s.* per 1000; in my own neighbourhood they cost 50*s.* and even 60*s.* for the same quantity; while in Huntingdonshire they have been sold for five years at 22*s.*; the price of coals is 23*s.* there, and here 28*s.*, which would justify a difference of 1*s.* 6*d.* only per 1000. The cost for tiles in draining a farm of 200 acres, if the drains were laid at the moderate interval of 33 feet, would at this moment be less than 290*l.* in Huntingdonshire; 528*l.* in Somersetshire; and here in Berkshire 660*l.* or even 792*l.* It is not, however, a mere question of economy, but of improvement or no improvement. A high price of draining-tiles is almost prohibitory of draining. Yet there are many large districts of England, as the Weald of Sussex and Kent, which without this improvement in the first instance can be scarcely benefited by any other. There are, probably, at least 10,000,000 acres in England which require to be tile-drained, perhaps many more. A saving, therefore, of 20*s.* in the price of tiles is a gain of 10,000,000*l.*; but it is more, for upon that saving may depend the power of farming them as they ought to be farmed.

It may be convenient to insert an estimate of the prices at which tiles may be sold on Mr. Beart's system, according to the various prices at which coals can be obtained for burning them; and also of the expense at which landed proprietors who possess kilns may make their own tiles. I should think that, in their

case, the arrangement adopted by Mr. Denison and Mr. Beart must be the best, namely, to pay for the tiles delivered,—in fact, to employ their labourers, in this department, by piecework. There is a slight discrepance in Mr. Beart's statement as to the price of coals: I will therefore take the lowest price he has stated for coals (20*s.*), and the highest for tiles (22*s.*), in order that the reduction of cost may be underrated rather than be exaggerated:—

Price of Coals, per ton.		Making the Tiles at the Proprietor's Yard, per 1000.	Selling Price, per 1000.
s.	*d.*	*s.*	*s.*
6	0	11	18
9	6	12	19
13	0	13	20
16	6	14	21
20	0	15	22
23	6	16	23
27	0	17	24
30	6	18	25

This is certainly a great reduction, but it appears to be practicable. If it can be effected, no one thing would be more advantageous to English husbandry.

PH. PUSEY.

XIII.—*Trials on the Draught of Ploughs.* By TRELAWNY FREEMAN, Esq.

To Ph. Pusey, Esq.

Sir,—I SEND you an account of some trials I have made on the respective qualities of two ploughs made by Messrs. Hart and Ransome, as compared with those used in this county, and also with each other; and I have the more pleasure in doing so, as it was from reading your paper in the 'Journal of the Royal Agricultural Society' that I was first led to interest myself in the subject, for you have clearly proved that the same quantity of work may be better done by two horses with some ploughs than by three with others; and I conjectured, from the appearance of ours, that we used a great deal more horse-power than was necessary. The ploughs either have the improved Scotch mouldboard, which gives them rather a narrow breast, and curves out considerably behind, but with a thick narrow share and no wheel, or are fuller in the breast, have less expansion behind, and are also without a wheel. The very small farmers employ a light but clumsy implement, called the old Welsh plough, which has scarcely any iron about it but the coulter, a narrow share, and a band forming its very long sole-piece. The first trial was between these and one of Hart's: the ground selected was an oaten

stubble, naturally light, but then dry and hard. There were two iron ones of the first-mentioned form, weighing 12 stone each; a wooden one of the second, 10 stone; an old Welsh plough, 6½ stone; and also Hart's. In a furrow 5 inches by 9 inches, the draught of Hart's (by Mr. Cottam's plough-gauge), was 13 stone; of the wooden one 17 stone; the iron ploughs 19 and 20 stone; and the old Welsh 20 stone. I then fitted Hart's wheel to the wooden plough, which it reduced to 14 stone. The difference in the draught of the iron ploughs I think was owing to the share of the lightest being somewhat broader, for in all other respects they seemed perfectly similar. The lightness of Hart's must, I think, proceed from its open mouldboard, which reduces the surface exposed to friction; for it cannot be from its full breast, which pushes off the furrow-slice abruptly at its point of separation, where its resistance must be greatest; and I think the extreme disproportion that appeared between the working and surface draught of the old Welsh plough, which you have shown the importance of considering, must have been in some degree owing to its having that form; for the surface draught was only 4 stone, though in working, as we have seen, it drew 20 stone. The wheel is certainly a great advantage; for, besides keeping the plough always at the same depth, it greatly lessens its draught,—for much of the plough's weight must be transferred to it from its resisting the tendency the share has to draw the plough downwards.

But though Hart's plough is very superior in point of lightness of draught, yet for that soil, which was firm though light, it was defective in its work, and from the shape of its mouldboard I think it would be so in almost every case but that you mention, where the soil is so loose and adhesive, if I may be allowed the expression, that it would cling to and fill up the hollow of the curved mouldboard: but as I considered that with an alteration in its mouldboard it would make a very excellent plough in most soils (for its fault was that it left the furrow-slice standing on its edge, by which the surface-grass and weeds were not destroyed), I determined to get a mouldboard made for it of the same size and shape as to its length and breadth, but with a sufficient curve to give it a narrow breast and considerable expansion behind. I then sent for one of Ransome's F F ploughs, with which to compare it both in work and draught; to this I had fixed a light wooden beam and handles, and a single wheel, the same as Hart's. The ground in which I made the next trial was the same as before, but still more dry. The work of Hart's plough was much improved, and it now turned over the furrow-slice quite on its back, and its draught was rather less than with its own mouldboard, which I also tried at the same time. I think it gained more by its narrowed breast than it lost from the increased friction behind; nor could I discover any difference in the work of the two ploughs; but

more practical men, who were present, still gave it rather in favour of Ransome's, which also appeared quite equal to it in lightness of draught; but as this is different from the result of your trials, I am inclined to attribute it to the single wheel. It was next tried in a stiff clay, which had been ploughed before, against one of the iron ones; here also it was considered to do its work equally well, and retain its superiority in lightness, for it drew only 15 stone, while the iron one was 23 stone. We made some other trials, the precise results of which I do not now remember; but on the whole, Hart's plough, with the altered mouldboard, was considered to make good work, and to possess the merit of lightness to the horses, in a high degree, compared with the common ploughs of the county; and I have found two small brisk ponies do more work in the day with either this or Ransome's than strong horses with the common plough, and apparently with as little exertion; and if any one wishes to try it with this mouldboard it may be had, so made, of Mr. Cottam in London, or Mr. Marychurch in Haverfordwest.

I have the honour to be, Sir,

Yours very obediently,

TRELAWNY FREEMAN.

Easthook, Haverfordwest, S. Wales.
September, 24, 1840.

XIV.—*An Account of the Application of Gypsum as a Manure to the Artificial Grasses.* By CUTHBERT WILLIAM JOHNSON, Esq.

A PRIZE-ESSAY.

IT is useless to search in the works of the early agricultural writers for any notice of the employment of gypsum as a manure. It is true that Virgil speaks of the value of a very impure variety of it, when he is commending the use of ashes to the Roman farmers. The early inhabitants of Britain thus used it; the farmers of Lombardy did the same: but ages elapsed before even chemists were able to distinguish this salt from limestone, or other calcareous matter. Its uses, in its simple state as a manure, were first noticed, according to Kirwan, about the middle of the eighteenth century, by a very able German clergyman of the name of Meyer, who tried, with success, various experiments with a mineral substance found in his neighbourhood, which was long afterwards shown to be an impure sulphate of lime.*

* The name of plaster of Paris, by which this substance is commonly known, arose from its abounding in the neighbourhood of that capital, where it is burnt into a powder, and used as a stucco. The composition of sulphate of lime, when pure, is—

There is perhaps no artificial manure so decided in its effects upon some soils, so readily obtainable by the farmer, and so plentiful in this country, as gypsum; for an account of which the Society's premium has been this year offered. Its mode of action, too, is easily understood for it acts as a direct food for some plants, is not what is sometimes called a stimulant to vegetation, and has a very slight attraction for the moisture of the atmosphere; it neither promotes the decomposition of the organic matters of the soil, nor, like those decomposing substances, does it furnish the gases of putrefaction for the service of the plant. There are, in fact, only four commonly cultivated crops which contain gypsum in any sensible proportions; and to which, in consequence, it is a direct food: viz., lucern, sainfoin, red clover, rye-grass, and turnips. Now these are precisely the crops to which the farmer finds, on most soils, gypsum to be a fertilizing top-dressing. Wheat, barley, oats, beans, and peas, do not contain a trace of this salt; and the farmer tells you, that gypsum is of no service to these crops, however the application may be varied.* I have little doubt, therefore, whatever other imaginary powers this manure has been asserted to possess, that gypsum only operates as a direct food or constituent of plants. That it cannot operate by its attraction for atmospheric moisture, I some time since determined by my own experiments; for 1000 parts, previously dried, when exposed to air saturated with moisture for three hours, only gained 9 parts; while, under the same circumstances, a good arable soil, worth two guineas per acre, gained 14 parts; and when compared with other manures, the disproportion is still greater: thus, soot gained 36 parts, and horse-dung 145 parts. That it is not a promoter of putrefaction, I have ascertained by mixing this salt with various animal and vegetable substances; it seemed, in every case, rather to retard than promote

---

Sulphuric acid	43 parts.
Lime	33
Water	24
	100

But the gypsum of commerce is usually united with a portion of silica and carbonate of lime. It is thus combined in its native state.

According to Chaptal and Buchholz, gypsum consists of—

Sulphuric acid	32 or 43
Lime	30 or 33
Water	38 or 24

* Thus, 100 parts of the ashes of the complete plant of the oat, according to Bergman, contain—

Silica	55 parts.
Phosphate of lime . . .	15
Potash	20
Carbonate of lime . . .	5
With some oxide of iron.	
	95

the spontaneous decomposition of them all. The housewives consider *hard* water, which commonly owes its properties to the presence of this salt, to be rather a greater sweetener of tainted food than soft water. Davy, also, in some experiments with minced veal, thought that the addition of the gypsum rather retarded putrefaction.

There is no reason to believe but that the proportion of sulphate of lime, found in certain plants, is as essential to their growth as the presence of the other earthy salts and pure earths. Thus, those plants which yield this salt never grow well on lands which do not contain it: those in which carbonate of lime is found never flourish in soils from which this salt is absent. Plants which abound with nitrate of potash (saltpetre), such as the sun-flower and the nettle, always languish in soils free from that salt; but when watered with a weak solution of it, their growth is very materially promoted; and the saltpetre is then found, as shown upon analysis, in very sensible proportions. The same remarks apply to the growth of those plants which contain common salt, or phosphate of lime; the effect is the same, the result invariable.

I have noticed, in applying gypsum to grasses, that the weather at the time of spreading it has a very material influence upon the result of the experiment. Its effects are never soon apparent when it is sown in dry weather; but if the season is damp, so that the white powdered gypsum adheres to the leaves and stalks of the young grass, the good effect is then immediate. This observation was made, many years since, by Arthur Young, by Mr. Smith, and by the American farmers: it is a well-known fact with the saintfoin growers, of the Berkshire and Hampshire chalk formation; the clover cultivators of the gravels and loams of Surrey and Kent; and on the lucern grounds of the alluvial soils of Essex and Middlesex. The farmers of the United States, when dressing their turnips with gypsum, always found it answer best when spread in rainy weather.

The result of the analysis of the clover and sainfoin grasses shows that an ordinary crop of these usually contains from 1½ cwt. to 2 cwt. per acre of sulphate of lime: now this is precisely the proportion of gypsum which the best cultivators find to be attended with the maximum benefit: those of Kent and Hampshire find it useless to apply more; but then they all agree that the annual repetition of the dressing, as long as the grass is suffered to remain on the ground, is attended with renewed benefit. It is here again that the experiments of the chemist and the farmer mutually confirm, and illustrate each other; the very quantity of sulphate of lime which the first shows to be carried off the land in the clover, is precisely that which the latter returns to it in his dressings with gypsum.

One of the chief reasons why gypsum has not been universally employed by all cultivators of the artificial grasses arises perhaps from the fact that many good soils naturally contain sulphate of lime in sufficient abundance for the service of the plant; and, in consequence, to such lands the application of gypsum is useless—it is an attempt to supply a deficiency which does not exist. I have invariably found in those soils to which gypsum is not a manure an abundance of this salt. It is not, however, necessary for the farmer to have his soil analysed to determine the probable advantages of applying gypsum to his clover and other grasses; there are several easy observations which will readily indicate to him the nature of the case: thus, when he finds that those fields which once produced luxuriant crops of red clover or saintfoin, will no longer yield them in abundance; if he notices that the young plants spring up very numerously, but die away as the summer advances; if he finds that his fields will only grow clover successfully once in eight or twelve years, and that his neigbours tell him his land is *tired* of clover, or *clover-sick;* if he notices that even the application of farm-yard compost hardly adds to the luxuriance of his grasses; he may then safely conclude that his crops have gradually exhausted his land of sulphate of lime; and he may, with every confidence of success, apply a dressing of gypsum, at the rate of 2 cwt. per acre, taking care to choose a wet morning for the application; and this may be done at any season of the year, but it is best either in April or the first days of May. These facts I can attest from the results of my own observations and experience. In an old grass paddock, of about 70 acres, in the vale of Kennett, in Berkshire, the grass had for many years gradually become less and less productive, and this in spite of all kinds of applications: the earths (such as clay and chalk), farm-yard compost, &c., had been liberally and repeatedly spread, without producing anything like a luxuriant crop: but it was found at last that the peat-ashes of the banks of the Kennett, when spread at the rate of about 40 bushels per acre, produced the very best results—an excellent crop, both in weight and in colour; certainly more than a ton of hay per acre beyond what the soil yielded before. The fact was now evident that it was gypsum that the soil needed; for as these peat-ashes contain about 12 per cent. of sulphate of lime, more than 2 cwt. of gypsum was conveyed into the land in them: it constitutes, in fact, by far the chief fertilizing ingredient in these peat-ashes; the remainder being about 40 per cent. of sand, and the rest chalk, red oxide of iron, and a small quantity of common salt.

If this conclusion, therefore, was correct as to the gypsum being the only valuable portion of the peat-ashes, it was certain that an application of 2 cwt. per acre of gypsum to the same land would produce similar beneficial results: and, upon a trial, it

was found that benefits, fully equal to any yielded by the application of the peat-ashes, resulted. Two cwt. per acre of gypsum, in fine powder, was spread on a portion of the grass, with the most excellent effect; the grass not only grew with greatly increased vigour, but a quantity of white clover and other grasses made their appearance on the portion dressed in so marked a manner as to attract the attention of the tenant to the fact. The soil on which these experiments were tried consists of—

Organic matter, chiefly vegetable . .	3·5
Soluble matters	3
Carbonates of lime and magnesia . .	19
Oxide of iron	2·75
Alumina	8·5
Sand and gravel	62
	98·5

This is about 10 inches deep, and it rests on a thin stratum of gravel, and then chalk.

There is another fact which clearly supports these conclusions; viz., the great use of common coal-ashes as a top-dressing to clover, saintfoin, and lucern; there is no manure universally in the possession of the farmer, in fact, equal to them for immediate effect upon those grasses. Now, coal-ashes usually contain about 10 per cent. of sulphate of lime; and therefore a dressing with 50 bushels of coal-ashes per acre is equal to an application of about 5 bushels of gypsum: the remaining portion of the ashes consists principally of about 10 per cent. of lime and sand, and a small portion of red oxide of iron and alumina: so that the gypsum is here again evidently the active ingredient—the other constituent parts being nearly inert substances. My own experiments and observations have been confirmed by many others within the last two years; for gypsum is evidently creeping gradually into use as a manure for the grasses. Mr. James Barnard, an excellent and extensive farmer of Little Bordean, in Hampshire, in a recent communication thus describes to me his experience with gypsum:*—

"The soil of my farm is of a clayey nature, and would be very stiff but for the number of stones there are in it. I have sown gypsum six or seven years, and never on clover or saintfoin without satisfactory proof of its efficacy, having usually grown half a ton more of hay per acre by its use. But the effect in 1838 was wonderful: I put on a bag ($2\frac{1}{4}$ cwt.) per acre, on a two-year old piece of saintfoin, on the 1st of May, with the plants very forward, just leaving the ground and coming to stalk: the gypsum had so increased the growth of the grass by the 9th of the same month, that when crossing the land with a friend we observed the difference

* December, 1839.

from one of the fields to the other; and at harvest time the extra produce of hay was quite one ton per acre. I then laid the field up, and cut it again in October; when the effect of the gypsum was still more apparent, there being $1\frac{1}{4}$ ton of hay per acre from the so dressed portion of the field, and scarcely any on the remainder of the land. Cutting the saintfoin twice in one year, and the enormous difference in the produce, brought a great many persons to look at the field, who all declared they had never seen the like before. On the same piece, this year (1839) I did not use gypsum, thinking it would be good enough without, and the difference was quite as great. I mowed twice the gypsumed portion, but there was nothing to cut on that which had not the gypsum. I can even see the effect where three years ago the gypsum was spread. I always leave a strip or two in every field to prove the effect. There is one thing more I wish to observe, that I never put on gypsum before the last week in April or the first in May; and choose, if possible, a moist morning. I have not found much good effect from its application on either chalk or cold clay soils."

The expense of the application of the gypsum is about 7*s.* per acre: this substance being usually sold at Reading and Southampton at 1*s.* 9*d.* per bushel. In the midland counties it may be had at a still more reasonable rate: thus, in Derbyshire, it is so plentiful that the farmers' cheese-room floors are commonly formed with it; it abounds too in the north of England. The comparative produce of the gypsumed over not gypsumed land is very great—it of course varies in amount; I have seen it double the produce of clover-hay, and give an equally copious crop of lucern; but this last I invariably cut green for soiling.

Mr. Smith, of Highstead, found still greater benefit from the use of gypsum to his clover leys; for where the simple soil produced one ton only per acre of hay, the portion of the same soil to which 5 bushels per acre of gypsum had been applied yielded 3 tons: the first yielding only 20 lbs. of seed, while the latter produced 105 lbs. Mr. Smith, too, first noticed—what my own observations have confirmed—that cattle, horses, &c. always prefer the grass growing on the gypsumed portion of the field to any other. The same remark is made by those who spread coal-ashes on their grass leys: the peat-ashes of Berkshire produce the same effect.

The general introduction, then, of gypsum as a top-dressing for the artificial grasses, which I have mentioned, is certainly an object of no mean interest to the farmer; especially if he cultivates the poor inland soils of England, where artificial manures are scarce, and the carriage of even the most portable is expensive: for gypsum possesses in this respect two advantages combined, which do not belong to any other, even of the saline manures; its first

cost is trifling; its carriage light, since a waggon will convey enough gypsum to dress 30 acres of grass. It is a manure, too, that abounds in all parts of England—hardly a county is destitute of it in some form or other; and there is no extensive district to be found in which large breadths of land are not benefited by its judicious application.

XV.—*On the means of calculating the number of Calves which will probably be produced by a herd of Cows.* By Earl Spencer.

It would be a considerable practical advantage to breeders of cattle, and particularly to those who purchase cows, if there were any means of ascertaining whether a cow was certainly in calf at an early period of her gestation. I have found that what I believe to be the ordinary rule among farmers, viz., that when a cow has not returned to the bull for six weeks after she has been bulled she is certainly in calf, is by no means to be depended upon; and having observed, as I thought, that this was the case in my herd of cattle, I resolved in the beginning of the year 1837 to ascertain with accuracy, first, whether a cow, not having returned to the bull for six weeks, was either certainly or to a very high degree of probability in calf? and secondly, if it should prove that this was not the case, at what length of time after she had been bulled this certainty might be assumed. The result, I am sorry to say, has been to prove that the cessation of taking the bull for six weeks is so far from indicating with any certainty that a cow is in calf, that, in my herd at least, very nearly half the cows who have gone six weeks will prove not to be in calf, and moreover that there is no period at which a man can feel the certainty required.

I am aware other modes of ascertaining this fact have been suggested by a very able and experienced veterinary surgeon, in the Journal of our Society. He stated that by placing your ear close to the cow's flank you may at a very early period of her gestation hear the double pulsation of the fœtus, and be satisfied whether she is in calf or not. I have tried this frequently with cows not only at early but at late periods of their gestation, but I must confess that my sense of hearing has hitherto never been sufficiently acute to perceive the slightest intimation of the existence of the fœtus. I have tried the use of a stethoscope, but from want of practice in the management of the instrument, or from some other cause, I have with this also been equally unsuccessful. I have also seen a surgeon well accustomed to the use of a stethoscope try it and fail as completely as myself. As to the other modes of examination which are suggested in the same paper, in

addition to other objections personal to myself which I should have to making use of them, I conceive they would have so great a tendency to make a cow slip her calf, that I should be very sorry to allow them to be employed with any cow of mine which I valued.

The result, therefore, of my experience is, that no man can be certain that a cow is in calf until he can feel the calf by what is called punching the cow in her flank, an operation which is perfectly safe unless performed with most extraordinary and unnecessary violence. But as this cannot be done until the cow has been pregnant at least six months, and in cows in good condition sometimes till much later, the value of this mode of ascertaining the pregnancy of a cow to breeders of cattle or purchasers at sales is not very great.

Although I thus failed in effecting the object which I had in view when I commenced the series of observations which I am about to state, they have led to results which I find very useful. The mode I adopted was this: I noted each cow in succession who had not returned to the bull at the end of six weeks, and when 50 were so noted I commenced a fresh series. I then noted how many of each 50 went 7, 8, 9 weeks, and so on to 21 weeks, before they returned to the bull, and how many proved in calf, together with the number of live calves which they produced. I have now the results of 8 of these series, or of 400 cows, who have gone 6 weeks before returning to the bull. I here insert the different series, together with the sum total of their results:—

6	7	8	9	10	11	12	13	14	15	16	17	18	21	In calf.	Calves.
50	45	41	39	38	37	34	33	32	32	30	29	29	28	26	26
50	44	39	35	33	32	30	28	27	27	27	26	26	26	25	23
50	41	38	36	31	31	30	29	28	27	27	27	27	26	23	17
50	45	41	36	34	31	30	27	26	26	26	26	26	24	20	16
50	47	44	43	43	43	42	40	39	39	37	36	36	35	33	31
50	45	42	36	35	34	32	30	26	24	24	24	24	23	20	18
50	42	41	39	37	36	35	32	31	30	30	30	30	28	26	24
50	48	47	41	41	39	39	36	36	36	34	34	34	31	29	26
400	357	333	305	292	283	272	255	245	241	235	232	232	221	202	181

It will be seen from this Table that the variations between the different series are not very great, and that a man applying a calculation founded upon the sum totals of them to any one would not err more than must always be the case in any calculation founded upon probabilities. Having found this to be so with respect to cows who had not returned to the bull for 6 weeks, I applied the same principle to all the cows who were bulled, in order to ascertain what was the probability of each cow bulled

going six weeks. This I began doing in the commencement of 1838. I have now taken notes for this object with respect to 1000 cows bulled, and I here subjoin a Table taking the series at 200 cows in each, which will show the results of my observations:—

Bulled.	3 weeks.	4 weeks.	5 weeks.	6 weeks.
200	158	115	107	87
200	137	92	85	71
200	142	87	80	72
200	148	94	81	78
200	139	87	74	63
1000	724	475	427	371

The small variation between the different series in this Table is very remarkable, I having expected that it would be much greater than in the former one.

By the means of these Tables I have now the opportunity of calculating, first, the probable number of cows who have not gone six weeks who will go that time, and of those who have gone six weeks the probable number who will prove in calf.

Although therefore, as I have said, I am not able to arrive at anything like a certainty with respect to any individual cow proving in calf, I have been able to calculate the number of calves I shall have from all or any given number of the cows bulled with much greater accuracy than I expected. In order, however, to make this calculation, it is necessary to make an allowance for the number of pregnant cows who may either slip their calves or produce dead calves at their full time. Not having any data at the time I began these observations on which to ground this allowance, I took it at one in eight, which proves to be too great, for, as it will have been seen from the first Table which I have inserted, I have had 181 live calves from 202 cows in calf, and consequently I ought only to have deducted one in ten, instead of one in eight; and therefore the results of my calculations of the probable number of calves I should have in any given period have generally proved rather too low. In order to show that the principles which I have adopted may be practically applied, I will state several of the trials which I have made of my calculation.

On the 22nd of October, 1838, I calculated that I should have 48 live calves previous to the 1st of August, 1839. I had 49.

On the 24th of January, 1839, I calculated that I should have 53 live calves previous to the 1st of November, 1839. I had 55.

On the 18th of August, 1839, I calculated that I should have 37 live calves previous to the 25th of May, 1840. I had 41.

On the 21st of October, 1839, I calculated that I should have 40 live calves previous to the 1st of August, 1840. I had 48.

I have made several other calculations of the same kind to test my principle, but it would be tedious to state any more of them. This last is the one in which the event has differed the most from the expected result. It will be seen that in all these trials of my system I must have included in my calculation all the cows bulled up to the day of making it, for the period over which the calculation extends equals the ordinary time of the gestation of a cow, and therefore I think the accuracy with which the result of the calculations has agreed with the event proves that a Table of Odds may be constructed, which upon any given number of cows will prove tolerably correct.

It is so obvious that it is hardly necessary to state how I make these calculations. Taking the first Table I have given, for instance, I divide the sum total of the cows in calf by the sum total of the numbers in each of the previous columns, and the decimals which will be the product of such divisions will show the probability of a cow proving in calf who shall not have returned to the bull at the end of each week respectively. This process I apply to ascertain the probabilities in the other Table. I then multiply the number of cows who have gone 21 weeks by the decimal belonging to this column; the number who have gone 18 weeks and not 21, the number who have gone 17 and not 18, and so on, by the decimals respectively belonging to these columns. I add the products of these multiplications together, and the sum total gives the probability of the whole list: I mean, it gives the probable number of cows who will prove in calf. From this must be deducted the number who will probably not produce live calves, according to the allowance to which I have referred above. With respect to the other Table, I treat it in the same manner, and assume the probable number of cows to go six weeks as if they had actually gone that period, and add it to the first column of the first-mentioned Table.

If I thought that the observations which I have made would apply to cattle generally, as well as they appear to have done to my own herd, I should think them of considerable use; but I do not think this is likely to be the case. My object in breeding is to breed bulls, and I am therefore constantly in the habit of persevering in the attempt to procure calves from cows, and by bulls who are so uncertain as breeders that a farmer in ordinary circumstances would have put them to feed and have sold them to a butcher long before I do. But I think that, if any breeder will take the trouble to make the same sort of observations with respect to his herd which I have with respect to mine, he will very soon arrive at full as great accuracy in the results as myself. I am

very desirous that breeders should attempt this, and for this reason it is that I have prepared this paper. Because, if it should prove, by a number of breeders being induced to give the result of their observations so made to our Society, that a Table of Probabilities applicable to cattle generally can be established, it appears to me that it will be a discovery of great value.

XVI.—*On a peculiar Disease in Ewes.* Addressed to Lord Spencer by John Buckley, Esq.

My Lord,

I take the liberty of troubling your Lordship with a statement of some cases of an extraordinary complaint in my flock, which is altogether novel amongst us.

Several ewes have been attacked with a disease which turns out, after death, to be an affection of the liver. This organ appears as if it had been parboiled, and is in the first stage of decomposition; the gall-bladder is unnaturally full; but the rest of the intestines are in an apparently healthy state. Sometimes a violent purging comes on; and the complaint, throughout, is accompanied with great debility. Condition seems to have nothing to do with it, as those in high as well as those in low have alike been attacked with it; it is confined *entirely to ewes* at different periods *after parturition,* varying from fourteen days to a month, or longer. Not a fluke has been discovered in their livers, or any other symptom of "rot" whatsoever. I think, in some cases, the disease fixed itself on the udder, with less affection of the liver; but it has terminated fatally in every instance; some have died in forty-eight hours, others have lingered a fortnight. Calomel and other purgatives have been tried—in cases where great debility existed, stimulants of different kinds have been tried—but all to no purpose.

I fear my description of the complaint is a very imperfect one; but if anything of this kind has come within your Lordship's knowledge or under observation, I should feel much obliged by being informed whether any and what remedies have been successfully administered.

The suffering animals have an extraordinary thirst upon them.

I beg to subscribe myself, &c. &c.

John Buckley.

Normanton Hill, Loughborough,
May 13th, 1840.

Report from Professor Sewell, on Mr. Buckley's Account of a Fatal Disease among his Ewes.

It appears to be a chronic disease of the liver, produced by continued wet weather, and leaving the constitution so much debilitated, that the secretion of milk required to nourish the lamb as its growth advances increases the debility until exhaustion ensues, under which the animal sinks.

An experienced veterinary surgeon might throw some light upon the nature of the disease by treating a few cases, and reporting thereon; and also describe the *post mortem* appearances.

Both the depleting and stimulating treatment having failed, I think mild tonics should have a trial. Dissolve half an ounce of sulphate of iron* in a quart of hot water, and give half a pint twice a-day. To check purging, give one ounce of finely-powdered common chalk in half a pint of water daily, if required. Keep under shelter, and give dry food, and a lump of rock-salt to lick. Remove the lambs.

A small proportion, four or five, might be sent before lambing to the college.

No similar disease has been reported from any other district.

William Sewell,
Professor, Royal Veterinary College.

May 18*th*, 1840.

XVII.—*Experiments and Communications on the Application of Nitrate of Soda as a Manure.* By David Barclay, Esq.

Our President having requested me to continue my inquiries respecting cubic nitre, or nitrate of soda, in its application to agricultural purposes, and to communicate the results to our society, I have much pleasure in complying with his request; and should have had much more if it had been in my power to discover the principle on which this manure acts, and thereby supply some tolerably certain guide for its application. My experience and inquiries during this year have, I think, on the contrary, involved the subject in greater obscurity, inasmuch as the results of its application in different places to the same object of cultivation, and notwithstanding a great similarity of soil and climate, have been very contradictory.

I have received communications on this subject from the Earl of Zetland; from our President, Mr. Pusey; Mr. Walter Calvert; Messrs. Drewitt, and Mr. Dewdney; the last three, in reply to

* Called green vitriol, or copperas.

additional inquiries from myself, and in which I particularly urged that cases of failure, as well as of success, should be described; both being equally important to the investigation which I had been requested to pursue. I will now proceed to transcribe these communications, beginning with that from our President.

My dear Sir,

As you have undertaken to collect for our journal any further information that can be obtained respecting the value of the nitrate of soda as a manure, I send you the result of the trials which have been made this year by my neighbours and myself. These trials, I should say, have not been generally successful; but as the manure, though a new one, has been strongly recommended by many practical farmers, is of undoubted value, and is likely to be largely used in the coming year, I think it may not be useless to show that caution is required in its application. I am the more induced to state these trials, because, where they have succeeded, it has been in direct opposition to the rule which has been laid down on the subject by Dr. Sprengel, who, in his work on Manures, gives his opinion that the nitrate is beneficial chiefly upon light soils. Mr. Cuthbert Johnson too in his pamphlet on the subject, sums up the evidence thus:—"Whatever doubts may exist as to the use of the nitrates of potash and soda as manures for the heavy clay arable soils, there are none with regard to the value of them on the light, warm, thirsty, upland soils." In this district, however, the failures have occurred upon the light sands.

My neighbour, Sir Robert Throckmorton, tried the nitrate upon some light sheep pasture in April last: it did not even darken the colour of the grass, as it usually does in a few days. I found the same thing myself here. He applied it to two meadows resting on clay. It increased the crop of hay. It did not indeed improve the after-grass: but the cost was repaid by the hay. The following is the result of its application to one of his wheat-fields—a good sandy loam upon stone brash, which had been for many years in a state of high cultivation, and had been three years in grass. A square chain, or one-tenth of an acre, was measured on the dressed and on the undressed portions. The seed had been drilled 6 inches apart, at the rate of 2 bu. 1 peck to the acre. The nitrate was applied on the 18th of April, at the rate of $1\frac{1}{4}$ cwt., or 140 lbs. to the acre:—

	Produce. bu.	pks.	Weight in lbs.	Produce per acre. bu.	pks.
No. 1. Dressed with nitrate	4	2	266 or $59\frac{1}{10}$ per bu.	45	0
„ 2. Not dressed	4	1	261 or $61\frac{4}{10}$ „	42	2

The nitrate in this case had appeared to act strongly, darkening, as usual, the colour of the crop; but as the gain was only $2\frac{1}{2}$ bushels per acre it cannot have repaid the outlay, even when allowance is made for the increase of straw, especially as the gain of bulk is accompanied by an almost equal loss of weight; for the increase of weight in the field was only 50 lbs. per acre, or less than one bushel. The nitrated land was affected by mildew, the other was not. On some light blowing

sand, however, Mr. Williams, who manages the farm, informs me that the nitrate appeared to answer with oats and with rye-grass; he has no record of the trials, but intends to renew them next year.

Another of our members, Mr. Harris, applied the nitrate to a variety of crops on many different fields of his farm at Hinton, measuring the plots in order to register the result. This farm is chiefly a free loam. He was much disappointed to find that on one lot only was any visible effect whatever produced. This particular spot was pasture, consisting of a thin layer of sandy loam upon heavy clay. Here the action of the nitrate was clearly to be seen in October; the grass was much fresher and more closely eaten down by the sheep.*

On my own land the nitrate was tried in two places on wheat. As I wished this to be done in showery weather, and the spring was very dry, its application was delayed until the second week of June. On some stone-brash land, sown late with spring wheat, it produced no visible effect. This may, however, have arisen from the red gum which attacked the wheat a few days afterwards. But in the other case the result was successful. This was on two wheat-fields of 20 acres, the soil of which (the Oxford clay) is as strong and unmixed a clay as can be found. It has always been ploughed very shallow: as low as the plough has gone, about 4 inches, it has the quality of mould, but if left unploughed for a few years it soon loses that character and returns to its former state, that of a mere clay. These particular fields were in a fair state of cultivation, and had been dunged for the wheat; but the rain had been unceasing from July until February; much of the seed had rotted in the ground, the plant was consequently extremely thin in April, and was choked with what appeared to be the weed called black-grass, which, however, was carefully hoed out. In consequence of the constant drought which now followed, the nitrate was not applied, as I have mentioned, until the second week in June, when it was sown by hand, between showers, having been previously mixed with half its bulk of dry sand, that it might spread more evenly. In the middle of one field four ridges were left undressed, and of the other field three. The dark-green, which the nitrate produces, showed itself within four days,

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* Account of Mr. Harris's trials of the nitrate:—

Sowed some cubic nitre in eight different fields, a square chain in each field, after the rate of 1 cwt. per acre.—

1st. On some greensward for mowing—the soil a strong loamy sand—no visible difference either in quantity or quality.

2nd. On a feeding ground—soil, strong loamy clay—no difference to be seen.

3rd. On a feeding ground—soil, loamy sand with a clay subsoil.—Effects: It altered the colour of the grass very much, and the sheep and cattle have kept it fed down very close up to the present time.

4th. On some spring wheat—soil, very poor light sand—no difference.

5th. On some low grass—soil, very shallow stone-brash—no difference.

6th. On some barley—soil, good loamy sand—no difference.

7th. On some oats—soil, loose spongy black sand, with a very bright grit in it—no difference.

8th. On some Italian rye-grass—soil, stone-brash—no difference.

The weather on the day it was applied was misty, and a little rain falling at different times throughout the day; it came on heavy in the evening, and a good deal fell during the night, and it rained more or less every day till the 19th of the same month (May).—John Harris, *Hinton, Berkshire*, Nov. 16, 1840.

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the blade soon became broader, and the superior vigour of the corn which had been so dressed might be seen from a great distance. This appearance, however, as you have pointed out in our last Journal, might be delusive. At harvest time, however, a clear difference still showed itself between the dressed and the undressed wheat on each side of the boundary furrows. It was not that the corn stood thicker where it had received the nitrate, which had been applied too late to make it tiller out; but the mode of operation was this: on the undressed side there were many short or underling straws, as they are here called, with short ears; on the other side there were none of these; all the straws were of equal length, and all their ears were evidently longer. The difference seemed, however, rather less in one of the fields, the soil of which was in a slight degree the least heavy. Six ridges, which stood together two and two, were harvested separately, being fagged or cut at the ground, that the whole of the straw might be weighed. The result was as follows:—

	Measurement.		Produce of Wheat.			Produce of Wheat per Acre.	Straw.	Straw per Acre.
	R.	P.	Bsh.	Pks.	Qts.	Bushels.	lbs.	Cwt.
No. 1. Nitred . .	1	32	17	2	4	$39\frac{1}{9}$	3,858	$34\frac{1}{2}$
„ 2. Not nitred .	1	36	12	3	5	27	2,760	$24\frac{1}{2}$
„ 3. Nitred . .	2	5	13	3	4	$26\frac{1}{10}$	2,856	$25\frac{1}{2}$
„ 4. Not nitred .	2	1	11	0	1	$21\frac{3}{4}$	2,260	$20\frac{1}{4}$
„ 5. Nitred . .	1	10	7	3	0	$24\frac{4}{5}$	2,732	$24\frac{1}{2}$
„ 6. Not nitred .	1	7	6	0	2	$20\frac{1}{3}$	2,252	$20\frac{1}{4}$

The outlay on the manure was therefore repaid by the increase of the crop. The samples were shown to good judges: some of whom preferred the nitred wheat for its brighter colour; and they were sold for seed at the same price of 66*s.* the quarter, the best market-price of the day. If the average increase of wheat produced by the nitrate be taken, as I think it may, in the first field, at six bushels the acre, and of straw at 7 cwt., the account will stand thus, independently of the tail-corn:—

	£.	*s.*	*d.*
Average Increase of wheat per acre, 6 bush., at 8*s.* 3*d.*	2	9	6
Ditto straw, ditto 7 cwt., at 1*s.* .	0	7	0
	2	16	6
Deduct for nitrate laid on . .	1	8	0
Profit, per acre, by nitrate .	1	8	6

In the second field—

Increase of wheat per acre, $4\frac{1}{2}$ bushels, at 8*s.* 3*d.*	1	17	0
Ditto straw, ditto, 4 cwt., at 1*s.* . .	0	4	0
	2	1	0
Deduct for nitrate	1	8	0
Profit	0	13	0

In this last case the expense comes so near to the increase of produce as to show that the employment of this manure might not be advisable in all states of the market.

I must admit, however, that when some of the corn was ground the yield in flour did not bear out the equality of price for which it had sold. A bushel of the wheat which had received no nitre weighed $62\frac{3}{4}$ lbs., of the other wheat only $60\frac{1}{4}$ lbs.: and this difference of weight told in the produce of 4 bushels of each which were sent to the mill, as appears by the following account:—

	Weight. lbs.	Flour. lbs.	Pollard. lbs.	Bran. lbs.	Waste. lbs.
4 Bushels of wheat nitred .	241	176	17	40	8
4 Ditto not nitred . . .	251	197	13	33	8

The nitred wheat yielded less than its proportion of flour, not only according to measure, as might have been expected, but even according to weight; for the 241 lbs. of wheat should have given 189 lbs. of flour, but they gave only 176 lbs., a further serious deficiency of 7 per cent., so that the bushel of wheat not nitred gave $49\frac{1}{4}$ lbs. of flour; that of nitred wheat 44 lbs. only; nearly 10 per cent. less of flour according to measure. One miller who ground some of each wheat stated to me that the condition of the two parcels was very different—one appearing to him so soft that he had no doubt it had been badly harvested. They had grown, however, on neighbouring ridges; had been cut and carried together. It was the nitred wheat, of course, which was soft, and, as the miller stated, gave out its flour ill. The same miller informed me that even in the golden-drop wheat he has found this defect. He also stated, generally, that wheats which are grown on farms where that crop recurs oftener than every four years, though well-farmed superior soils, yield less flour than corn produced upon poorer soils, on which the four-course rotation is observed. Hence it appears that, whether we increase the produce of wheat by manure, by improved seed, or by a more rapid succession, we have to contend against this deduction, that the produce of flour does not increase in the same proportion. Still, in the present case, the produce of flour per acre turned out favourably:—

	Wheat. Bushels.	Flour. lbs.
Acre with nitre . .	30 at 44 lbs.	1320
Acre without nitre .	24 at $49\frac{1}{3}$ lbs.	1077

Not only, however, did equal measures of the two wheats give unequal weights, and equal weights unequal quantities of flour, but even the same quantities of flour did not give precisely the same weight of bread. In six successive bakings 9 lbs. of each flour were separately made into bread. There was always a deficiency, more or less considerable, in the bread produced by the nitred flour. I will trouble you with the last trial only, which may be taken as an average one. Nine pounds of each flour previously dried were made into dough according to the process of Colonel Le Couteur:—

	Dough.		Bread.	
	lbs.	oz.	lbs.	oz.
9 lbs. of nitred flour gave . . .	13	8	11	6
9 lbs. of unnitred flour	13	10	11	10

It appears that in this trial the nitred flour absorbed 2 oz. less of water than the other; but this difference is not sufficient to account for its inferior yield of bread, since that deficiency amounted to 4 oz. Though even this latter difference does not appear large, it takes two loaves from every hundred. It may be, however, that as much nourishment is contained in the smaller number of loaves. The bread of the nitred wheat, I must say, seemed the best and most agreeable, resembling the common white bread made in the south of Spain, the wheat of which country abounds, I believe, in gluten. Still, with all these abatements, the nitrate appears to be a very promising manure; and fortunately we need not apprehend that, as with bones and with some other artificial manures, the increase of its use should so raise its price as almost to absorb the profit of its employment; for the supply of it from the extensive beds which lie near the surface in Peru must be as inexhaustible, for centuries at least, as that of coals. This ample supply, as well as its easy carriage, increase its importance, and render it the more desirable that we should ascertain the causes of its success and its failure. At present the nitrate appears most capricious in its operation; but it is not, of course, Nature who is variable, but we who are ignorant. That it has a strong power over vegetation is certain: why it should have failed here, on the light soils, I cannot discover; possibly the dryness of the late summer may have checked its action. The same drought, I have been told, has occasioned a coat of common dung, laid on a grass-field in this neighbourhood, to produce no effect. On the grass-lands south of Newbury wood-ashes are an established dressing; but they, too, I am told, have been known to fail in dry weather. All top-dressings, I believe, require to be followed by rain. Our light land suffers particularly in the absence of rain: and the barley sometimes burns the soonest where the ground has the most dung. I shall mention as a caution, that the nitrate has actually produced this effect in a case which has come within my own knowledge. One of my neighbours dressed some wheat and barley lying near each other on a free loam near Abingdon, with 140 lbs. of the nitrate per acre, in the middle of May. The wheat acquired the dark green, but was not benefited. The barley showed no immediate effect, but in the end suffered serious injury. On the part which had been dressed the straw did not reach more than half its proper height, the ear was blighted, the crop in fact was completely burned up. In the case of Sir R. Throckmorton's wheat, the land may have been too high in condition already; for there are limits, of course, beyond which the produce of a given soil cannot be brought by any manure, or any quantity of it. If a dressing of dung raises the yield of an acre from 32 to 40 bushels, no practical man will expect that a double dressing will produce 48 bushels, or that three times as much dung will give 56 bushels. It is, I think, very likely that the land at Buckland has been so highly farmed as to bring its fertility to the utmost point, so that the nitrate would be in the same relation to the soil as a third dressing of dung. Possibly this

may have occasioned a similar failure which you mention to have occurred on your own farm. An objection has been made to the use of the nitrate, that its effect lasts for one year only. If it brings back its own cost, however, in the year, the objection is not just, at least when it is applied to grass; for we must not forget that an increase of food for stock once raised on grass-land by any fresh means is a new capital created, which circulates between the stock and the land, giving more dung to the soil, and, again, more food to the additional animals which are maintained on that soil, for as many years as the farm continues to be well managed. Whether it exhaust a soil by increasing the crop of grain is a more difficult question, which cannot be answered without further observation. But the investigation of its effects is, I think, as likely to advance scientific as practical farming. Hitherto manures have been classed rather loosely as real or nutritious manures, such as dung, and stimulating manures, such as lime and other minerals; which last are supposed not to support the plant directly by affording it food, but indirectly, by exciting other substances, that are thus rendered capable of giving nourishment to it. German writers, however, now maintain that dung itself acts not by any power which it possesses as having formerly been a part of living bodies, animal or vegetable, but as uniting those chemical elements, some of them mineral, which constitute the food of plants; and that a compound of these elements, artificially brought together, would act precisely in the same manner as dung. Dr. Liebig, who is regarded as the first living authority on organic chemistry, maintains this view in the important work he has just published on "Chemistry in its application to Agriculture," and goes far to prove it. This is, in fact, the great question, if it still be a question, in agricultural chemistry. But the substance we are considering throws, I think, some light on this point and on the operation of other manures. It is now admitted that the most active principle of farm-yard dung is the urine that is mixed in it. When this urine, which is the liquid-manure of the Flemings, is applied to growing crops as a top-dressing, it gives a dark colour to the grasses (including those grasses which bear grain, that is, common corn); it has a tendency to lengthen, but weaken the straw,—to increase the bulk, but diminish the weight, of the grain. I need not remind you that this liquid, when putrified, contains much ammonia: soot, I believe, acts in the same manner, and also contains much ammonia. The refuse-liquor of gas-works was mentioned in the first Number of our Journal as producing the same dark colour and active growth in barley. I have tried it this year in consequence, and found it to act in the same manner on carrots. The chief ingredient of this liquor is also ammonia, as may be perceived by its pungent smell. It appears clear, therefore, that one active principle of these three very different manures is that substance in which they agree, namely, ammonia. But the nitrate of soda enables us, I think, to go a step further. Ammonia is a combination of nitrogen with hydrogen: either of these might be the source of its power over vegetation; but we have seen that saltpetre, or nitrate of potash, and cubic saltpetre, or nitrate of soda, act upon crops in the same peculiar manner with fermented urine, with soot, and with gas-liquor. These last, however, do not contain hydrogen, and

so differ from the other three, but they agree with them in containing nitrogen in the form of nitric acid. Nitrogen appears, then, to be the active principle of the five substances. Dr. Liebig, in proving the efficacy of ammonia as a manure, has shown the necessity of nitrogen for forming the most nutritious part of our vegetable food, such as gluten, which nitrogen again appears as a most essential element of all animal frames. It is possible, however, that where a large portion of nitrogen is applied to wheat-crops as manure, gluten may be produced in excess, and that the wheat may be deficient on the other hand in some essential element, such as lime. According to Dr. Liebig's principles, we should be able to remedy this defect by applying lime at the same time in such a state as would be readily absorbed by the plant. I mention this, however, rather as an exemplification of those principles than as a practical suggestion. But having been led almost too far into this subject, I will only express the hope, that men of science who are competent to do it justice may be disposed to assist us by investigating the operation of manures and the food of plants. I cannot but think that we are on the eve of important discoveries in this department of theoretical agriculture. With regard to the practical use of the manure, to which you have called our attention, its effects in this neighbourhood have certainly borne out the doubts which you expressed. It seems to me that we should all try it, since it is of undoubted efficacy in many cases, but not on a large scale at first, unless we know that it has acted well on the particular soil and crop we wish to benefit, because its cost is considerable, and it sometimes fails altogether.

Yours, my dear Sir, very truly,

PH. PUSEY.

Pusey, Nov. 6, 1840.

To D. Barclay, Esq.

Extract of a Letter from the Earl of Zetland.

Upleatham, Nov. 3rd, 1840.

MY DEAR BARCLAY,

I HAVE received a letter from Mr. Pusey, begging me to communicate any further information I may possess on the use of Nitrate of Soda, for the use of the Journal. I have answered him that I was about to write to you on the subject, and that I conceived he would be satisfied to have my observations communicated through you. I now enclose you some remarks made by my bailiff, John Alderson. In addition to his information I have little worth communicating, because I have not made accurate measurements; and having sown whole fields with the nitrate, I have not the means, by my own observation, of making comparisons. I had two fields of wheat at Marske sown with nitrate of soda. Owing to the very bad seed-time last year these two fields were not sown with wheat till January. The nitrate was put on about the 13th of May. Both these fields were

reaped within a few days of the time that the earlier-sown corn was reaped. The straw was abundant, and one field produced 42 stooks per acre, and the other 45 stooks per acre. It is estimated that they would both yield about the same quantity of grain, viz., about 37 or 38 bushels per acre; the straw in one field being coarser and taking up more room than the other. I do not think these fields produced more wheat than my other wheat-fields at Marske; but then the other fields were in better condition, and had been ploughed with the subsoil-plough, which I believe, on the Marske land, produces a very great effect. The fields sown with nitrate had been heavily cropped, were rather in an exhausted state, and would not have been sown with wheat if it had not been for the convenience of bringing a farm, which I had just taken in hand, into a regular rotation. I believe my wheat-land at Marske produced at least 10 bushels an acre more than the average of my neighbours on the same sort of land.

I have not tried the nitrate on oats, but Mr. Hart, a very good farmer on the Gisbrough estate, told me that he tried it on *one* ridge of oats, and that ridge produced three sheaves to two sheaves on the adjoining ridge. Mr. Vansittart tried it on a whole field of oats, which field had grown wheat the preceding year. He had a remarkably good crop of oats over the whole field, when he had only a right to expect a very moderate one. I have not tried it on any other crops besides wheat and grass this year. Last year I tried it on turnips, and thought it did no good. Mr. Vansittart tried it on turnips this year with dung on strong land, and his opinion is that it did harm to turnips. I cannot give you any account of the weather immediately after sowing the nitrate, as I was not in the country, and Alderson does not recollect that there was anything particular either one way or the other in the weather.

At Aske I tried it on a very fine meadow-field—a good loamy soil, well drained, with sandy stone and limestone below. Another part of the field was manured with a compost of lime and salt: the result was, in weight of grass—

24 square yards . . .	Nitrate of Soda . . .	136 stone
,, . . .	Lime and Salt . . .	100 ,,
,, . . .	Without Manure . .	96 ,,

The above was weighed immediately after it was cut. I believe that lime and salt mixed are of little use, and that, separate, either would have more effect. This does not show so great an increase as was produced here last year, when the weight of grass was more than doubled; but the land at Aske is much finer and richer land than that on which it was tried here.

Enclosure alluded to in Lord Zetland's Letter.

Some Remarks on the Effects of Nitrate of Soda.—by Mr. John Alderson.

Nine ridges in a meadow belonging to the Earl of Zetland were sown with nitrate on or about the 1st of August, 1839. Two of the same ridges, with the remaining part of the meadow, were sown with nitrate of soda

on the 13th of May, 1840. The best grass this year was on the two ridges sown with nitrate of soda twice, that is in August and again in May, the second-best that part which was sown in May, and the worst was that part which was sown in August, 1839. This shows that nitrate of soda has a little effect the second year, but not much.

The Earl of Zetland's farming-man at Marske Farm, in returning home from sowing nitrate of soda on wheat, grass, &c., found in one of the sacks a small quantity left, and, being desirous not to waste it, took the trouble of going into a poor man's cottage-ground, where was growing a small ridge of wheat. This small quantity of nitrate of soda was sown on one end of the ridge. In a few days, to the great astonishment of the poor man, he saw so great a change, both in *colour* and *size*, that he called together his neighbours to see if they could find out the cause; but as neither he nor his neighbours could make it out, they returned home satisfied to wait till the secret was revealed.

A respectable farmer in the neighbourhood of Marske, who had used a little nitrate of soda last summer, gives his opinion that he had not reaped or seen the benefit reported. On making inquiry it appeared that only 1 cwt. per acre had been applied: this agrees with my opinion, that not less than 1½ cwt. should be sown, and I am rather inclined to say more.

Nitrate of soda may be sown on pasture to a good effect, particularly on pasture that does not eat off regularly; but the farmer will not see the good effect without *minute observation*, as the cattle eat the grass as it grows.

Two fields belonging to the Earl of Zetland, at Upleatham, were sown with clover in 1839; in 1840 one of the said fields was sown with nitrate of soda, and had a good effect. After the clover was cut, in the course of a week, the nitrate evidently showed itself in the fog or after-grass. During the months of August and September the two fields of clover-fog were depastured with cattle and sheep. The field sown with nitrate of soda was eaten by the cattle and sheep regularly away. The field not sown with nitrate of soda was left by the cattle in *tufts* or *hots* not eaten regularly off. This evidently shows that nitrate of soda has the effect of sweetening the grass.

JOHN ALDERSON.

Letter from Walter Calvert, Esq.

MY DEAR SIR,

EXPECTING a late and uncertain harvest, I lost no time in getting up the corn whenever it was in proper condition, and did not make any measurements. As far as appearances went, they justified the good opinion I had formed of the nitrate of soda. From 1 cwt. to 1½ cwt. per acre is about the quantity, in the spring, when the corn begins to be alive from the effects of the winter. I think, also, it pays for putting upon grass. It has very little effect the second year; but we have put it on two years running, and it showed itself as much the second year as the first.

I remain, yours sincerely,

WALTER CALVERT.

Oakley Court, Sept. 29.

Letter from Messrs. Drewitt & Son, Piccard's Farm, near Guildford.

SIR, *Piccard's Farm, Guildford, Oct.* 1, 1840.

IN addition to our communication of the 2nd of March last, we have but little to say on this subject.

We are in doubt whether you did not misunderstand what we said as to its effect, or rather its non-effect, on our chalk soils for the turnip-crop. The chalk we cultivate is a very dry rubbly chalk, without any admixture of loam, and but little other mould; and on this soil it had no effect on *turnips*, though for every other crop it was admirable. And what is a curious circumstance, and rather gratifying, where it had no effect on the turnips last season, and where of course they were inferior, its effect on the succeeding crop of barley was very great; it was superior to any other part of the field.

Its effect on the growth of corn, on land of every description we cultivate, chalk as well as other soils, is quite sufficient to induce us to continue the use of it. When we sowed it over our crops last spring, the land and the weather were very dry, and until rain fell it had no effect; but afterwards it showed as usual, and produced an increase in the wheat-crop of nearly one-third.

It seems a doubtful point with us whether, sown on grass, either upland or meadow, the additional produce of hay is sufficient to repay the expense.

We are, Sir,
Your very obedient servants,
DREWITT & SON.

David Barclay, Esq.

Letter from Mr. George Dewdney, of Dorking.

SIR, *Castle Mill, Dorking, Oct.* 23, 1840.

I BEG you will excuse my apparent neglect in not answering your letter of the 28th ult.; but I have been anxious to give as much information as possible, by obtaining the opinion of most of the practical farmers who have used the nitrate of soda this year, not confining myself to this immediate neighbourhood, but generally throughout the Weald of Surrey and Sussex.

Nitrate of soda has been used with various success; in most instances amply repaying the farmer, by yielding a much larger proportion of grain and straw; in others barely paying the cost and expenses attending the use; and in some a complete failure, I may say positive loss, though I am glad to add the latter instances are rare.

I propose dividing this subject under different heads, and shall begin, first, with its success on wheat and oats, and secondly its failure.

Upon an average I find the increase of crop to be about 8 bushels per acre, and from 14 to 17 trusses of straw. On oats the benefit has been universal, particularly where sown on ley-ground, which is common now on our clay-lands, paying the grower from 27*s.* to 30*s.* per acre above the cost.

When its failure has taken place, I find the nitrate has been sown early, and when the land has been in a very dry state, consequently working but partially to the root: in these instances the crop has more or less blighted. There are also some kinds of wheat which are more susceptible of blight, and on which I think a much less quantity than is usual, viz. 1¼ cwt. per acre, ought to be used,—I mean the Great Fluff, or Rough Chaff, and the Chidham; for where nitrate has failed this year most, I find it is with these kinds of wheat. On strong ground, or land in a high state of cultivation, I think it dangerous to use nitrate, there being a greater probability of the crop blighting. I am still of opinion that the best time for sowing the nitrate of soda on wheat is, from the middle of April to about the 10th of May, and on oats to the end of May; but of course much depends on the season. I have invariably observed that where it has been sown in showery weather, or immediately after rain, it is more certain in its effects.

The benefit of nitrate on green crops I still find to be great; for where sown this last spring on clover, pasture, and meadow ground, the crop has been very superior, far surpassing the adjacent lands.

I have also a very high opinion of this kind of manure, as a top-dressing on the Swede and turnip crop, particularly on light land; but recommend it to be sown broad-cast, at the usual rate of 1¼ cwt. per acre, a few days after the seed is deposited. Where it has been drilled with the seed mixed with ashes, I find the crop not so good as where sown by hand. In two instances which have come immediately under my notice, where a strip of ground had been dressed with nitrate only, I observed the plants throughout to be free from mildew, whilst the adjoining pieces suffered much, during the late dry weather.

I am not at present prepared to give an opinion as to its after effects, except on grass; that there is better after-math where nitrate has been used is beyond doubt.

I remain, Sir,
Your obedient servant,
GEORGE DEWDNEY.

David Barclay, Esq.

The experiments with nitrate of soda on my own farm, during the present year, were made, with varying results, upon clover-seeds, tares, sainfoin, peas, beans, grass, swedes, turnips, oats, barley, and wheat.

On the clover the effect was equal to the rest of the field dressed with farm-yard dung, at the rate of 9 cart-loads to the acre.

On the tares the effect was visible, but not sufficient to pay for the cost of the nitrate.

On the sainfoin the effect was perceptible, but the improvement would not more than repay half the cost of the nitrate. The same may be said of the results of the experiments as applied to beans and peas, which are calculated with exactness.

The application of the nitrate on my grass-land was attended with very little visible effect; but it was remarked that the cattle fed more on that part of the park where it had been sown.

The result of the experiment on swedes I am unable to state, as, unfortunately, the whole field was dressed with the nitrate: the crop suffered much from mildew, and was not heavy. The turnips on which it was tried were sown after a crop of peas had been taken off, at the latter part of July. The effect of the nitrate in this instance has been very remarkable, and will amply repay the cost. On an adjoining piece of land, which had been cropped with tares and dressed with nitrate, after the tares were cut it was ploughed up, and, without any additional dressing, sown with turnip-seed. The turnips are very superior on the lands in question, which can only be attributed to the effect of the nitrate that had been sown upon the tares. This is the first instance which has occurred within my knowledge of any benefit having been received by a second crop from the application of this manure.* The tares were not much improved by it; and it is therefore presumable that its fertilizing principle remained nearly dormant until the land was again ploughed and sown.

The experiments upon oats were made on strong heavy land, with a subsoil of clay; and upon winter-oats on a flinty loam, with a chalk subsoil. The beneficial effects on the former were partial, and barely sufficient to pay the cost of the nitrate: on the winter-oats the effect was very remarkable; the adjoining land having produced only at the rate of 5 quarters of corn and 61 trusses of straw the acre, while that dressed with the nitrate of soda produced 7 quarters and 4 gallons of corn and 90 trusses of straw the acre. The field was mown in the middle of July, at which time the oats would have sold for 30*s.* the quarter, and the straw at 25*s.* a load. At these rates, and after deducting the cost of the nitrate, the gain by the use of this dressing amounted to 4*l.* 3*s.* 9*d.* the acre.

Applied to barley the result of the trial was also very satisfactory.

	Bus.	G.	Q.	£.	*s.*	*d.*
An acre dressed with nitrate produced	55	3	2			
Which, at 35*s.* per quarter, amounts to .				12	2	9½
Straw, 56½ trusses, at 1*s.* . .				2	16	6
				14	19	3½
Less cost of nitrate . .				1	0	0
				13	19	3½

* A remarkable instance is also stated in Messrs. Drewitt's letter, see p. 127, and another by Mr. Wilson, p. 137.

	Bus.	G.				
An acre without nitrate produced . .	44	2				
	£.	s.	d.			
At 35*s*. per quarter, amounts to	9	13	7			
Straw, 45½ trusses, at 1*s*. .	2	5	6			
				1	19	1
Gain by the use of nitrate .				2	0	2½

My experiments on wheat were made on a field of heavy land sown with spring wheat (Talavera). Some effect was observed, but not sufficient to pay the cost of the soda: on another, of autumn-sown Chidham wheat, the land in high condition, the effect was rather injurious than otherwise, forcing the straw to the prejudice of the grain. The third experiment was made on 17 acres, part of 40 acres considered the poorest on the farm; the result was as follows, after a very careful measurement: viz.—

One acre, with nitrate, produced 39 bus. 5 gal. 2 qts. of thrashed wheat, which, at 66*s*. the quarter, amounts to . . .				£16	7	7
64½ trusses of straw at 1*s*.				3	4	6
Weight per bushel 63½ lbs.				19	12	1
Cost of nitrate				1	0	0
				18	12	1
One acre, without nitrate, produced 33 bus. 7 gal. 2 qts. of thrashed wheat, which, at 66*s*. the quarter, amounts to	£14	0	2			
56 trusses of straw, at 1*s*. per truss . .	2	16	0			
				16	16	2
Gain per acre by the use of nitrate				£1	15	11

Weight per bushel 63½ lbs.

The samples of oats, barley, and wheat, dressed with nitrate of soda, were taken to a neighbouring market, and compared by good judges with samples grown on adjoining lands not so manured, and no difference in the qualities could be discovered; nor was there any noticeable difference in the weight of the bushel, either of the oats, barley, or wheat.

My farm is situated on the confines of the clay and chalk formations; the soil of the western part is mostly of a heavy description, with a subsoil of stiff clay; the experiments made on this portion, whether upon corn or grasses, have been unsuccessful, while those which have been made on the light land with the chalk subsoil have, with few exceptions, been attended with beneficial results—thus tending to confirm the opinion of the Harle-

ston Club; but, on the other hand, Mr. Pusey's experiments in Berkshire, and Mr. Calvert's on the stiff clay of the Weald of Surrey, furnish evidence of a directly contrary tendency. Similar contradictions are worthy of remark in the letters and experiments which I have transcribed. Lord Zetland, in Yorkshire, and Mr. Dewdney, in Surrey, have experienced great benefit from the application of nitrate of soda to meadow and pasture land; whereas on my grass-land it has been almost a failure; and Messrs. Drewitt, it will be observed, doubt if either upland or meadow grass will repay the cost of this dressing. My experiments on swedes in 1839, and this year on turnips, have been strikingly successful; while those made in Yorkshire by Lord Zetland and Mr. Vansittart have altogether failed: how are we to account for such remarkable discrepancies?—are they to be attributed to some peculiar properties in the different soils?—has climate any influence in these cases?—or are these discrepancies to be attributed to variations in the mode of applying this manure, or to accidental circumstances, such as the state of the weather at the time of its application? Science may throw much light on this inquiry; and all must unite in the hope expressed by our President, "that men of science who are competent to do it justice may be disposed to assist us by investigating the operation of manures and the food of plants."

The singular variations in the results of many actual experiments with nitrate of soda, by parties seeking to advance the cause of agricultural improvement, are calculated to discourage the use of it as a manure. It cannot, however, be doubted that it has a very powerful action on vegetable life; and by persevering in our experiments we may hope, with the aid of science, to understand the laws which govern it, and eventually arrive at practical conclusions of great national importance.

D. Barclay.

Eastwick Park, near Leatherhead, Surrey,
Nov. 11*th*, 1840.

On the Effects of Nitrate of Soda. By John Burgess, Esq.

To the Secretary.

Sir,

I beg to communicate to you a few experiments I have made upon my farm, which is stony thin land with a substratum of chalk. I found the saltpetre, which I only used on my wheat, gave an increase of about five bushels to the acre, with a considerable increase of straw. But I gave up the saltpetre for the nitrate of soda; and I believe I am the first individual who has tried it as a manure: and have found it

answer beyond my most sanguine expectations. The quantity I have used has been an hundred weight to the acre, both of the saltpetre and the nitrate, as a top-dressing. The first trial was in a field of eight acres of oats, using the nitre upon alternate lands, and where the corn was thinnest, the increase was rather more than two quarters to the acre, with abundance of straw, and the sample the best, according to the opinion of several farmers who came to see the field. I tried it upon my barleys, and I think I had better success with them than with the oats, and also upon a meadow. The mowers, with others who came to see the effect of the application, gave it as their opinion that the increase was about three-quarters of a load to the acre. I used it last year upon a field of six acres, four acres of which had been dunged with the yard-dung, (about eight or ten loads to the acre, worth five shillings a load) for turnips, but to the other two acres I applied the nitrate without any dung. To my great satisfaction I found that the turnips grew so fast that they soon got out of the way of the fly, which had been very destructive to the other parts of the field, and indeed this was the only good piece in the field: in this case the nitre was used soon after the turnips were up.

This year I applied the nitre to my wheat, when, from the wet season and the wire-worm, the plant was nearly destroyed, and I found it particularly beneficial, the wire-worm either being killed by the application or forsaking the roots; and, consequently, I think I have above an average crop of wheat. I have now growing a field of six acres of turnips, remarkably fine, and without any other manure than that of the nitre, and very superior to my other turnips where I have used the yard-dung in the quantity before stated; in this case the nitre was sowed a few days after the turnips, and before they were up.

I think from the numerous correspondents I have had, in consequence of my recommendation, that the application of the nitre as a manure is giving general satisfaction, and coming very much into use. The best season for the application is as soon as vegetation begins to feel the influence of the spring, taking care to avoid frosty nights as much as possible. Several farmers have informed me they have found it better to apply the quantity at two different times, one half when the corn first begins to feel the influence of the spring, and the other half about six weeks afterwards. I shall offer no apology for my long detail, knowing your object and that of your Council is to obtain information. And any further communication that I could make shall always be at the service of the Society.

And I remain, Sir,
Yours truly,
JOHN BURGESS.

Elmhurst, Great Missenden, Bucks.
9th Sept., 1840.

I am afraid many have used the Egyptian nitrate of soda, which is comparatively very cheap, and very inferior in strength, and consequently they have been disappointed in their expectations.—J. B.

Results of Experiments with Nitrate of Soda, and on Drilling for Wheat. By John Raymond Barker, Esq.

To the President.

Dear Pusey,

As President of the Royal Agricultural Society of England, I forward to you the result of some experiments I have tried with nitrate of soda, and also the results of wide and narrow drilling for wheat. The land upon which the experiments were tried is a light stone-brash, a poor thin soil. In October, 1839, I drilled half the field six inches between the rows, with 9 pecks of white Hereford wheat per acre. I drilled the other half nine inches apart, with only 5 pecks of seed per acre. The nine-inch drilled wheat appeared the strongest and best all through the winter. In February, 1840, I measured in the middle of the field four separate quarters of an acre; two of these quarters drilled 6 inches apart, and two 9 inches apart; I then, on a moist foggy morning, sowed 42 lbs. of nitrate of soda on a quarter of an acre of the 6 inch drilled wheat, and the same on a quarter of an acre of the 9 inch drilled; during the dry weather which followed and prevailed here all the summer, it was extraordinary to see how green and thriving the wheat continued that had received the nitrate of soda, while the whole of the remainder of the field showed evident symptoms how much it felt the dry weather: I took these small quantities in order that I might be more exact and sooner be enabled to give the results to the public, as had I taken the whole field I could not have been so exact, or been enabled to thrash out the corn so soon, but I have no doubt from the appearances that all the wheat with which I used saltpetre or nitrate of soda will yield the same results; not so with the barley, on which the saltpetre failed.

The results of the quantity of grain in measure and weight, with the weight of the straw also, is as follows:—

No.	Quantity of Land.	Seed.	Drilled distance.	Produce.				Straw weight.		
				Bushels.		Weight.				
	Acre.	Pecks.	Inches.	B.	P.	cwt.	lbs.	cwt.	lbs.	
1	¼	5	9	8	2	4	39	5	40	With Nitrate of Soda.
2	¼	9	6	8	3	4	96	5	56	
3	¼	5	9	6	0	3	22	3	80	Without Nitrate.
4	¼	9	6	6	1	3	32	3	87	

The *weight* of the grain appears light; but, it must be remembered, the wheat was carried from the field to the barn and thrashed immediately, and new wheat never weighs well.

The narrow drilled produced, as you will perceive, a little more than

the wide; but I am inclined to think, had I drilled seven pecks of seed instead of five, at 9 inches apart, the wide would beat the narrow drilled.

Hoping these experiments may be of service to my brother agriculturists,

Believe me,
Very faithfully yours,
JOHN RAYMOND BARKER.

Fairford Park, Gloucestershire,
Sept. 22, 1840.

Experiments on Grass Lands with Nitrate of Soda and Gypsum. By JOHN GREY, Esq.

To the Secretary.

SIR,

AT the request of Mr. Pusey I have now the pleasure to communicate to you, for insertion in the Journal, should you deem it worthy of notice, the result of an experiment upon grass land, from the application of nitrate of soda and gypsum. I applied nitrate and gypsum also, to alternate ridges of different kinds of grain, and at various stages of its growth; but the quantity of rain that fell in this part of the country both previous to and during the time of harvest, had the effect of producing so much straw and of laying the corn so flat, that it was found difficult to cut the plots so as to keep the produce of each perfectly distinct, and was also in other respects so unfavourable to the experiment, that I cannot reckon upon the result being very correct and satisfactory. Some part of the grain is yet in the fields, and not in a state to be thrashed, but should the experiment be marked by any decided result, I may have the pleasure of communicating it to you at some future time.

On the 28th April, 1840, I sowed upon each alternate ridge of a plot of land consisting of four acres, of good gravelly loam, which had lain three years in grass, and was thickly covered with plants, nitrate of soda at the rate of 1 cwt. per acre, having ascertained the exact contents of each ridge, and divided the nitrate accurately into the right proportions. To some of the alternate ridges I applied gypsum at the rate of 10 bushels per acre. To one ridge I applied both the nitrate and gypsum, upon the principle of "the more good things the better;" but the result in this case proved the maxim fallacious; and three ridges were left without any application whatever. The grass to which the nitrate was applied, in a few days assumed a darker colour than the other, rose quickly above it in height, came earlier into seed, and was sooner fit for cutting. The plot was all mown and made into hay at the same time, great attention being paid to keep the produce of each of the ridges intended for the experiment distinct. The following is the weight of hay produced by each plot, and at this time the aftermath of those ridges to which the nitrate was applied, is obviously better than the others:—

1. 112 square yards, without any manure, produced 9 stones 4 lbs. of hay, weighed, when newly made, equal to 2 tons 81 stones per acre.
2. 112 square yards, to which gypsum had been applied at the rate of 10 bushels per acre, gave exactly the same result: so that no benefit arose from its use in this instance. It must be remembered, however, that the grasses are of the ordinary kinds used in pasture, *i. e.*, white clover, rye-grass, timothy, &c., but without red clover, to which gypsum is known to be beneficial.
3. 112 square yards, to which nitrate of soda had been applied at the rate of 1 cwt. per acre, produced 14 stones 7 lbs., equal to 3 tons 146 stones per acre, being an increase of 1 ton 65 stones over Nos. 1 and 2.
4. 112 square yards, to which both nitrate of soda and gypsum had been applied in the above quantities, produced 14 stones—equal to 3 tons 125 stones per acre—and 21 stones less than the produce where nitrate was applied alone.

The cost of the nitrate on the ground was 22*s.* per cwt., and the increased value of hay per acre, as it stood in the fields, would be from 4*l.* to 5*l.*

From the many experiments which have been made, and which have all proved more or less beneficial, no doubt can be entertained that nitrate of soda is generally efficacious in the production of grass; but several experiments may yet be necessary to ascertain on which descriptions of soil and to what class of plants it is most so, and to what particular stage of their growth it is to be applied with the greatest benefit. I am inclined to think, from the little experience I have had in the matter, as well as from the consideration that it does not act through the medium of the soil, as a manure, but rather as a stimulus to the plants, that it ought not to be sown upon the grass until it has risen considerably from the ground, and the blades are sufficiently evolved to derive all the benefit.

I have the honour to be, Sir,
Your obedient servant,
JOHN GREY.

Dilston, near Newcastle-on-Tyne,
Northumberland, Sept. 26, 1840.

I applied nitrate of soda to a row of potatoes, at an early period of their growth. The tops soon showed the effect, and far outstripped the adjoining rows in growth; but when the potatoes were taken up, the produce of that row was found to be less than that of the others, both in weight and measure.

The first action of the potato-plant is to throw out its top. The roots make their growth at a later period. It seems, in this instance, that the stimulus of the nitrate had expended itself in the earlier process; and that, instead of being benefited, the roots had suffered by the application—probably from the greater shades and weight of top.

Nov. 30, 1840.

Result of Experiments with Nitrate of Soda, made at Newton Hall, in the County of Northumberland. By J. C. Jobling, Esq., communicated by J. Grey, Esq.

One acre of strong turnip-soil, from which the turnips had been pulled in the spring, was sown with barley in April last. So soon as the barley was well in blade, four stones of nitrate of soda were sown upon one half-acre of it. In harvesting, housing, and thrashing the produce of this acre, that half treated with nitrate has been kept accurately apart from that which was without such treatment, and the following is the comparative result:—Half an acre treated with nitrate produced 29½ Winchester bushels, weighing 115 stones, with 144 stones of straw: half-acre without nitrate, 23½ bushels, weighing 94 stones, and 105 stones of straw. Difference in favour of nitrate, 6 bushels 21 stones of barley, and 39 stones of straw. The cost of the nitre, including labour in sowing and carriage, was 11*s.* 6*d.*

It may be remarked that the sample of barley with nitrate is darker than that without it, and that the clover-seeds do not appear to have taken so well as on the other half-acre. The increased value cannot be estimated at less than 40*s.* per acre, after deducting the cost of the nitrate.

Half an acre of wheat, with ½ cwt. of nitrate of soda, produced 18 bushels of wheat, weighing 76 stones, and 142 stones weight of straw. The adjoining half-acre, without nitrate, but managed in other respects exactly the same as the other, produced 15 bushels of wheat, weighing 64 stones 11 lbs., and 117 stones weight of straw. The relative quantities stand thus:—

No. 1 . .	18 bushels.	Weight . .	76 st.	0 lb.	Straw . .	142 st.
No. 2 . .	15 ..	.. . .	64	11	.. . .	117
Difference upon the half-acre.	3		11	3		25

Results of Experiments with Nitrate of Soda. By the Hon. Henry W. Wilson.

To the Secretary.

Sir,

I send you, according to my promise, the result of my experiments with nitre and the nitrate of soda upon wheat. Last year I tried them to a considerable extent upon a light sandy soil, sowing in the spring 1 cwt. per acre: the difference between the produce of each was scarcely worth notice, not exceeding a quarter of a peck, but there was an excess

of one-sixth, both in quantity of grain and in weight of straw, over that part which was not sown with either. The turnips this year following the wheat are most decidedly better where the nitre or nitrate of soda were used, the tops still growing, and very luxuriant, while on the other part they are beginning to fall.

This year I have only used the nitrate of soda: 1 cwt. per acre, 1st, for wheat on a fair light soil, sown on the 20th of May, the produce 32 bushels per acre; where no nitrate was sown 27 bushels 2 pecks, being an excess of 4 bushels 2 pecks. 2nd, on better land, a fair loam, sown 26th of May (both after clover), produce 36 bushels per acre; without nitrate of soda 30 bushels 2 pecks, being an excess of 5 bushels 2 pecks. In both cases one-sixth more of chaff and straw, but no improvement in the quality of the corn. 3rd, for barley, on a very poor sandy soil, where the turnips the year before were nearly destroyed by the land blowing, produce 32 bushels per acre; without nitrate of soda 18 bushels; excess 14 bushels, and one-third more straw and chaff; the quality also of the grain improved.

This result is so satisfactory to me that, having tried it on above one hundred acres this year, I purpose using nearly double the quantity next season.

I am, Sir,
Your obedient Servant,

H. W. Wilson.

Didlington Hall, Brandon, Suffolk,
2nd Nov., 1840.

Experiments with Nitrate of Soda on different Soils. By Mr. William Greaves.

To the Secretary.

I have great pleasure in forwarding to you the result of my using nitrate of soda; and have endeavoured to calculate the quantities to the greatest nicety. The field is a heavy soil, on a clay bottom, about 10 acres, and was sown with brew oats on the 23rd and 24th of March last; the weather was dry generally till the latter end of April. I dressed the field with nitrate of soda on the 18th of April, at the rate of 1 cwt. per acre, with the exception of one land, which went up the centre of the field; this was carefully measured, as well as the one adjoining to it, and which was as near as possible of the same size. In the course of a fortnight, as far as the field could be seen, the land not sown could be distinguished from the other by its inferiority both in colour and strength; this continued till the last. The part of the field not dressed had the best chance of produce, owing to a heavy storm the first week in August, which completely laid flat the whole field, with the exception of the undressed land, which stood up. The field was mown on the first week in September, and carted on the 18th. The two lands were

carefully kept separate, and thrashed on the 22nd of September: each land contained 605 square yards, or one-eighth of an acre: the result was as follows:—

Yds.		Stones.	Lb.		Imp. Bushel.		Stones.	Lb.
605	undressed land	25	12	of straw and	$6\frac{1}{16}$	of corn, which weighed	16	12
605	dressed land	38	10	of straw and	8	of corn, which weighed	22	5

This calculated by the acre gives—

	Cwt.	Qr.	Lb.		Bushels.		Cwt.	Qr.	Lb.
Dressed Land	38	2	24	of straw and	64	of oats, net weight	22	1	12
Undressed Land	25	3	12	of straw and	$48\frac{1}{2}$	of oats, net weight	16	3	12
	12	3	12		$15\frac{1}{2}$		5	2	0

From the above results it appears that the dressed land produced the heaviest corn by a very little; but had it not been laid with the weather, it would doubtless have been heavier.

By the above calculation I consider the nitrate paid me very well, for supposing straw at 30*s.* per ton and oats at 1*s.* per stone, there will be a clear profit (after deducting 19*s.* 6*d.* for the nitrate of soda, 2*s.* 6*d.* carriage, and $2\frac{1}{2}$*d.* applying on ground) of 2*l.* 1*s.* $3\frac{1}{2}$*d.*

I made several trials of the nitrate of soda on a light brown soil, on limestone, which in appearance answered even better than the above. I applied it across a 6-acre field of oats, which grew above the rest of the field at least 10 inches. I also tried it on pasture (light soil), and the luxuriance was very great in appearance till the latter end of July, when the herbage was no better than in the rest of the field. The cattle kept the part dressed very bare of food, and appeared exceedingly fond of it. A friend of mine also used a few cwts. on a gritstone soil, which answered very well for both grass and turnips, as well as corn, but as he did not measure or weigh, nothing more definite can be said of it.

Wm. Greaves.

Bakewell, Derbyshire, Nov. 8th, 1840.

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*Experiments with Nitrate of Soda on the Duke of Norfolk's Estate in Suffolk.** Communicated by the Rev. W. L. Rham.

One hundred and fifty pounds weight of nitrate of soda per acre was sown on part of a piece of clover; the remaining part of the field was not manured.

The clover was cut on the 6th of July; on the 11th, when in good state to cock or cart, an equal portion of the field of clover was weighed:—

* This trial has already appeared in the Mark Lane Express.

CLOVER.

	T.	Cwt.	qrs.	lbs.		£.	s.	d.
Produce per acre where the nitrate of soda was sown .	3	1	1	20	Value 4*l.* per ton.	12	5	9
Produce where the nitrate of soda was not sown	2	4	1	24	Ditto	8	17	10
Difference in quantity, per acre .	0	16	3	24	In value	3	7	11
Cost of nitrate of soda per acre, and sowing . . .						1	9	0
Clear profit per acre . . .						£1	18	11

WHEAT.

		Bus.	pk.	pt.		Bus.	pk.	pt.
Sown with nitrate of soda, 12 rods	Produce	2	0	5	per acre,	27	0	1
Ditto without nitrate of soda, 12 rods . . .	Produce	1	1	12	ditto,	18	2	12
In favour of nitrate of soda .		0	2	9	ditto,	8	1	5

A poor, springy, sandy soil.

JOHN MUSKETT.

Fornham, Suffolk, May 8th, 1840.

Experiment on the application of Nitrate of Soda as a Manure for Wheat. By W. H. HYETT, Esq.

THE soil on which this experiment was made is what is technically called the stone-brash. It lies close on rocks of the upper oolite formation, which are powdered by wet and frost with more than the usual facility of rocks of that character. Their chief ingredient, a carbonate of lime, therefore abounds in the soil. It was a doubt with the mere chemist whether the use of a salt, the base of which is an alkali, on soils where an alkaline earth prevails to such an extent, was likely to be as beneficial as on soils where it does not. This experiment was intended to afford the practical result.

The land on which it was used was quite clean and in good condition, though, from accidental circumstances, out of the usual course of cropping. In 1838 it had been well manured, and drilled with swedes. There was a heavy crop, about three-quarters of which were carted off, and the rest fed off by sheep. In 1839 it was sown with vetches, about two-thirds of which were carried off for the cart-horses, and the rest fed off by sheep. The land was prepared for the wheat crop between September 13 and October 26, when it was drilled with white Sicilian wheat, at the rate of two bushels an acre. The crop came up strong

and healthy, but was touched by the cold nights of March, which left the leaves of a bluish colour.

April 21.—The nitrate, at the rate of 1 cwt. to the acre, was sown and hoed in over all the field, except two square portions, which were staked out and left unnitrated. April was peculiarly dry; the average quantity of rain of that month being 1·786 inches; while the "April showers" of this year, according to the register of the Royal Society, did not exceed 0·254, or less than a seventh of the usual average. There was no rain here between April 17 and May 8, nor the slightest apparent difference in the two crops, on which day we had moderate showers. On the 16th the usual effect of the nitrate was seen in the *dark green colour* of the plant.* From the 8th to the 18th great quantities of rain fell here. In London, as much in three days as 1·347 inches, or five times more than in the whole month of April; and it could scarcely be less towards the west, as the wind blew from that quarter and the south during the heavy rains of that month. Concurrent with this state of the weather, the nitrated part of the field continued to advance in its deep luxuriant colour and strength, while that which was not nitrated presented a curious contrast in its pale, thin, strawy appearance—a difference which continued till the wheat came into ear. About the end of May it was affected by the disease known as the red rust, the leaves being marked by blotches of a rusty colour, the powder coming off as usual on being touched. This disease is described by Loudon, in his Encyclopædia of Agriculture, much as it occurred in this instance. He states it to be generally preceded by cold moist weather, which, happening in the warm month of July, suddenly chills and checks vegetation. The disease here appeared earlier, but is probably to be traced to the same cause. The heavy rains in the middle of May were accompanied by a cold north wind, the thermometer being as low as 41°. At the end of the month the temperature rapidly increased, and on June 1 the thermometer was as high as 83°; and again on the night of the 4th fell to 48°·3. Under these circumstances, it was certainly to have been expected that the nitrated wheat, which was now three or four inches higher than the other, and apparently much more luxuriant, should have been more injured than the other. This, however, did not seem to be the case. At this time both crops appeared to be equally affected: whether the future difference in the two is to be traced to this period is not easy to decide.

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* The deep green of every crop where the nitrates of soda or potash are used is their remarkable characteristic, and has perhaps sometimes led to an estimate of the crop not proportionately borne out by its yield. The strength and size of the plant is certainly at the same time increased; but some degree of that tint and apparent luxuriance may be due, notwithstanding the generally received opinion of the cause of colour in leaves, to the chemical action of the alkali, in turning vegetable colours green. The farmer, therefore, who uses nitrate, should observe that, when this appearance results, the crop may probably not be as good as it would indicate. Off-hand estimates of the quantity of produce are often most deceptive. *Weight and measure is the only criterion.* In what mode and proportion the alkali is absorbed by the plant, and whether it really does act chemically on the colour without proportionately increasing the luxuriance, are matter of interesting and useful speculation for the vegetable chemist; but it can scarcely be repeated too often, that *the true test of a farmer's experiment is to be found in the bushel and the scales.*

Both crops came into ear at the same time, and much alike—viz. on June 8.

June 12.—The contrast in colour was beginning to diminish.

July 2.—Both crops blossomed together and alike. The difference in colour, which had been becoming less and less distinct, was no longer bservable, though the nitrated part still retained the lead in strength and size.

July 20.—The nitrated wheat was now observed to be mildewed in straw and ear, while the other parts of the field were not at all affected. On the 8th or 9th there had been heavy rains, probably as much as 0·5 inches—the quantity which fell in London on the 9th with the wind in the north-west. On the 13th the thermometer was as low as 49°. On the 15th it rose to 77°, and continued high, with little or no rain, between the 9th and the 20th; and it is probable to this latter state of the weather that the mildew in the nitrated part was owing, as it is observed that hot and dry weather, without dew, has a tendency to create that disease on the richer parts of a field, and the more luxuriant crops.

There are, I know, some farmers of experience in the use of the nitrates who think them peculiarly likely to generate mildew; and I have given the above meteorological details minutely, because it seems in this case to have been the usual and natural effect of the weather on the more luxuriant part of the crop, and not any inherent evil in the particular manure. At all events, they may afford others who are in the habit of registering and collating the weather with its effects on growing crops some data from which to draw an opinion.

From this time till harvest nothing particular was observed, except that the nitrated part presented a dirty, blackish appearance in straw and ear, while the other parts of the crop were bright and clean.

August 25.—Finished reaping—the nitrated wheat had not ripened as equally as the rest—about one-third part of the ears were in a milky state, while the rest was quite ripe. In the same ear one part was soft, and the rest hard and ripe. That which was not nitrated had ripened perfectly and equally. Of course, when the two samples were thrashed out they were of unequal quality, though the nitrated wheat was not as much inferior as might have been expected.

The quantity and value of the two crops are given in the table below. The two samples of wheat were valued by a respectable corn-dealer at the price at which he would buy it, without being aware of the object —the nitrated at 8*s.*, and the other at 8*s.* 3*d.* a bushel: the former weighed 60, and the latter 61lbs. He valued the tail wheat, though not a marketable article, as worth 5*s.* a bushel in each case; and they weighed the same to an ounce—50lbs. Straw has been selling in this neighbourhood as high as 50*s.* a ton, but this is higher than the general price; and in order not to err on the side of over-value, I have set mine at 40*s.*, the price at which I would gladly buy it.

The result of the experiment is as follows:—

Produce.	Measure per Acre.									Value per Acre.								
	Without Nitrate.			With Nitrate.			Excess.			Without Nitrate.			With Nitrate.			Excess.		
	Bu.	Pks.	Pts.	Bu.	Pks.	Pts.	Bu.	Pks.	Pts.	£.	s.	d.	£.	s.	d.	£.	s.	d.
Corn, clean	30	2	11	37	3	4	7	0	9	12	13	0	15	2	6	2	9	6
„ tail	2	3	11	5	3	7	*2	3	12	0	14	7	1	9	2	0	14	7
„ total	33	2	6	43	2	11	10	0	5	13	7	7	16	11	8	3	4	1
	Weight per Acre.																	
	T.	cwt.	qrs. lbs.	T.	cwt.	qrs. lbs.	T.	cwt.	qrs. lbs.									
Straw . .	1	3	1 21	1	11	2 3	0	8	0 10	2	6	11	3	3	0	0	16	1
Total value of corn and straw . .										15	14	6	19	14	8	4	0	2
Cost of nitrate on the ground																1	3	0
Net profit on the nitrate per acre .																2	17	2

This result satisfactorily proves that the nitrate of soda used on the stone-brash, in good heart, produces an abundant wheat-crop, though the risk of injury by weather, from over-luxuriance, seems increased. Still, making every allowance for actual injury in this case, and for the outlay, the increased value of the produce gives an ample profit in 2*l.* 17*s.* 2*d.* an acre—a sum nearly double the rent of much of the adjacent land of similar quality.

But then comes the question, does it exhaust the soil? The answer must of course be found by experiment and observation in future years; but in the mean time I know—and it is one of the many advantages of *weighing* and *measuring*—that I have 2*l.* 17*s.* 2*d.* an acre in hand towards reinstating the land if injured in its previous condition—the worst come to the worst, a considerable sum in the way of security against risk of loss from exhaustion of soil. But it is more than probable it will never be required for that purpose, and will remain for future purchases of nitrate of soda, for I shall not hesitate to pursue a practice which experiment, or rather experience, seems so fairly to justify.

It is but right, however, to add that similar experiments which I have made on grass and swedes, neither as experiments nor as to result, were as satisfactory as could be wished. On the contrary, as far as they go in result, they lead to the conclusion that, *as* applied here and *on this soil*, the practice would be anything but profitable.

* If the inferiority of sample, and consequently large excess of tail-corn, where the nitrate was used, is due to the mildew, and it had not occurred, the result would have been much more favourable. Taking the same proportion of tail-corn on the 43 bushels 2 pecks 11 pints as on the 33 bushels 2 pecks 6 pints, and setting both samples at the same price, viz. 8*s.* 3*d.*, the net profit would have been 3*l.* 13*s.* 5½*d.* instead of 2*l.* 17*s.* 2*d.*, and event his sum would have increased still farther if the nitrated wheat had ripened as well and full as the other.

An ingenious young friend of mine, accustomed to chemical analysis, has been kind enough to examine the two samples of wheat with great care and skill. He states that 100 parts of each gave the following products:—

	Wheat on which the Nitrate was used, gave	Wheat on which no Nitrate was used, gave
Bran	25·	24·
Gluten	23·25	19·
Starch	49·5	55·5
Albumen	1·375	·625
Extract	·375	·25
Loss and water . .	·5	·625
	100· parts.	100· parts.

This result is interesting and gives a somewhat different, though not less favourable, view of the use of the nitrate. It will be seen that the first sample contains 5 per cent. more gluten and albumen than the second, at the expense of a slightly greater proportion of starch—viz., 1 per cent.

Now as gluten and albumen contain nearly 16 per cent. of nitrogen, and are the only component parts of the grain of wheat in which it is to be found, their existence in excess in the nitrated wheat is clearly to be traced to nitrogen in the food of the plant; but whether derived entirely from the nitrate itself, or in part from the ammonia given off by the more rapid decomposition of other manures in the soil caused by the soda, admits of some doubt, and is a question which, if not already set at rest by the researches of physiologists, calls for their attention; for the answer would probably afford much of the information required as to the exhausting properties of these salts. In the mean time, whatever may be its *modus operandi*, the above experiments seem to establish that the nitrate of soda increases the gluten and albumen in the grain of wheat, and we may now consider some of the advantages and disadvantages of such an effect.

These substances, which, as such, are alone common to the animal and vegetable kingdom, and seem, indeed, to partake rather of the character of the former than of the latter, are believed to be more nutritious than any other vegetable products. Sir H. Davy says of gluten, that it appears to be one of the most nutritive of vegetable substances, and that wheat seems to owe its superiority to other grain to its containing gluten in larger quantities. In his analysis of wheats he gives gluten as varying from 19 to 24 per cent.

Professor Liebig, of Giessen, in his late work on "Organic Chemistry," says that "the meal of Alsace wheat contains, according to Boussingault, 17·3 per cent. of gluten; that of wheat grown in the Jardin des Plantes, 26·7; and that of winter wheat, 3·33." He alludes also to one—the produce of an animal manure, which yields the maximum of

ammonia, as actually giving 35·1 per cent. "Such great difference," he adds, "must be owing to some cause, and this we find in the different methods of cultivation. An increase of animal manure gives rise not only to an increase in the number of seeds, but also to a most remarkable difference in the gluten they contain." Sir H. Davy also says that it abounds in wheat of warm climates, and that the wheat of the south of Europe, in consequence of the larger quantities it contains, was peculiarly fitted for making preparations of flour in which a glutinous quality is considered as an excellence.

The coincidence would be curious if the excellence of Neapolitan macaroni made from wheat growing on a volcanic soil were to be traced to nitrates found in the soil, though, as fermentation and decomposition go on so much more rapidly in warmer climates, the nitrogen of the ammonia evolved is probably sufficient to account for the glutinous character of the wheat in such situations. Sir H. Davy says also that the gluten in wheat, being in larger quantity than in other grain, seems to form a combination with the starch and water which renders wheaten bread more digestible than other species of bread.

Bread in its formation takes up and consolidates one fourth of the water used. A sack of Italian, Sicilian, or Russian (Odessa*) flour, when tough in kneading, or, according to the baker, "*full of proof*," or gluten, takes up in consequence from five to six gallons more water than a similar quantity of British flour, and makes in consequence from four to six more quartern loaves. When the wheat in England is not well harvested it is frequently necessary, in order to make a loaf which will "stand† up in the oven" and sell, to mix with it flours of the above description. The experienced dealer who valued my sample of nitrated wheat at once recognised its resemblance to Russian, and its bran, when subsequently shown him, he said to be from foreign grain of the south.

Starch is perfectly white, while albumen, the same substance as white of egg, is of a greyish colour, and gluten by exposure to air becomes brown. The flours called "fines" and "extra-fines" are made from Dantzic wheats when to be had. I am not aware of the exact proportions of their ingredients, but from their whiter colour, and their taking up in the formation of bread less water than wheats from the south, they must contain more starch and less gluten and albumen. Our British wheats used also for fines and extras, in which the former is known to abound, are also whiter; and as articles of luxury, it is true that the whiter wheats bring a higher price. But flours from the south, from containing more gluten, are browner, and seeming to be less well dressed than they are, and to contain more bran than they do, sell at a lower price; still they go farther and make a more wholesome and nutritious bread. The intelligent labourer, who bakes his own bread from "seconds," knows this well; it keeps him better up to his work than whiter flours.

In selecting their purchases, it is well known that some corn-dealers,

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* I have lately had some of this Odessa flour analysed. It gave 31 per cent. of gluten.

† It is the gluten in wheat-flour which causes the "rising of the dough;" the carbonic acid gas disengaged by fermentation and detained by the viscid gluten distends and converts the heavy tenacious paste into a light spongy loaf.

and millers especially, chew the samples till a stringy, Indian-rubber-like substance remains in the mouth, the quantity of which is their measure of value. This, though unknown to them, is gluten, and obtained by a process not very unlike that recommended by Sir H. Davy, who says that the flour should be made into a paste, which is to be cautiously washed by kneading under a small stream till all the starch is carried off.

Thus it seems, then, that the nitrate not only gave an abundant crop, but that the quality, though suffering from accidental injury, when tried by chemical tests was by no means as inferior as its appearance indicated; that, in fact, the flour, containing 5 per cent. more of the most nutritive and wholesome of vegetable substances, would make a greater proportionate quantity of bread, and that, resembling in those qualities the foreign grain of warmer climates sometimes required for peculiar purposes, it may occasionally supersede them. If on future trials these facts should be borne out, and particularly if it should be established that a large proportion of the nitrogen, to which the increased quantity of gluten is owing, is directly afforded by the nitrate, and not by other substances decomposed by the alkali, it cannot be doubted that the use of this manure on wheat will confer an essential benefit on the farmer and the public; and even should the latter be its mode of operation, it by no means follows that its use may not be attended with much advantage. At all events, the experiment is not without its interest in pointing out chemically the application of one of those manures which supply directly or indirectly the component parts of the plant. On this point generally, and particularly on the effect of ammonia arising from the decay of animal and vegetable manures, and the assimilation of its nitrogen in the plant, the work of Dr. Liebig, cited above, gives much interesting information. He makes it quite clear that the quantity of gluten and albumen will augment when the plant is supplied with an excess of food containing nitrogen; but he is not quite so satisfactory in his reasonings as to the source of that nitrogen. Drs. Turner and Thomson think that soluble salts are directly absorbed and assimilated as such by plants; and the latter supports this view by the very conclusive evidence that plants near the sea contain soda and common salt, and inland plants potash: that phosphate of lime is a constant, and phosphate of potash a very common, ingredient in vegetables—*nitrate of soda in barley*, and nitrate of potash in nettles and the sunflower. He states that experiments made with peculiar salts promote vegetation in peculiar plants—cites Duhamel as proving that sea-plants require common salt, and languish without it, and Bullion as having made seeds of the sunflower grow on a sandy soil containing no trace of nitre, which on examination gave no nitrate of potash, but that the salt made its appearance as usual when the plants were watered with a weak nitrous solution.

These, and a variety of experiments of a similar sort, lead to the conclusion that the nitrate dissolved in water is taken up, and is in itself a part of the food of the plant—a fact which to a certain extent accounts for its luxuriance without any exhausting effect on the soil. Still the circumstance that the alkali might be disengaged and decompose more rapidly other manures already in the soil, together with the opinion held by

some practical men of the exhausting effect of these salts, prevent a perfectly unqualified decision on the subject. I regret that by accident my unnitrated wheat was disposed of before the two samples were compared by the test of incineration. The case in point would have superseded all argument by analogy.

The experiments which are the subject of this paper were carried on, and the practical part of them, though not in writing, have already been detailed to the Farmers' Club at Gloucester, for the purpose of drawing the attention of the farmer to the simplicity and many other advantages of a fairly made and circumstantially recorded experiment; for after all, it is by the accumulation of isolated facts—the results even of such trifling experiments as those reported above—that the science of agriculture can alone be advanced. As an art, the oldest of all and the most universal of all, it is still at this day *more* the work of empiricism, and *less* that of induction, than any other. Since the time when the Board of Agriculture turned the attention of Sir Humphrey Davy to the pursuit, how little has been done *in this country* to advance it to the rank of a science! From his time to the present, with one or two exceptions, no very important step has been taken in that direction. It is true, the process of experimenting and storing up results is necessarily a slow one. The Board of Agriculture did much in their liberal encouragement of Davy. The useful work on Organic Chemistry, by Professor Liebig, though a foreigner, is owing to the British Association for the Advancement of Science; but the Royal Agricultural Society opens much brighter prospects.

Remarks of so general a nature I should scarcely have presumed on, did I not find that others far more entitled to consideration have not thought them unnecessary, and were they not intended to preface a practical suggestion which I venture, with much deference, to offer for the consideration of the Committee of our Society. Might they not draw a list of a few of those experiments which they deem most interesting, and each year submit two or three for trial to the members? They might even, to insure uniformity of purpose and accuracy, prescribe the scheme for the conduct of each experiment; and surely there are many of the most competent in the country who would bring their zeal and skill to bear upon the point suggested.

The advantages to be expected are numerous, and far exceed those of any single experimental farm. A number of independent gentlemen would be induced to employ themselves on an interesting and useful subject, who, having no particular system to uphold, would have no bias to anything but an accurate and true result. Such experiments would be conducted contemporaneously, and under the influence of the same season, but on different soils. Even in detail you would check earlier than is done at present the adoption of much erroneous and unprofitable, and encourage that of much improved and profitable, practice, while by degrees you would acquire a store of facts which could not but form, sooner or later, the groundwork of a very general and extensive improvement in our agricultural system.

W. H. Hyett.

Painswick, Gloucestershire, Nov., 1840.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

I.—*On some Varieties of Wheat.* By Sir Charles Burrell, Bart., M.P.

Having been requested by Mr. Pusey to send some account of several kinds of wheat sown on my farm, I beg to forward the following results of produce at the last harvest, calculated, according to his wish, from half-acres, premising that considerable disadvantage arose, first by the very untoward season of 1839 for sowing (and for drilling especially), and again by the ill effects of heavy rain and wind when the wheats were in bloom in this part of Sussex, which injured them considerably.

1.—Browne's Prolific ten-rowed white wheat yielded 15½ bushels to the half-acre.

The straw was abundant and long, the sample middling and inferior to the seed sown, having been much injured at blooming time by rain and wind; but our opinions are not changed as to the general productiveness of this wheat.

2.—Hunter's white wheat, the seed obtained from Mr. Prime, M.P., yielded 15 bushels to the half-acre.

The straw was sufficient, but the grain not quite true. This defect, it is hoped, will be remedied by drawing it with care. This wheat also was much injured at blooming time.

The following sorts were obtained by favour of Col. Le Couteur from Jersey.

3.—Col. Le Couteur's seedling yielded 14 bushels to the half-acre.

The straw was slight and short; the grain very true, but not so good as was expected from the sample of seed sown: it had been injured at blooming time.

4.—Dantzig white wheat yielded 13 bushels 1 gallon to the half-acre.

The straw was abundant, the sample coarse and indifferent: the seed has not been used again.

5.—Bellevue Talavera yielded 18 bushels to the half-acre. The straw was abundant, but the plant thin on the ground, having been dibbled in December last, and much beat about by bad weather before it was ripe. The sample was lean, but of good colour; and all that could be spared was eagerly purchased by neighbouring practical farmers.

Summary.	Bushels per Acre.
Browne's Prolific . . .	31
Hunter's White . . .	30
Le Couteur's Seedling . .	28
Ditto White Dantzig . .	26
Ditto Bellevue Talavera .	36

These wheats were grown upon a clay soil, which has been well drained by Pearson's draining plough, at 8½ feet distance, to the depth of 2 feet.

Knepp Castle, Horsham.

II.—*On a Productive Variety of Wheat.* By Robert Blyth Harvey, Esq.

To the Secretary.

Dear Sir,

I deferred sending you a specimen of my wheat until I had threshed the crop, and could inform you of the produce. It is not, as I believe, a new variety, but an old stock improved by careful cultivation; the circumstances attending which are somewhat singular.

About four years since, a neighbouring farmer discovered a single blade of wheat in his garden, which he carefully tended, but how it came there he has no knowledge. It might have been casually dropped by some person on the premises, or brought there by birds. The produce was enormous. I dare not trust my memory with the number of ears, or the kernels in them, but the total quantity was greater than I ever before heard of. Last year I procured 8 pecks of him, 2 of which I mixed with 5 or 6 others of the most approved varieties in this district; but the ears of this were larger and better filled, and the straw longer and stiffer than any of the others: the remaining 6 pecks I had dibbled, on 1½ acre of land (clover-stubble), by the side of 2 acres of Whitington and 2 acres of another white wheat, all at the same rate of seed,—viz. 4 pecks per acre. The red wheat was on the best land in the field, and the Whitington on the worst; and I should have expected, with the same wheat, 4 bushels per acre more where the red wheat grew: the produce of it however exceeded either of the others by more than 12 bushels per acre. It did not suffer in the least from disease; whilst both the others were slightly mildewed, and very much affected by the red gum: neither was it rootfallen or broken down by the wind, like the others. The produce of the 1½ acre was 9 qrs. 5 bus. of best wheat, and nearly 3 bushels of dross. Had it not been dressed rather higher than usual for seed, it would have exceeded 10 quarters! The above is all the information I can give you about the wheat, which has no name: perhaps Colonel Le Couteur, who I observe is one of the *curators* of your Wheat Museum, may know its species, and name it accordingly. It most approaches in character, both of berry and straw, to what is here called the Copdock Red; originally, I believe, an Essex wheat.

Yours faithfully,
Robert B. Harvey.

Harleston, Norfolk,
Oct. 14th, 1840.

III.—*On the Marquis of Tweeddale's Tile-making Machine.* By James Hunt, Esq.

The machine invented by the Marquis of Tweeddale is on the simplest construction, and may be described as follows:—A trough is made at the head of the machinery of the exact width of the intended tile. Into this the clay is placed by a workman, and is drawn through two

revolving cylinders, compressing it with great force, so as to give it a consistency and firmness unattainable by hand labour.

The clay thus flattened by the rollers is drawn forward by the machinery on a web of canvass, and passed through moulds which give it the exact shape which it may be required to bear, when it is cut off, by a very simple process, at any length which the maker may desire: thus, every tile being pressed in precisely the same manner, passed through the same moulds, and cut off at exactly the same length, they all obtain a uniformity of size and construction which is not to be attained to a similar extent by any other manner.

The tile, being thus made, is carried away by an endless web passing over rollers which are turned by the same machinery that makes the tile, and thus travel of their own accord without the labour of carriage, between the sheds erected for their reception, in which they are placed in rows on either side by labourers stationed for the purpose.

By these means four or five men can in a day make with ease from 8 to 10,000 tiles, all of uniform shape, size, and consistency, and when formed of good clay and properly burnt attain almost the durability and firmness of stone. It may indeed be safely affirmed of them, that if properly planted in the soil they would last almost for ever.

Nor is durability after the tile is laid down the only advantage in its construction; for all who have used the tiles made by hand will have experienced how great a loss arises in the breakage occasioned by their carriage from the tile-yard to the spot where they are to be used, as well as by the labourers employed in putting them into the ground; increasing their cost often as much as ten per cent., which loss falls entirely on the consumer.

The patent for the manufacture of these tiles has been assigned to a company whose object is to introduce it extensively throughout the kingdom: possessed of large capital, they have the means of erecting the most efficient working establishments, and of producing tiles of superior qualities at a cost much under the average market-price, and they are prepared to establish works on the estate of any landowner whose consumption of tiles, coupled with the demand of the neighbourhood, is sufficient to justify the necessary outlay for building sheds, kilns, &c., and to manufacture the tiles at a price to be agreed upon; or if works are at present in operation, the company are willing to become the tenants of them, paying a fair rental for the buildings and a royalty per thousand for the clay.

They have at present establishments working at Strathfieldsaye, Hants; Broom Hill, near Alnwick; Sandon Bank, near Stafford; Thatcham, Berkshire; Hanwell, Middlesex; Chippenham, Wiltshire; Brixton Hill, Surrey: and are proceeding with the erection of others at Reading; Hull; Howden, Yorkshire; Coldstream, Berwickshire; Windsor Great Park, for Her Majesty's Commissioners of Woods and Forests.

The price of the patent tiles varies with the cost of fuel, &c., but the company have found no difficulty, where the demand has been considerable, in supplying them at a reduction in price varying from 10 to 20 per cent.

They are 15 inches in length, or about one-fifth longer than those usually made, and of various sizes, to suit the views of purchasers, with a sole or flat tile at bottom, on which it rests,—this mode of laying tiles being found far superior to any other in the efficiency and permanence of the drain formed by it, and by the exclusion of all vermin, which, if they find a means of burrowing under tiles laid on the ground without a sole, produce incalculable mischief.

James Hunt.

10, *Whitehall, London,*
Nov. 19, 1840.

IV.—*On the necessity of Care in the Preservation of Agricultural Implements.* By W. Crosskill.

As the cost and wear and tear of agricultural implements have now become a serious consideration in the farmer's outlay, and as other improved implements, both of a local and general character, may be expected shortly to be brought into use, it must surely be deemed a point of importance to render this item of expense as little burdensome as possible. In order to accomplish this I would advise farmers to bear jointly the expense of such implements as are only required for particular seasons; but more especially to contrive by care and good management to make the implements as durable as possible. To effect this, might not every farmer have a suitable shed, that would admit light and air, with a clean hard floor, the walls being whitewashed every year; within which building each implement should have its proper place?

When the ploughs are done with, let them be washed and put in their proper places; let the same be done with the drill, and so on with all the machines on the farm. The cost of this will be trifling, compared with the advantage. In order to effect it, select the most likely agricultural labourer upon the farm; put the implements under his care; make it a strict rule with all the men that each implement done with for the season shall be brought to one particular place, say near the pond or pump; the man having charge of the implements must then wash and clean them well before putting them into the shed, and at a convenient time, when not otherwise engaged, or in weather when outdoor-work cannot be performed, get them repaired and paint them. At the end of this shed, or implement-house, there might be a lock-up workshop, with door to open into the place, with a few tools, paint-pots, &c., the expense of which would not exceed 5*l.* The man should be encouraged to make his duty a pleasure, and to feel a pride in showing his master's implements in fine order.

The waggoner might be the most proper man to be the *farm mechanic*, and he would also have the opportunity of getting what he wanted when at the market-town.

Beverley, Yorkshire, July 11*th*, 1840.

XVIII.—*A View of the past and present State of Agriculture in Northumberland.* By John Grey, of Dilston.

In endeavouring to comply with the request conveyed to me by Earl Spencer, from the Journal Committee, "that I would give some account of the present state of agriculture in the best districts of Northumberland," it may not be unprofitable to occupy a little time in taking a hasty retrospect of the state of this part of the country, which continued in a great measure wild and uncultivated so late as the beginning of the last century, when peace and industry had produced their happy effects in the improved appearance and increased productiveness of the more southern provinces of the kingdom. And if it should excite surprise that large districts, which even within the last eighty years were in a state of nature, covered with broom, furze, or rushes—the indigenous productions of the soil; which were the latest in attracting the attention of the husbandman, and experiencing the benefit of his skill and industry, should in the interval have outstripped those in the march of agricultural improvement which had been for centuries in a course of cultivation; the fact may perhaps be in some measure accounted for by the existence of the very circumstances which at first sight seem unfavourable to such a result. Agriculture had begun to experience considerable encouragement and to make considerable progress in different parts of England, while the country on both sides of the Scottish borders continued to be the scene of rapine and violence—of hostile incursions and of predatory warfare. Such a state of society afforded no security for life, and no protection for property—the fruits of industry were too uncertain and precarious to induce to its exercise in the cultivation of the soil, and the habits and dispositions of the people were little fitted for the task. Nor did they for a long time after that blessed union had been effected, which put an end to the state of hatred and hostility which existed between the two countries, and which has contributed so essentially to the happiness and prosperity of both, betake themselves to settled and industrious habits.* They lived in houses of the

* Such was the state of society in the part of the county traversed by the Roman wall that those great antiquaries, Sir Robert Cotton and Mr. Cambden, were deterred from following its course in the year 1600, as stated in Cambden's own words:—"From hence the wall bends about by Iveston. Forster and Chester on the wall near Busy-Gap, noted for robberies, where we heard there were forts, but durst not go and view them for fear of the Moss-Troopers." And Warburton, who was Somerset Herald to George II., and published his "Vallum Romanum" in 1753, says, in reference to the same subject, "such was the wild and barren state of this country, even at the time I made my survey (1715), that in those parts now called the wastes, and heretofore the debateable grounds, I have frequently discovered

meanest description, and the accommodation supplied to their cattle was scanty and inconvenient. The country remained generally uninclosed; and the part on which they bestowed cultivation, such as it was, consisted of small crofts adjoining their dwellings. The plough then in use is described as a clumsy and inefficient instrument; and the harrow was constructed without joints and without iron, of branches of the mountain-birch, fixed together with wooden pegs, with tines of the tough broom,* which it was the business of the husbandman to sharpen or renew by help of his clasp-knife, while his unshod cattle, yoked by hempen traces, were turned off to regale themselves upon the neighbouring waste. The rent then paid consisted of a contribution in kind from the produce of the land and in personal service. Such was the state of things in the border counties at a period when the fields of "merry England" were already divided by luxuriant hedge-rows, and yielded their annual harvests to the cultivator's toil. But this apparently unpromising state of things contained within it the seeds of a rapid improvement, and the growth of a system of agriculture, approaching probably as near to perfection as any that this country at present exhibits. Habits of domestic peace and industry gradually succeeded those of broils and discord. The open country, hitherto undrained of its fertility, offered a tempting field for the exercise of skill, industry, and enterprise. But few inclosures of inconvenient size, and fences of wasteful dimensions, stood in the way of laying out and dividing farms into fields of approved size and convenient arrangement; and what is of still greater importance, perhaps, few of those customs and prejudices were to be overcome and uprooted which too frequently impede the introduction of improvements among the occupiers of anciently cultivated districts. Cultivation continued gradually to extend itself: an improvement took place in

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the vestiges of towns and camps that seemed never to have been trod upon by any human creature than myself since the Romans abandoned them; the traces of streets and the foundations of the buildings being still visible, only grown over with grass." And it is certain that it was not till after the accession of George III., in 1760, that the King's writ might be said to run throughout the county.

* The now highly-cultivated Vale of the Till was in former days much covered by broom—the classic "Planta Genista" which gave the name to the powerful dynasty of the Plantagenets. "In the beginning of the 16th century a body of Scots, who had concealed themselves in the tall broom in Milfield Plain, were attacked and defeated by Sir Wm. Bulmer, of Brancepeth Castle, who commanded the forces of the bishopric of Durham. 500 or 600 of the Scots were killed, and 400 taken prisoners."—(History of Northumberland.) And a story is told of a farmer in Milfield, eighty years ago, who lost a mare for some weeks, which at length emerged from the forest of broom followed by a foal. Tines of broom and other kinds of wood are used in some parts of Holland at this day.

the farm-buildings and offices, but still great tracts of land were not brought regularly under the plough, most farms being divided into what was called the *infield* and *outfield* land; the former being subjected to a severe course of cropping, with very inadequate cultivation; the latter left to its native produce as a pasture for sheep and young cattle, or if choice portions of it were occasionally broken up, it was to rob it of its fertility by the production of a succession of corn crops, and then to leave it to recruit itself by several years of pasture. But it was not till about the middle of the last century that the rapid and spirited improvement in the agriculture of Northumberland began to show itself, from which we must date the era of its present advanced system.

Men of intelligence, activity, and industry were attracted from other quarters to settle in the fertile vales in the northern parts of this county, of whom none bear a more distinguished name in the annals of agricultural improvement, or are more deserving of the praise and gratitude of their countrymen, than the late Messrs. Culley. These able men, who had traversed the provinces of the land which were considered to possess the most approved modes of husbandry and the best descriptions of stock, migrated in the year 1767 from their paternal property on the banks of the Tees into the district in Northumberland called Glendale, carrying with them superior knowledge and intelligence, which they brought at once to bear in their extensive undertakings with unremitting application and perseverance. The example set by these and other energetic and spirited agriculturists, together with the signal success which attended their exertions, gave a stimulus to the surrounding district, and in a few years the inexpert operations and languid system of husbandry which had previously prevailed gave place to others of extraordinary expedition and efficacy. The owners of property too, fortunately for themselves, for the cause of improvement, and the benefit of the country at large, co-operated with their spirited tenants in the great work which was in progress, by giving them farms of such size as to afford scope for their operations to be conducted with economy and effect, and for such length of lease (not less than twenty-one years) as afforded the guarantee of a return for their outlay and industry. Without the security and inducement to expend capital, which leases afford to tenants, such a rapid change as that we are contemplating never could have been effected. The growing of turnips had been introduced partially and upon a small scale, sown broadcast and hoed by gardeners, for several years before; but it was not until between the years 1760 and 1770 that the system now in universal practice of sowing them upon raised drills, with manure well prepared and applied immediately below the plants, afford-

ing at once the largest produce at the least expense, with by far the most effectual working of the land and removal of weeds, was commenced by that intelligent agriculturist, Mr. W. Dawson, on his farm in Roxburghshire, and ten or twelve years more elapsed before it came into general use on the borders.* The prevalence of turnip-growing in the place of naked fallows, or crops of peas full of weeds, together with the use of artificial grasses, which was introduced about the same time, made a complete revolution in the management and value of land, and added immensely to the productiveness of the country. The money which was made by farming was again eagerly applied, under the encouragement of leases, to the reclaiming of waste lands and the promotion of agricultural improvement. Section after section of the *outfield* lands, so called, were brought into productive cultivation; the sober labour of the flail became too slow a process for the increased produce. Threshing machines, worked by horses or driven by water, and sometimes by wind, became general, although in our days the latter fickle and uncertain power has been universally superseded by steam; comfortable and substantial farm-houses were built, and commodious sets of farm-offices, laid out upon regular and compact plans, were erected in central situations, with roads diverging from them so as to give the easiest access to all parts. The gradual increase of rents after the termination of the unfortunate American war in 1783, encouraged landlords in the outlay necessary to effect such substantial and permanent improvements; an increase in the demand for labour in manufactures, in the rate of wages, and in the population, all tended to an advance of the farmer's profits, and a consequent increase of the competition for land and of the rents offered for it. And when the war arising out of the French Revolution, with the extraordinary expenditure and unprecedented issues of paper-money attending it, were in full operation, producing, if not real wealth, yet something which for the time stood in the place of it, the rents of farms which fell out of lease from the year 1795 to 1805 were advanced frequently three, and in some cases fourfold. Then it was that the last great impulse was given to the already rapidly improving system of Northumbrian agriculture. The farmers found themselves in possession of abundant capital, with habits, energy, and capacity for the greatest exertions; the last re-

* It is stated in Bailey and Culley's Survey of Northumberland in 1797, that Mr. Pringle, formerly a surgeon in the army, who had an estate near Coldstream, was the first person in these parts who cultivated turnips in drills, in 1757, which he made 3½ feet wide, and that he had taken the idea from Tull's book on Husbandry. And that Mr. Dawson, who entered upon the farm of Frogden, near Kelso, in 1762, adopted the practice, trying drills of various width, and deciding upon those of 30 inches, as best suited for horse-hoeing and for producing a full crop.

maining portions of land which were by any means accessible to the plough were put in requisition; large stones were dug up and removed from the sides of mountains to procure an arable surface; bogs were drained, and lands hitherto open and unproductive were inclosed, and, by the application of lime and good husbandry, made to wave with golden harvests. Reductions of rent, failure of tenants, and change of occupancy, were the effect of subsequent events; but still the system of agriculture, which a time of unexampled prosperity produced, has been maintained, and a substitute has even in a great measure been found for the high prices of the war, in the increased produce obtained by recent improvements, such as the use of bone manure, extensive and systematic draining, subsoil ploughing, and a somewhat better understanding of the application of animal and vegetable chemistry to agricultural objects, or, in other words, the combination of the science with the practice of agriculture. The grand desideratum, however, of basing the practice of agriculture upon scientific principles, it must be confessed, has as yet made but small progress. To effect that important end, the culture of the mind must precede that of the land; and although the farmers of the district now under review, holding large tracts of land, and possessed of great capital, have received a more liberal education, and are more distinguished for intelligence and information than many others, yet the daily occupations of the practical farmer, as such, are in no way favourable to scientific research and intellectual attainments. We must look to other quarters for the consummation of this great object; and happily a new era is opening upon us, and brighter prospects are rising to our view: the great and influential of the land have engaged themselves in the work. This most important branch of our national industry, and source of our national prosperity, is no longer to be left for its advancement to the chance-directed discoveries of the unlettered rustic. When wealth and intelligence lead the pursuit, and call the resources of knowledge and science to their aid, it is not unreasonable to expect that sources of fertility and productiveness, as yet unknown, will be developed—that the practice of agriculture will be founded upon principles which, though in strict dependance upon philosophic rules, shall be rendered familiar to the understandings of "the rough-shod race," whose stolidity has hitherto been subject of proverbial reproach with the learned; and that agriculture shall take the stand among the sciences, to which it is so justly entitled, as well by the great interest which attaches to it as by the immense national importance which it possesses.

Having hastily traced the progress of Northumbrian agriculture from the most imperfect to its present advanced state, it re-

mains to show in detail what the practice is in the best districts, which I understand to be the object required. And at the commencement it may be necessary to specify which those districts are, and why they are entitled to a preference over the others. The county of Northumberland, as is well known, consists in great measure of mountain pasture and of bleak unprofitable moors; while the vales, beautiful and fertile as they are, by which these mountains are intersected, and the level country on the coast, form but the exception to the general rule. In the southern part of the county, the valleys of North and South Tyne, with others branching from them, and also that of the Wansbeck, contain land of excellent quality, and afford many specimens of superior husbandry; but in general the farms are on too small a scale, and their occupiers too limited in means, to entitle them to a place in the list of those distinguished agriculturists who occupy extensive farms in the highly-cultivated districts of Glendale and Bambrough Wards. The Vale of the Coquet, too, is fertile and well cultivated; but in pointing to the parts of the county to which the following remarks must be understood especially to apply, I would take the line along the base of the Cheviots, extending from Whittingham by Wooler to the banks of the Tweed, as a district universally adapted to and occupied in the turnip course of husbandry; and that along the coast from Warkworth to Berwick, as being of a stronger and heavier quality of soil, and more generally fitted for the growth of wheat and beans, intermixed however with many portions of fine turnip loam and of rich grazing pasture; in other parts of the county which are not included within these limits, good farms and good culture are to be found, and the same system prevails, though with certain modifications, throughout.

It will be necessary to treat of the two districts specified above, separately; but as the tenure on which farms are generally held is a subject common to both, I shall begin by observing that the custom prevails generally of letting farms upon *leases* for twenty-one years, a custom which has tended very materially to increase the value of property to the owner, and to produce the high state of cultivation which is found to prevail in an especial manner in the district extending from the source of the Till to the Scottish border at Carham on the Tweed, comprising many excellent farms, varying in annual rent from 500*l.* to upwards of 2000*l.* The fall of rents and the dissatisfaction or change of tenants after the year 1815, together with the apprehension of still farther changes, had the effect of curtailing the length of leases in many instances, but still on the best estates and largest farms the term of twenty-one years is adhered to; on others, where less capital is to be employed, and where few extensive im-

provements are contemplated, the term of fifteen years has been adopted, which is very suitable for farms where the five-course rotation prevails, as giving the tenant three full courses over all his land. Some few exceptions do exist, and those in high quarters, to the granting of leases; but wherever this is the case, the lands bear evidence of the evil, by the obvious absence of the spirited and improved style of management which other parts of the county exhibit; buildings, fences, and roads are found neglected and disorderly. The crop of the present year may be cared for; but every outlay, the remuneration for which would only be received in future years, is avoided; and lands which grew rushes fifty years ago are growing rushes still. With the exception of church-lands, where all things conspire to their stationary sterility, estates held by annual occupancy partake least of the advance in agricultural improvements, make the worst returns to their owners, and contribute in the smallest degree to the welfare of the country. There are but two sources from which the outlay needful to effect extensive, or indeed any improvements, are to be derived—those of the landlord and of the tenant. If undertaken by the landlord, except in conjunction with the tenant, it requires little sagacity to anticipate the jobbing and waste, as well as the inefficient execution, which the absence of due vigilance and personal attention will engender; and if by the tenant, whether alone or aided by his landlord, it is obvious that he must be secured in his possession for such a term of years as will afford him the prospect, upon a fair calculation, of being remunerated for his expenditure, time, and attention. It may seem that I have dwelt at unnecessary length upon this head, but my apology is to be found in the importance which I attach to it, believing as I do that to the custom of letting land on long leases, more than to any other cause, though of course in conjunction with other causes, this county is indebted for its rapid improvement and high state of cultivation.

The size of farms in Glendaleward is various, but they are generally of considerable extent, ranging from 300 or 400 to 1000 or 1200 acres; and in cases where the tillage-land at the foot of the Cheviot range is held in connexion with mountain-pasture, farms may be found to contain 2000 or 3000 acres. This is perhaps, of all others, the kind of occupation which possesses the greatest variety and interest, and is attended with the least risk. Upon strong lands, if the wheat crop should fail, or the prices be low, the farmer has little else to rely upon for his rent and expences, and therefore it is a bad year with him; but, in the case in question, the arable land is fertile, and the mountains supply sweet herbage and healthful pasture for sheep—the low grounds fatten the flocks which the high lands rear; and instead of de-

pending either exclusively upon the sales of live stock or corn, the farmer is in possession of both, with a large parcel of wool of superior quality. In no county, perhaps, has the introduction and cultivation of turnips added in an equal degree to the produce of the land as in this; and in few, probably, are the alternate systems of grazing and tillage made to work together with greater advantage. In former times, a large portion of the pasture-land was preserved uneaten during a great part of the summer for the use of the sheep-flock in winter; which, with the aid of a little hay, was brought through in poor condition. To produce hay for this purpose, and for horned cattle and horses, occupied another portion of the grass-land, so that little stock, comparatively, could be kept; nor could it be fattened in the district—the practice being to sell the disposable stock in the autumn, to be driven into Yorkshire and other counties: but now that one-fifth of the tillage-land is annually producing fine turnips, little hay is required for sheep; a far greater number of sheep is produced, and the district is capable of fattening in the winter a large portion of the stock that is reared. At the same time, the produce in corn, in consequence of the extra quantity of manure arising from a full stock of cattle, the superior state of the land from the high culture bestowed upon the turnip-crops, and the richness imparted to it by consuming a large portion of them by sheep upon the land where they grow, has been increased in a degree almost incredible. It is difficult to obtain data to prove the real extent of this increase; but I happen to have one instance in point, for which I am indebted to my friend the present Mr. Culley, of Lowberry, upon which I can fully rely. The Messrs. Culley, of whom I have previously made mention, entered to the farm of Wark, which is situated on the southern banks of the Tweed, opposite to Coldstream, in May, 1786. The crop of that season, belonging to the preceding tenant, was valued over to them, as is common, at harvest, and was estimated at 15 bushels per acre for oats, and 9 for wheat. But the crop on the same farm, after being in Messrs. Culley's occupation for 15 years —some family arrangement having caused it to be valued—was estimated at 84 bushels per acre for oats, 62 for wheat, and 72 for barley: and it is reasonable to suppose that the increased value of the live stock and green crops on the farm would be somewhat in a similar proportion.* From this statement it ap-

* It ought to be observed, that this extraordinary crop was the produce of a favourable season, and of the best land in that district. From such information as I have been able to obtain, I should rate the produce of the Tweed-side lands, on an average of seasons, at from 28 to 36 bushels of wheat per acre; barley, 38 to 46; oats, 45 to 56. Mr. Thompson, of Scremerston, who is a very active and intelligent farmer, paying a rental of

pears that the great increase in the value of such lands arose much more from their improved cultivation than from the advance in the price of produce. The rent of this farm in 1786 was 800*l.*; it consisted of 1200 acres: it then rose to 1000*l.*; and in 1812 it was let for 3200*l.*; being just four times its rental in 1786. The estate of Pawson, in the same neighbourhood, which consists of good turnip-land and sheep-pasture, advanced within the same period from 560*l.* to 2140*l.* I have been obligingly favoured with the rental of estates of Earl Grey, some of which consist of fine turnip-soil and others of strong wheat-land, with a portion of grazing pasture. Seven farms of the former description produced, in the beginning of the present century, a rental of 5560*l.*; but, falling out of lease, were re-let for 12,057*l.*, the present rental, being an increase of 6497*l.*, or about 117 per cent. While six other farms, of strong land, under similar circumstances, advanced from 3925*l.* to 4642*l.*, giving an increase of 717*l.*, or 18 per cent.: which shows the great advantage of friable or turnip-soils over retentive and clay-soils, though of good quality and favourably situated, as are those in question, being near the coast. I have not had an opportunity of ascertaining the rental of these estates in 1786, as of those previously quoted, but apprehend it would not exceed one-third of its present amount. Others of Lord Grey's farms, which partake of a medium quality between turnip and strong land, have experienced a medium advance.

If the system of furrow-tile draining and subsoil ploughing should have the effect, as in some instances it has been proved to have, of converting strong and retentive into turnip-land, what an immense increase of wealth to individuals, and of produce to the public, might be obtained! With this view a large manufactory for draining-tiles, on the Tweeddale patent, has been established on the last-mentioned property; and the noble owner has, with the prudence and liberality which have always characterised him as a landlord, instituted an extensive process of draining at his own cost, for which outlay the tenants pay interest. In stating the great advance of income produced by land, it is proper to remark, that it has by no means been realised by the owners in the degree which appears upon paper; for, on every one of the farms referred to, a large expenditure has been incurred by the landlord, in buildings and other improvements, in some instances

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nearly 4000*l.*, gives it as his opinion that the average produce of the colder lands on the coast will not exceed 24 bushels for wheat, 30 for barley, 36 for oats, and 22 for beans. He also considers that the general produce of the district has increased from 20 to 30 per cent., upon lands let on leases of 21 years, since the year 1800. I am inclined to think that he states the average produce too low.

to the amount of several thousand pounds. The buildings recently erected on two of Lord Grey's farms cost 10,000*l.*, besides all carriage of materials, which was done by the tenants.

The following will show the rental of two detached portions of the Greenwich Hospital's property, at intervals of 20 years, from 1735 to the present time. Spindleston, in Bambrough Ward, 550*l.*, 620*l.*, 885*l.*, 2077*l.*, 3838*l.*, 3250*l.* Scremerston, 3 miles south from Berwick, exclusive of minerals and fishing, 302*l.*, 467*l.*, 775*l.* 10*s.*, 1560*l.*, 3405*l.*, 2912*l.* In 1735, and for long after, a considerable portion of this estate consisted of unreclaimed moor, and the highest rental here quoted was of short continuance, as some tenants failed, and others abandoned their engagements. The instance of the greatest reduction following a rapid rise of rent, that comes within my knowledge, is that of the farm of Grindon, which consists of 1480 acres: about one-third is good land, though rather wet; one-third tolerably good; and one-third very bad; but none of it very free turnip-soil, though made to grow turnips to a considerable extent. In 1786 the rent was 850*l.*, subject to tithes; in 1795, 900*l.*; in 1807, 2400*l.*; since which time it was reduced to 1600*l.*, and is now understood to be let at 1250*l.*; a proof that wet land is less in request than ever.

The lettings of other farms at different periods will show the fluctuation of rent; proving a rapid advance, though varying in degree according to the quality of the land and its previous state of improvement, and a subsequent decline.

	LETTINGS IN					
	1772-3.	1793-4.	1805.	1814-5.	1835-6.	1840-1.
	£.	£.	£.	£.	£.	£.
Newtown	450	750	..	1400	1150	1200
Turvelaws	340	550	..	960	830	900
Chillingham Barns—part of it clay	400	550	..	900	800	..
East Lilburn—turnip-loam .	360	800	1600	1200 including	1050 corn tithe	..
Wooperton—turnip-loam .	240	400	1200	800	800	..
Fenton Demesne—part wet and strong	350	500	..	600	600	..
Fenton Town Farm . . .	450	800	..	1600	1050	1050
Doddington, South . . .	..	750	..	1500	1200	..
Doddington, North . . .	..	1200	..	2000	1500	..
Horton—turnip-loam . . .	..	650	2000	1800	1715	..
Milfield; subject to all tithes.	250	..	900	..	800	..

The rotation of crops now almost universally practised on the turnip soils in Northumberland is,—

1st year after grass, oats.
2nd, turnips and a small quantity of potatoes.
3rd, spring-wheat and barley.
4th, clover and other grasses.
5th, pasture.

And in some cases, where land is of inferior quality or in a high situation, and where the rearing and feeding of stock are considered more profitable than the frequent repetition of corn, the land is kept in grass for 3 years before being ploughed out. Tempted by the high price of corn during the French war, it was not unusual for farmers to break up the grass-land after one year's clover; but that was found to be, after a few courses, unprofitable, as the clover by frequent repetition was apt to fail, and the land lost that freshness which is so favourable to the growth of turnips, upon the success of which the produce of the entire course so much depends. The soil, as well as the climate of this district, is peculiarly favourable to pasture; and while land is *resting*, as it is called, in grass during an interval of two or three years between the repetition of corn-crops, it is not only acquiring a fitness for producing them, by the fresh state in which it comes out again—the want of which even an extra quantity of manure would not compensate—but it is in the mean time paying its way as sheep-pasture. This effect, however, is by no means universal, and therefore the practice cannot be recommended without having experience of its result upon the peculiar soil to which it may be applied; for, in some districts in the south of England, and especially perhaps on those where chalk and flint prevail, the second and third years' grasses would not only be poor and unproductive, but the land would be less calculated to grow good corn than if it had been only one year in grass, and folded with sheep.

The Poland and Dutch oats were much grown on the best soils at the beginning of the present century, but are now almost entirely superseded by the potato and Hopeton varieties for the best lands, and the common Scotch and Angus for those of poorer quality and higher climate. The potato-oats produced in the district are said to be the best shown in the London market, frequently weighing 46 lbs. per bushel, and sometimes more: they are very short and plump in the grain, and very bright in colour, if got in a good season. I remember to have sent a cargo of this description, of my own growing, to Mark Lane, several years ago, expecting to obtain a high price for seed, but the merchants would not buy them for that purpose, asserting that they had been *doctored*—by which they meant, as I was told, subjected to a clarifying process upon a hair-cloth with sulphur burning below; a trick which they might understand, but I had never till

then heard of. Tartarian oats are grown partially on strong lands, but are not much in repute on the best soils, for, though productive, the grain is inferior and the straw coarse. Oats are commonly sown broadcast, on ridges of 15 feet wide; but, in some situations, where annual weeds prevail, they are sown in drills, and hoed. The season for sowing is in March and April; the quantity of seed varying, according to soil and grain, from 4 to 6 bushels per acre. They are reaped with the sickle, and tied up into sheaves immediately, as the best descriptions are liable to much waste, by shedding, if subject to be turned and handled.

The corn-crop succeeding the turnip fallow, and with which grass-seeds are sown, consists of spring-wheat and barley, in such proportions as the season and quality of the land render advisable. If one part of the turnip quarter be superior to another, attention is given to sow that first with turnips, so that it may be cleared at the earliest period for the wheat sowing; but if the quality of land does not materially differ, then it is desirable to alternate the crops, growing wheat this time where barley grew the last, and *vice versâ.* The season which is preferred for wheat sowing is the month of February, though it is often continued through the whole of March; and, when long-protracted snow-storms have prevented it, much has been, in some seasons, sown so late as the first week in April, and produced good crops. The kinds of wheat sown at this late period are much the same as in other districts are grown from autumn sowing—brown and white Kent, Burwell red, golden drop, Whitington, &c. &c. New varieties are often introduced under the attractive names of *nonsuch* and *prolific,* which on trial turn out nothing better, and probably not so good, as others that have been in common use, although, by help of a little puffing, they may serve for a time an individual purpose.

Spring sowing requires more seed than autumn, as the stems have less time to tiller. The quantity commonly used in broadcast sowing is 3 bushels, in drills about 2 bushels, per acre. This practice, which answers so well on turnip-soils in the north, has not, I believe, generally succeeded in the south of England; probably because, though long retarded in the north, vegetation is quicker when it comes, and that the greater heat and dryness of the atmosphere in the south have a tendency to shrivel and ripen the grain before it has come to perfection. This circumstance may in some measure account for the inferior quality of the oats grown in the south of England to those produced in the northern counties and in Ireland. Wheat is invariably cut with the sickle or teethed-hook, and tied up immediately. The operations of harvest are very different here from the method of the southern counties. The Northumberland farmer is continu-

ally in terror of those shake-winds which the vicinity of his native mountains occasions, and must guard against the heavy rains which often succeed them. He cuts his corn several days before the farmer in Kent or Surrey would deem it fit, and instead of leaving it exposed on the ground for days afterwards, his object is to get it as fast as possible into a state for resisting rain, and for standing till it is safe to carry it into stack; the practice of housing it in barns being here unknown. For this purpose he applies all his force (50 or 100 reapers, as it may be) to one plot, and marshals them under his own eye, placing in regular order two or three upon each ridge, according to their width; the centre reaper twists or knots a band of corn, which is laid in the middle of the ridge, and filled as they proceed. A binder follows each party or band of six reapers, ties up the sheaves as tight as possible, setting eight or ten of them in a double row, close at top and wide at bottom, which done he covers those with two other sheaves, in form of the ridge of a house; this is called a "stook," and, when skilfully set, these are often found, after many days of stormy weather, to have sustained little injury. This mode of working precludes the possibility of cutting by the acre, so that most of the harvest-work is done by day's wages, and in part by bands from Ireland and the Highlands of Scotland, who visit the county in great numbers at that season. It is cut very low in the district in question, about 4 to 6 inches from the ground; but I cannot commend the farmers in the south end of the county for following this good example, whose slovenly habit in this respect tends to a great loss of manure. Three reapers should cut an acre per day, on an average; and the wages, without food, are, for men, from 18*s.* to 20*s.* per week, and for women 15*s.* In the case of the Scotch and Irish, they are supplied with food by the farmer, and with blankets in barns and outhouses, and receive 12*s.* or 14*s.* per week. When fit to be stacked the corn is carried home, and built into round ricks, of such size as the threshing-machine on the farm can manage in a day if worked by horses, or in half a day if driven by water or steam. These ricks are covered by a thatching of straw, previously drawn into bundles, and tied down by ropes made of twisted straw, and laid regularly over, meeting at top, diverging towards the eaves and fastened to a belt-rope, which is first of all tied round the stack. This forms the constant occupation of the men when a dewy morning or a shower renders the corn unfit for stacking; and the ropes are either made at such times, or prepared previously by old and infirm men, capable of doing little else, with each a boy twisting the straw with his throwcrook as it is passed in regular thickness through their hands. Such a minute description of so simple an operation, generally performed at times when other

work is impeded, may seem ridiculous to those to whom it is familiar; but I am induced to notice it because it answers all the purpose of the more nice, but infinitely more expensive, covering invariably applied in the southern counties, which is reserved for particular hands, as requiring a degree of skill and ability beyond the reach of the ordinary labourers on the farm.

The portion of land, after turnips, not sown with wheat, is occupied by barley, unless in cases where it is of a moorish or clayey nature, when oats are preferred. The Chevalier kind is sown on the best lands, and the common Scotch barley where the land is inferior or the time of sowing very late, as the latter ripens about ten days earlier. Land which has been well cultivated for turnips is frequently in tilth sufficiently fine to admit of being sown after once ploughing into ridges, in which case it is frequently drilled or ribbed by means of one-horse ploughs which are used for clearing turnip-drills, and then sown by the hand, the seed falling into the ribs or furrows made by the little ploughs 8 or 9 inches apart, and then being regularly covered by harrowing. This process is more expensive than the use of a drill-machine, but it works the land better, and, as far as the crop is concerned, I am inclined to think is preferable, inasmuch as the roots are not confined in so small a space as when deposited by the drill, and are apt to shoot more vigorously; although for hoeing, if weeds prevail, the closer row from the machine is better. If any stiffness or want of friability appears in the land, it ought to have more than one ploughing for barley and grass-seeds. The time of sowing is from the middle of March to the middle of May, as the land can be got ready and the weather may be suitable: early sowing is not desirable, as the corn while tender is apt to get a check by frost, and I should say that in an average of seasons, the best crops of barley are from land sown from the middle to the end of April. Harvest commonly begins in August, but is seldom concluded till late in September, and in some seasons much remains to be done in October. Barley, especially that which is early ripe, is more frequently mown, either with the cradle-scythe, or the short scythe, or double-handed sickle, than any other grain; but if the weather be fickle and the season advanced, the farmer is generally anxious to have it tied into compact sheaves, for although it may be tied up directly from the scythe, it does not pack so tightly together from the swathe as the sickle. The produce of the district far exceeds its consumption, and much of the surplus is shipped from the port of Berwick.

Turnip cultivation is the branch of rural economy in which this district peculiarly excels, which exercises by far the greatest influence upon its prosperity, and has produced the greatest effect,

as I have previously stated, upon the value of the land and the well-doing of all who possess and are connected with it. The process of preparing land for turnip sowing is so nearly the same in all districts as scarcely to require notice: when lime is applied, it is frequently spread upon the stubble soon after harvest and ploughed lightly in, which ploughing is succeeded by a deeper one in a contrary direction, by which the lime is intimately mixed with the soil without being placed too deep, to which it has a tendency; by applying it at this season, less work is left to be done in spring when it is of more importance, and the risk of injuring the growth of the plants, which sometimes follows the application of quicklime in a dry season immediately before sowing, is avoided. The land is stirred in the spring with more or less frequency, according as its natural friability or adhesiveness renders it necessary, the object being to clear it of couch and weeds by picking them off after each process of ploughing and harrowing, or rolling and scarifying, and to keep it in a state of the finest pulverization possible. Swedish turnips are commonly sown in the latter part of May (although as good a crop as I ever saw was sown on the 15th June), and white turnips through all the month of June. The proportion of swede to white turnips varies from $\frac{1}{4}$ to $\frac{1}{2}$, according to the quality of soil and supply of manure: a good crop of swedes is much more valuable than an equally good crop of white turnips, but better land and more dung are required to produce it; and inferior land will produce a tolerable crop of white, which would not bring forward swede turnips at all. The selection of the kinds most suitable to soil and situation is matter for the exercise of individual judgment in every distinct case. Turnip culture is like gardening upon a large scale; the land ought to be in such a state of pulverization for the reception of so small a seed and of the manure, as to fall from the plough like meal. Every operation connected with it requires great nicety, and where so much work as the sowing of 100 acres or more upon a farm is to be done in so short a period, men and cattle are stimulated to the utmost pitch of energy and activity. The process, when conducted on a large scale, presents a scene of uncommon animation and interest, and might afford to Adam Smith himself an apt illustration of the advantage of the division of labour. The occupier of a small farm, with force in proportion, cannot avail himself of this advantage; the various operations must be performed with the same men and horses; much time is lost in the frequent changes from plough to cart and back again during the day: land and manure are exposed injuriously to the sun, and the work at once expensively and inefficiently performed; but the farmer whose force is adequate to conduct the whole process at once, makes his arrangement so that no part of it can stand still

or is required to wait for another. So many ploughs are set first to make the drills or ridges, which they continue at throughout the day: so many men are set to fill the carts at the dungheap, which has been previously made in such a situation as to give the easiest access, and to be conveyed by carts with one horse in each, to the drills; these carts are driven by boys (the empty ones often at a trot) between the heap and the man who is appointed to unload them, which he does by setting up the cart to a certain degree by means of an upright slip of iron in front, which slides into another with notches, to go higher or lower as required; this adjusted, he puts his horse in motion, and with a hack like a fork with prongs turned down, he draws out the dung which falls into the centre drill of the three which the cart occupies, and never stops from a quick walk until the whole is emptied out. To do this with regularity, and at times to give a little extra manure to a part of the ground which stands more in need, requires great activity as well as judgment, and is a task allotted to one of the most able and judicious among the men. So soon as he has emptied his cart another is at hand for him, and thus he keeps on without intermission through the day. The manure thus laid in the centre drill is divided equally among the three, by a person who follows with a three-pronged fork, and is again spread carefully along the hollow of each drill by women, who, each taking one, go on at good speed. Following close upon their heels is another set of ploughs reversing the drills and covering up the smoking dung; after them comes the sowing-machine, which finishes off two drills at once, having a roller in front to smooth and compress them—the funnels to deposit the seed in the centre of them an inch or two above the dung, and a light roller following the funnels. This machine is drawn by one horse and guided by a man walking behind, who attends to supplying the canisters with seed, and to clear away obstructions, driving the horse by reins. This man concludes the operation of sowing, and does not leave the field till he has finished the last drill; and thus a plot, which in the morning presented a flat and uninteresting surface, has before evening been twice turned over by the plough, had a quantity of manure applied to it, no particle of which is now visible, and is laid in rows equal in size, and of undeviating straightness. In this way from 8 to 12 acres are done in a day, according to circumstances; and if bone manure is employed without dung, and sown from the drill-machine in common use, which does three rows at once, the operation goes on still more rapidly; and in this case the drill-ridges are not set up so high, that the bones may not be deposited at too great a depth below the seed; in some cases the seed and bones are sown together; but I believe it is better that the plants should have a little soil to go through before reaching the bones;

and for one reason among others, that the bone-dust is less apt to be drawn to the surface and lost to the turnips in hoeing them. Swede turnips with dung are sown upon drills of the width of 27 inches from centre to centre; and white turnips on drills from 28 to 30 inches: with bone-manure, and for spring food, a width of 26 inches is sufficient. The quantity of seed used is 2lbs. of white and 3lbs. of swedish, per acre. For the purpose of clearing and working the land effectually between the rows, it is of great importance that room enough be given for the action of the small plough and scuffler, and that the drills be perfectly straight. In a district where such a breadth of turnips is cultivated, and which affords but few populous villages and towns to supply extra labourers, it is necessary that as much of this kind of work as possible be done by horsehoeing, leaving to manual operation only the thinning of the plants and removing weeds from the top of the drill. The latter is light work, and is performed with great quickness and dexterity by young women and boys who strike the hoe through the young plants in a way which, to a stranger to the process, conveys the idea of utter destruction, but is found to leave a sufficient number, and those the strongest, at very regular intervals. To give room for a full crop, where land and other circumstances are favourable, swede turnips should be allowed an interval of 8 inches between the plants in the row; and white turnips from 10 to 12, although on poor land, with late sowing, inferior manure, and for spring food, it will be prudent to leave them much closer. A large weight cannot be produced but from large bulbs. A moment's consideration will show that the last inch in the diameter of a large turnip will of itself be equal to several small ones; even in this, however, a medium is to be observed, for very large turnips, if not consumed early, do not stand long, and are inferior in nutritious quality. It would not be safe to state the average produce of the district at more than 25 tons for swedes and 28 for white turnips, when cleared of top and root—although 40 tons have been grown, and 35 are not uncommon—but such large weights are only produced by an extra quantity of dung, which endangers the succeeding crop of corn by lodging, and consequently the grass-seeds along with it: of the latter, the kind which produces the largest bulk is the tankard, but from its shape and size it is so much above the ground, that it is injured by the earliest frost, and it is therefore advisable to sow it only on such land and in such quantity as is intended to be fed off by Christmas at latest. Next to it is the globe turnip, which, if the seed be raised from well-selected plants, preserves a good shape and nutritious quality. Several varieties of the swedish kind and also of hybrids are cultivated, each probably possessing properties which render them applicable

to peculiar situations, but which it is unnecessary here to treat of in detail. The first operation upon turnip-drills, so soon as the plants are of sufficient size to bear it, is to take the soil from the side of the drill with the small single-horse plough, by going along one side and returning on the other, which cuts down also any weeds that may have sprung up, and lays them in the hollow of the drill; the plants are then thinned and the top of the drill cleaned of weeds, which are also drawn into the hollow by hand-hoeing. Where bone-dust has been used, it is recommended rather to thin the plants by pulling than by striking the hoe through them, as in that way less of the bone-manure is drawn off from the roots of the turnips. After ten or twelve days, when the weeds have had time to wither and the plants have recovered their upright position, a scuffler is run along between the rows, stirring the soil which the little plough had laid there, and shaking the weeds with which it is mixed; the turnips are again hand-hoed; and after a while, unless a tendency to weeds renders another hoeing necessary, in which case the scuffler may be again applied also, a double mould-board plough is run along, laying the soil back against the sides of the drill, but not so high as at all to cover up the bulb, which would prevent the growth of the turnip. This is the finishing process, previous to which the little plough and scuffler will have been more or less frequently employed, as the tendency to weeds, or an unkindly state of the land from heavy rains or other causes, may render advisable. There is, however, great truth in the common saying, "that the more the irons are among the turnips, until the leaves begin to spread across the intervals between the rows, the better;" even if there are no weeds to overcome, the turning back and forward of the soil, and the free admission of air, have a great effect in promoting the health and growth of the plants. Having brought the crop of turnips to this stage, it now remains to state the manner in which they are used, and the means employed for preserving them from frost. The character of the district in question, the dry and early quality of the land, the alternate system of husbandry, and the general absence of old grazing pastures, render it much more calculated for the production of sheep than of cattle; in consequence of which no more of the latter are kept than are necessary to convert the straw into manure, which is done by feeding them in fold-yards with turnips in the winter: by far the larger proportion of the turnips are in consequence consumed in the fields by sheep. As it is essentially a breeding district, every farm has its flock of ewes: these go over all the pastures in the autumn and winter, and, except in times of snow, rarely get turnips till within five or six weeks of lambing, but receive them from that time till the spring of grass renders them unnecessary. Turnips are laid out

to ewes in the grass-fields in certain quantities each day, but by no means so many as they would consume if put upon the ground, as it is considered to be more safe that they should not be too fat at lambing, and that they should have grass along with turnips. The hogs and fatting-sheep of the previous year, now $1\frac{1}{2}$ year old, which have not already gone to market, are put upon turnips in October, or whenever the pastures cease to improve their condition. The turnips required for cattle and for the ewe flock are drawn off in alternate rows in the proportion of $\frac{1}{4}$, $\frac{1}{3}$, or $\frac{1}{2}$, as the convenience of the situation, the goodness of the crop, or the quality of the land may dictate; the remainder are then consumed on the ground by the other sheep, which are confined by nets, supported by and twisted round stakes, at intervals of 3 or 4 yards, which is the only folding that is applied to land in this county. As the fields are large, and much of this kind of moveable fencing is required in consuming turnips, nets are preferable to hurdles, from being so much more portable, that the shepherd can at any time, with no assistance but that of his dog to keep back the sheep meanwhile, take in a fresh supply of food. A net of 50 yards long, with strong cord at top and bottom to twist round the stakes, costs 10*s.* or 11*s.* At the beginning of the season, and while turnips may yet be growing, such as are wanted in the fold-yards are carted as required from the field; but the habit of going to the field day by day throughout the winter, at one time injuring the land by carting up to the axles; at another, wasting labour and turnips by pulling them in frost, or digging them from beneath snow, and generally bringing them at great waste and expense in a very uncomfortable state to the cattle, is almost entirely laid aside. Having determined on the quantity of turnips to be drawn and the situation most convenient for storing them, whether near the fold-yards or near some road of easy communication with them, the farmer takes a good day and applies sufficient force to the work—some hands to pull and clean the turnips, some to fill the carts, boys to drive quickly between, and men to unload and deposit them; and by judicious arrangement and active proceeding he gets a greater quantity moved in the course of one day, in cleaner condition and without injury to his land by carting over it when wet, than could have been done at double the cost by any other process. The modes of storing turnips are various, according to the uses for which they are intended. To fatten cattle in yards the best will be taken: it is usual to keep such cattle on white turnips till about the end of the year and afterwards to give them swedes; in either case the tops and roots are taken off the turnips when pulled, taking care not to cut into the bulb, as wounding it so, promotes decay: the tops are spread out for the sheep, if they be following over the ground,

or carted to young cattle in the straw-yards. The turnips are laid in some dry and convenient situation, upon the ground in long heaps which are rounded at top and covered with straw, which admits the air but excludes the frost: if covered with earth or even laid in a close house which prevents evaporation, they will quickly rot; but under straw, swedes will retain their qualities and continue good food for cattle through all the month of May. This covering is cheaply done by using the same straw and ropes which have covered the stacks that may have been threshed; the ropes, broken into right lengths, need only be thrown over the turnip-heaps from side to side and fastened down at the ends by laying a spading of earth upon them, like a little ditch round the heap. For preserving turnips in a juicy and fresh state till late in the spring, the plan is sometimes followed of taking them to a field ploughed for fallow in the next summer; a furrow is made by the plough, which furrow is planted full of turnips, another furrow is laid over them and the hollow filled with turnips again, and so on.

This mode, though it preserves the turnips in a sound state, has its inconveniences; they cannot be got out if wanted in frost, and are rather expensive to take up at any time; and the tops shoot out early in spring so as to draw the juice from the bulbs, making them less nutritious for cattle than if laid up in heaps without tops, although for ewes when at or near lambing they are more wholesome, as a little fresh top corrects the too astringent quality of the swedish turnips, and promotes milk more; at the same time that, in a scarce season, an extra quantity of food is obtained: they do very well too for young cattle fed on straw. A very common mode of storing turnips for such young cattle, or for sheep in grass-fields, is to place them with roots and tops on, close side by side upon a piece of dry ploughed land, or even rough grass, if it be more convenient; the roots put out fibres which keep the turnips in sap, and the tops are sufficiently close to cover them tolerably well from frost, with this advantage, that a slight shower of snow protects them, which would be of no service to them standing singly on the drills. In this way they can be placed conveniently for the ground on which they are to be used, so as to be accessible even in deep snow, and can be filled into carts with grapes or 3-pronged forks in clean and dry condition. I have dwelt at such length on this part of the subject, because it is important in itself, and is proved to be considered so by the Society, from their having offered a premium for the best essay respecting it. It remains, however, for me to describe another mode of preserving turnips, those left on the land for sheep-feeding, and having naturally no protection but their leaves, which a few days of frost, without snow, will destroy. I am not prepared to say that

it is in common practice in Northumberland, or so much so as it deserves, probably because it is attended with a good deal of labour; but I have myself used it, when I was a large grower of turnips, with much success, and in one season especially, when a hard frost, without snow, in the end of January, destroyed nearly all the white turnips in the district, and they rose in price from 4*d.* and 5*d.* to 9*d.* and 10*d.* per week for sheep, I had by this precaution 60 acres of fresh and sound turnips standing in the spring. When the turnips have ceased to grow, and those intended to be stored up are removed, and the headlands cleared, a double mould-board plough, with two horses abreast, is set to work; the horses walk in the outside drills of three, leaving the centre one for the plough, which is set to such depth as to raise the soil so as entirely to cover up the turnips on each side, just leaving the tops above ground. The work is heavy, but the effect certain, unless the turnips be unusually large; in which case it is impossible entirely to protect them. The only inconvenience attending the eating of the turnips is, that as the sheep can only get the tops, so soon as they have taken them off, as many turnips must be drawn out by the picker from day to day as the flock requires; and from the hollowness of the drills, the sheep have more difficulty in getting up if they *lay awkward,* as the phrase is.

Such farmers in the district as have more turnips than they require, find a ready sale for them to the stock-farmers in the mountain-range, selling them to be consumed on the ground by sheep from 5*l.* to 7*l.* per acre for white, and probably from 8*l.* to 10*l.* for swedes; or for 3*d.* or 4*d.* per week for hogs, and 6*d.* or more for aged sheep. Sheep are generally made fat for market in this county with no other food than turnips; and in like manner three-year-old steers are sent to market in the spring, of good weight—say from 60 to 80 stones of 14lbs.—which have tasted neither oil-cake, corn, nor hay; although many people now use cake or meal for the improvement of the manure, and that they may send off two lots of fat cattle in the season instead of one. The superior feeding quality of the turnips in this and the counties north of Tweed has excited the surprise of agriculturists from Cambridge and other counties where good turnips are produced, but which they say will not bring stock to maturity without adventitious aid. This may arise from a combination of causes—the greater friability and loaminess of the soil, the larger size of the turnips and their more solid texture, from the greater moisture in general of the climate. They are certainly less subject to the ravages of the fly at the outset, and of mildew afterwards; for though frequently attacked by the fly, they are seldom overcome by it. Their success in this respect may be mainly ascribed to

the vigour with which the plants generally come up in consequence of the mode of cultivation: pains are taken to have the manure in a proper stage of fermentation, so that it may be spread smoking in the drills and covered up immediately—a process (that of fermentation) which it is better should go on under the surface than above it, although in a crop like turnips, where the object is to produce an immediate effect, nothing being of so much importance to its success as a rapid and unchecked growth in the first stage, a more advanced stage of decomposition is necessary than in the case of wheat and crops which continue for many months to draw their nourishment from the soil and the manure incorporated with it. The Northumberland farmer places his manure, of whatever kind, in the situation where the plants must at once strike into it, and is the more delighted the greater difficulty he experiences in keeping up with hoeing them; while the mode of sowing, much used in the midland counties, upon a flat surface with a large portion of the dung drawn to the top and left to the influence of the sun and wind, fills him with astonishment.

Grass-seeds are universally sown by a drill which lays them with great regularity, and avoids all the inconvenience and unequal distribution occasioned by unfavourable winds in sowing by hand. It is drawn by one horse, and attended by a man who drives the horse with reins while he walks behind the machine and sees that all is going right. The horse walks in the furrow between the ridges, which keeps him in a straight course, and the machine sows to the middle of the ridges on each side, being constructed to sow 12 or 15 feet, as may be required, and to deliver various quantities of seed, according to the amount per acre wished to be sown. All descriptions of seeds intended for sowing are mixed thoroughly together by frequent turning on the granary-floor before being carried to the field and put into the machine. A man and horse will easily sow 30 acres in a day on ridges of 15 feet wide. Seeds sown upon wheat are commonly rolled and lightly harrowed; those with barley are sown at the same time, *i. e.*, previous to the last turn with the harrow by which the seeds are covered, a roller following to leave a smooth surface. The seeds sown consist of a mixture of red and white clover, a little trefoil, perennial rye-grass, and occasionally timothy or Italian rye-grass and cocksfoot; in the portion intended for hay a larger quantity of red clover is introduced and less of some of the others; clover-hay is thought to be improved for horse-feed by a mixture of rye-grass, and it is more easily made. There is a description of perennial rye-grass grown in Scotland and Northumberland which is considered preferable to Pacey's, on account of its producing more blade and less of the seed-stalk,

which renders the pasture dry and barren during a greater part of summer; sheep eat it closer, and it is less exhausting to land. Where turnips form so important and cheap an ingredient of winter-food, hay is not grown to a great extent, farm-horses being fed, during a great part of winter, on straw and swedes with oats. Old meadow-lands are scarcely known in this part of the country, and the hay that is made is from the first year's seeds—from $\frac{1}{5}$ or $\frac{1}{4}$ of the clover-quarter, as it may be—the remainder is fed by sheep, and in the next year the whole is used as pasture. From this circumstance the hay-harvest is less considered here than in most parts of the kingdom, and I regret that I cannot bestow the same commendation in this respect as I have freely, but deservedly, given to the cultivation of turnips, for neither the operations of mowing nor of making hay are so well executed as elsewhere. It is true that the modes of making old-land and clover-hay are, and ought to be, completely different. In one case it cannot be tossed about too much, or made too quickly; but in the other, to follow that practice would have the effect of shaking out the rye-grass-seed and breaking off and wasting the clover-leaves, which are the most valuable and nutritious parts of it; it is, therefore, desirable to make new-land hay by turning it in the swathe entire from time to time, so as to spread it out as little as possible, and to get it quickly into large cocks and then into *pikes* or small ricks containing $\frac{1}{2}$ a ton or more, so as to stand two or three weeks before putting it into large stacks. The custom of putting hay into *pikes* is, I am aware, condemned by amateur hay-makers; still I am convinced it is the safest in the long run, in a climate so variable as ours, and where the hoeing of turnips at the same season requires so much attention. The whole of the hay intended to be put into a stack cannot be got ready in the same day; it is safe therefore to draw into pikes that which *is* made, that it may stand free from danger till the remainder be made too, so that all expedition may be used in finishing the stack when once begun. There is small consolation in having saved the expense of putting it in *pikes,* through the hope of stacking it in a day or two without, when a heavy rain causes it to be all spread abroad again and the process of drying to be repeated, with all the loss of quality attending it. If pikes are firmly put up, and in right form, it requires an excessive rain to penetrate more than an inch or two, which is not discernible in the bulk when taken down, and the hay thus managed is less apt to heat too much in the stack. To say that *pikes* are sometimes seen standing when they are black outside and the clover has grown up around and is spoiling the bottoms, is only to say that some people are bad managers of their property, but is no valid proof of the impropriety of the custom.

The *sheep* stock are in the hill-district the improved Cheviot sheep, which are more hardy than the Leicester, and produce finer wool, and come sooner to maturity than the black-faced mountain-sheep. The wether sheep are fatted on turnips in their third winter; the ewes are sold in autumn at four years old into the grazing districts in Yorkshire and elsewhere, where after feeding one set of lambs they are sent to the butcher. The Leicester sheep are the universal stock of the low grounds. They were first introduced by Messrs. Culley, about the year 1766, from the founder of that breed, Mr. Bakewell, of Dishley. Messrs. Thompson, Jobson, Smith, and other men of judgment and spirit, seeing their superiority over the old breed of the country called "mugs," quickly followed the example, and the custom of hiring rams becoming general, the old breed in the course of a few years entirely disappeared. The management of the flock has been pretty fully detailed under the head of turnip cultivation, with which it is intimately connected. The district is particularly healthy for sheep; it is reckoned that one-third of the ewes should produce twins, and in some situations one-half of them have been known to do so. They occasionally have three at a birth, but that is not desirable: 600 ewes on the farms of Milfield Hill and Flodden produced in one season upwards of 900 lambs; 33 of the ewes yeaned 100 lambs, viz., 32 three each and 1 four. This flock had some rape in the previous autumn. After having three sets of lambs, the ewes are sometimes fatted at home, but mostly sold in September to other parts, to breed another set and then be fatted. The lambing-time is in March and April; the lambs are weaned in July, and often taken to moors or rough pasture for six weeks, the change of land being considered healthful, for which keep from 2*d.* to 3*d.* per head per week is charged; they are brought home to fogs and clover-stubbles, and put upon turnips about the end of October. The gimmers are put to breed in the second year; the wether-hogs are taken more pains with during the winter than the gimmers, frequently having their turnips cut and getting a little hay, for the purpose of selling them fat as soon as they are turned out of the wool; they may at that time run from 17 to 21 or 22lbs. per quarter, according as they have been well kept. Such as have not had much care bestowed upon them are run again on pastures through the summer and sold in the autumn, or put upon turnips and sold fat at all times in the course of the winter, the weekly markets at Morpeth and Newcastle affording constant opportunity of doing so. The Leicester sheep of this county are generally very pure in blood, correct in form, and possessing great aptitude to fatten. Rams are occasionally introduced, by way of change, from the flocks of the distinguished breeders in Leicester and Notting-

ham, and many are also let yearly at good prices in this county, of which none hold a higher place than those of Mr. Jobson, of Chillingham Newtown. Attempts have, in some instances, been made to increase the size of Leicester sheep by crossing them with large and coarse rams from the Teeswater or old Lincolnshire breeds, but the experiment has generally proved disappointing, and in some instances extremely injurious, producing animals with inferior quality of wool and mutton, defective in form, slower in growth, and, after a few crosses, less in weight than the original. It may gratify the mistaken vanity of a farmer to obtain a larger price per head than his neighbour, but the price per head forms no criterion of his profits. The sheep is not naturally a large animal, and it is well known, as well as perfectly reasonable to suppose, that without forcing and if left to their own feeding on light land, or on any land that is sufficiently stocked to be profitable, sheep of smaller size come to greater perfection and more early maturity than large ones. If an acre of land which will fatten 4 sheep of 25lbs. per quarter will fatten 5 of 20lbs., which there is no reason to doubt, the profit must be on the side of the latter; the quantity of mutton is equal, and so it may be presumed is the weight of wool; the smaller mutton is more valuable in the shambles, and it has been produced at less cost, because, if left to shift for himself, the smaller sheep gets sooner fat; he can gather as much food in a time of drought, or any other case of scarcity, as the larger animal, and it does him more good, so that he keeps his condition, or improves, while the other is losing or standing still. If there are markets where large joints sell better than those of moderate size, and situations where sheep depend almost entirely upon stall-feeding, then my reasoning will fall to the ground; but where flocks are extensive and fed abroad on the pastures, I am strongly of opinion that it is unwise to obtain size at the risk of losing quality, and in a degree beyond what the kind of keep and character of the soil are calculated to maintain and mature. Excellent sheep are produced by the first cross between Cheviot ewes and Leicester rams—of equal weight with the Leicester and with finer wool—and in the intermediate lands between the mountains and low country this mode of breeding is followed to a considerable extent. It is proper to mix some young cattle in the pasture with sheep, as the one will often eat the grass which the other rejects. It is not easy to estimate with accuracy the comparative profit between the feeding of sheep and oxen upon grass-land, as, besides the quality of the land, the price of wool and the relative value of beef and mutton must be taken into account. I should say, however, that on all dry and loamy soils, if not of the richest quality of old grazing pasture, the advantage is on the side of sheep, and that land will produce

more grass if grazed by sheep than by oxen. As sheep graze much closer than horned cattle, the pasture after them is always in a state to spring afresh, but in ox-pastures a considerable quantity of grass is allowed to go uneaten, and to attain a state beyond which it does not improve; just as a field of hay, when fit for cutting, would not improve if left uncut, although after cutting a large produce of aftermath comes up. This, however, may be considered more matter of speculation than certainty, and therefore irrelevant to our present subject.

The *cattle* of the county are essentially of the short-horned breed, although many are imported from the Scottish Highlands. This breed was early introduced from the stock of Messrs. Colling, and has superseded every other, as is the case in many counties. A reference to the 'Herd-Book' will show that the district contains many extensive and eminent breeders of short-horned cattle, who sell their young bulls and heifers at good prices and into distant parts; and although individual specimens of equal merit may exist throughout England, in no part of it will the general stock in the hands of farmers be found better, or perhaps even so good, as in this. It is not a dairy-country at all, and cows are kept only for family use and to produce calves, which are reared from the pail, and by means of linseed-meal, hay-tea, oil-cake, &c. Three calves are generally reared for each cow that is kept. In some cases, where extensive pastures of rough and poor land are connected with a farm, it is not unusual to breed cattle by crossing West Highland heifers with a short-horned bull, allowing the calves to suck till they are of age to be weaned, and then fattening the cows for the butcher. These two breeds, though suited to different climates, pretty much resemble each other in quality, being the best for their respective localities, as I believe, that anywhere exist; and when the parents on both sides are pure in blood and well selected, the produce rarely fails in combining the excellences of both. That well-known breeder, Mr. Thomas Bates, when in Northumberland, brought this cross to great perfection. The calves in either case are kept during the first winter in the straw-yard, with a moderate allowance of turnips daily; but in situations where much loss has been sustained by "quarter ill," or "black leg," as the sudden mortification is sometimes called, with which cattle at that age are frequently seized in the limbs or back, a little oil-cake and hay are substituted for turnips with good effect. A constant supply of rock-salt in their mangers is, I am inclined to think, of great use in this respect.

In the next summer they have commonly an inferior pasture, or are put among the sheep to eat up the coarse grasses which they refuse: during the second winter they get turnip-tops, and

towards the spring turnips with straw. A better pasture is allowed them next summer, and in autumn they are put into open folds to full turnips, coming out in the spring months fit for the butcher, and weighing on an average about 70 stone of 14 lbs., although many steers of three years old are seen in the months of April and May, at Wooler and other places of sale, from 80 to 90 stone; the heifers are generally about 10 stone less, and this with a very small quantity of cake in the last six weeks of their feeding. In some cases it is found more profitable to push the young cattle forward in the second year than to keep them till the third, in which case cake is indispensable from the month of January or February at latest. In the spring of last year Mr. George Grey sold a lot of steers, two years old, grazed on my property on the Tweed, for 21*l.* each, weighing 62 stone; part of them were a cross from a short-horned bull and West Highland heifers, and not quite so heavy as the pure short-horns. It would have required good food to make them pay for keeping another year. A large and good breed of cattle existed in this county long before the present race was introduced from Durham, which attained immense weights. The two famous oxen bred and fed at Howick by Sir Henry Grey weighed above 150 stone each, of 14lbs.; and a heifer 132 stone (the beef only), but then they were seven years old. Oxen are not now allowed to attain such venerable age, the object of the breeder being to obtain early maturity in an animal which lays its beef upon the most valuable parts and produces least of coarse meat and offal. The custom of keeping animals tied by the head in stalls, during the whole time of their being fatted, is quite abandoned; and they are put in folds in small numbers together, having well-littered sheds open to the south to lie in, and the power to walk about at pleasure. The custom of ploughing with oxen is also exploded.

The horses used in this district are below the size of draught-horses in general, short and clean legged, with small heads, light necks, and thick middles, capable of enduring long journeys and great fatigue, though not of moving such heavy loads as some others. The real black cart-horse, with thick legs, round quarters and heavy shoulders, though capable of throwing great weight into the collar, would cut a poor figure after going in the plough, making turnip-drills for 10 or 11 hours a-day, in the warm month of June, at the top of his walk. The lighter and more nimble horse, which moves quickly and with little trouble, is much more fitted for the great exertion required of him in turnip cultivation. A pair of such horses in preparing turnip-land will plough 1½ acre, and in large fields where the turning is less frequent, 2 acres a day for days together; but the pace common in making and splitting the drills in seed-time is

still more severe, although the work is not so heavy. Each farm has one or two pairs of a heavier description for carting corn to market, carrying coals, &c., which horses have frequently to travel from 30 to 40 miles in a day when delivering corn to the seaports.

The implements are such as are used generally in the south of Scotland: threshing-machines are universal. In a country with an undulating surface and well supplied with streams, a supply of water can often be obtained for working a machine, to which it is usual to add a pair of common mill-stones, to bruise corn for horses and pigs. When water cannot be had, steam is now in general use: the winnowing process is also worked by the water or steam-power, in connexion with other machinery. For carrying corn and hay, long carts are used, which are commonly drawn by two horses at length, and sometimes by one: they are close at bottom, but with railed ends and sides, and very light; for carrying loads upon turnpikes the single-horse Scotch-cart is used. One man drives two at once, the horse in the latter being fastened by a light chain attached to the former, and joined to a broad belt round his neck. The carts used on the farm are of the same construction, but larger, and with moveable bodies, so as to set up for the purpose of turning out their load at once, and with an additional sideboard to put on, for carting manure, turnips, and any bulky article; the wheels and axles of these are changed at pleasure to the harvest-carts; for as the farm-horses cannot occupy both carts at once, a double set of wheels and axles is unnecessary. The question has often been discussed as to the relative draught between one-horse carts and waggons, and many circumstances tend to decide in favour of the former, such as the lightness of the carriage, the smaller degree of friction from the division of the loads into several parts, the necessity for each horse doing his own work instead of imposing upon his neighbour, his nearness to the load, and the saving to roads: but, independent of this question altogether, the great superiority of such carts where quick motion is required, turning, loading, and unloading, and especially the conveying and depositing manure in turnip-drills, and in carting off turnips, as already described under their respective heads, must be acknowledged. And as the same, or some of the same which are employed upon the farm, may also be used when required upon the roads, the saving of a double set of carriages, even admitting some inferiority in one respect, would fully warrant their use.

The plough is the Scotch iron swing-plough drawn by two horses abreast, the man who holds the plough driving them with reins, but chiefly by speaking to them. Ploughs with wheels to regulate the depth of the furrow have never been used, and in

many parts the inequality or stoniness of the surface would operate against them; the argument, however, against their introduction, that they form a nursery for bad ploughmen, is not very wise, if it can be proved that an inferior ploughman can make as good work with them as an expert one can do with the others, and with greater ease to his horses. We did not oppose the introduction of threshing-machines as an improvement upon the old mode, because it would take the flails out of hands which were expert in the use of them; and as all ploughmen are not good ploughmen, we ought not to deny the farmer who happens to have indifferent ones the means of remedying the evil. Any unnecessary and injudicious pressure upon the handles of the swing-plough operates in a greatly-increased degree upon the draught at the end of so long a lever—this the application of the wheel will correct; at the same time some addition to the draught may be created by the friction upon the wheel; it is therefore still doubtful on which side the balance of advantage may be found. I am of opinion that the wheel-plough is not so applicable to the hill-sides and uneven surface of Northumberland as to many other districts; but the investigation is a very important one, and I rejoice that it has attracted due attention and been undertaken by such able hands. One improvement has often struck me as being obvious, without reference to the question of the comparative merits of swing and wheel-ploughs at all. The mould-board, which is adapted to turn over and lay at a proper angle the tough grass furrow, is not the best suited for working in loose land and deep ploughing in fallow; in the latter case the draught is rendered unnecessarily great by the load of earth, especially if the land be damp, which hangs upon the breast of the mould-board instead of slipping easily off it; and even in sandy or very light soil, when horses might be expected to enjoy comparative ease, they seem to be harder pressed than ever on this account. Now without going to the expense of maintaining two sets of ploughs for different kinds of work upon a farm, it would not certainly require any unusual degree of ingenuity to contrive a mode of adapting and fixing by screws mould-boards of different casts, and suitable for each kind of work, upon the same plough.* The subject, however, is well deserving of consideration.

The drill for sowing grass-seeds is an important improvement (by its equal distribution of the seed over the land, its capability of sowing in any wind, and its lightness, with which a man and horse can easily sow thirty acres a day) over the old plan of sowing by hand, which was obstructed by wind and rain, and where

* Mr. Hart, of Wantage, has lately made a plough with two shifting mould-boards of different shapes, adapted to different qualities of land, in agreement with the opinion of Mr. Grey.—Ph. Pusey.

one patch would be found much too thick and another destitute of plants, so as to leave a good deal of land unoccupied. It is not possible to ascertain the fact with precision, but I do not hesitate to state an opinion, that land sown by such a machine will produce more hay, and graze a greater quantity of stock, than that left in the patchy condition which follows the unequal distribution of small seeds by the hand, subject always to the fitful influence of the winds. Corn-drills are not in general use, because the land is well cleaned for the turnip-crop, and unless for the extirpation of weeds, broad cast sowing produces more corn, the land being more equally accessible by the roots, which draw nourishment from all its parts; whereas in drills they are clustered in narrow rows, and the ears are less regularly exposed to the sun, especially if the drills lie from east to west. Rollers, scufflers, scarifiers, and other implements, are much the same as those found in other districts; the double turnip-drill with rollers, sowing two rows at once, is universally used.

Manures.—Lime of good quality for land is found in several parts of the district, and may be had at a distance of 10 miles from any part of it, although it is carried to double that distance into the adjoining counties of Roxburgh and Berwick. It is not applied like dung at every fallowing, but once in 10 or often 15 years, and then in quantities from 160 to 240 bushels per acre, either spread upon the land intended for turnips, or ploughed in during the previous autumn or spring. After frequent repetition the effects of lime become less apparent, but at such an interval they are generally to be seen, especially in producing a better take of grass-seeds and a more nutritious pasture. On its first application to lands newly taken into cultivation, and containing abundant vegetable matter to work upon, the effects of lime are remarkable. An anecdote illustrative of this is related in Messrs. Bailey and Culley's Report of Northumberland, in 1797:—"About 12 years since, when looking over the farm of Thornington," (the same which is now occupied by that eminent breeder of short-horned cattle and field horses, Mr. Hunt,) "we were surprised by a sudden alteration in the verdure of the land; one side was eaten very bare, and covered with a thick mat of clover and ray-grass; the other was a dingy brown, chiefly composed of *small bent* and *sheep's fescue*, and in a great measure neglected by the stock. An explanation was required for so great a contrast, and Mr. Hall, the tenant, informed us that when that field was last in fallow the part which was eaten so bare and looked so green was *well limed*, but the other which was left uneaten had never been limed." I have seen various instances of a similar effect from the use of lime upon fresh soils: land that has lain long in grass will produce excellent crops of turnip

and rape with lime alone, but on old tillage-lands the stimulus is not so effective, and the use of other manures is requisite. In turnip-fallows it is of consequence to have the fold-yard manure in a state of active putrefaction when applied; for which purpose it is removed at intervals, chiefly in frost, when ploughing is laid off, to situations in the fields most convenient for being taken to the land for which it is intended, and is turned over a few weeks before being applied, except such part as remains in the fold-yards for land near at hand, which is turned up where it lies. Great pains are taken to make the quantity as large as possible by cutting the corn low, and collecting everything to increase the bulk of the dung-heap. Where turnips abound, comparatively little straw is eaten by cattle, and the great proportion being trodden down as litter gives a large return of manure, so that if the straw of the previous corn-crop has been bulky, in many cases sufficient dung is made on the farm to go over the fallow or turnip quarter; but, generally speaking, the fold-yard manure is applied to lands nearest the offices, and those from which it may be most convenient to draw a considerable portion of the turnip-crop, leaving those which are distant, or steep, or in any way less easily come at, to be done with bones, the portability of which, and their easy application on hill-sides and distant parts where dung cannot readily be conveyed, render them a most valuable accessory to the dung made on the farm, and have had the effect of extending the breadth of turnips, and of cultivation generally, in a considerable degree. Few other adventitious manures besides bones are used in the turnip district, although near the coast those obtained by importation are in partial use. Compost heaps made of the scouring of ditches, road-scrapings, &c., are common here as elsewhere; they are always mixed with lime, and would be much improved by some layers of salt, the chemical combination being highly beneficial. The successful experiments which have been made with nitrate of soda have led to much inquiry respecting it, and its use will next year, I suspect, be greatly increased.

The foregoing remarks and details, though under the head of turnip cultivation, are in so many respects applicable to the stronger soils upon the east coast, that little will require to be said of them, except in as far as the management differs from that hitherto detailed. The implements are the same; the horses somewhat heavier and slower in their movements; the breed of cattle is the same, but where the quantity of summer-grazing exceeds the winter keep from want of turnips, cattle are bought in the spring, made fat upon grass, and sold in the autumn. And where land is unsafe for keeping a regular breeding-flock, from its liability to rot, cast-ewes from the higher country are bought

in autumn, and after fatting their lambs are again disposed of. Most farms even in this district have portions of land which grow turnips, and are cultivated in the five-course rotation previously described, although their produce in turnips is not so certain as that of Glendale and the borders of the Tweed. By the progress of tile-draining much land is now being brought under turnip cultivation and the five-course rotation, where it could not be attempted before; and a great inducement exists to favour such attempts, as will be seen by the comparative rise in the value of loamy and of clay-lands in the early part of this paper. Many fine grazing pastures in the eastern part of the county were converted into tillage, when the exorbitant price of corn during the continental war, and their capability to produce several crops in succession, formed a temptation to farmers to offer, and to landlords to accept, high rents for them. This step has been generally repented of, as it is a short process to break up an old grass-pasture, but the work of many years to restore it. They are still found, however, in many parts with large ridges, high in the centre, and shaped like the letter S, and generally occupied in connexion with the adjoining tillage-land, as at Howick, Embleton, Tuggal, &c., but they are not unfrequently let by auction in the spring to be depastured from May-day to Christmas, as at Haggerstone, Lowlin, and various other places, bringing a rent for those months of from 3*l.* to 5*l.*, and even 6*l.*, per acre.

The rotations pursued on the best wheat-lands are either the four or the six-course; both requiring good land and abundant manure to maintain them in any degree of vigour, and now in many parts given up, for the introduction of a more gentle course, with more of grazing and stock; the four-course is, oats, fallow well dunged, wheat, clover with a light mixture of rye-grass on half the land, and beans, or beans and peas mixed, on the other half. By so alternating them, the clover and beans come each only once in 8 years, and are of surer produce, especially the clover, which does not bear frequent repetition. The six-course is, oats, beans drilled and hoed, wheat, fallow, wheat, clover. There is another course, which, though it may not be very common, I consider applicable to a kind of land which, without being a stiff clay, is much too strong and retentive for growing turnips, and if grown, for taking them off without injury: and as I have pursued it for 21 years with success, I feel myself more at liberty to recommend it to public notice. I was induced to take into my own management, though at an inconvenient distance from my residence, an estate of my own on the banks of the Tweed, which had been long subject to a severe course of wheat-growing, and was in consequence in an exhausted condition. One part of the farm consists

of strong turnip-loam, which I immediately divided into five equal shares and managed in the five-course rotation, growing turnips in the regular course: the other consists of heavy land upon a retentive subsoil; this I divided into seven shares, planting some additional hedges to make the necessary equal divisions, and introduced upon it the following rotation:—oats, beans drilled and hoed, barley, naked fallow with dung, wheat, grass, grass; my object in making this arrangement was to obtain two years' grazing, to recruit the land after over-cropping with corn, to keep a repetition of the same kind of grain as distant as possible, and to introduce a barley-crop, which was quite new to the land, and which it was considered incapable of producing. With this, however, I had no difficulty; for although such land, if ploughed in the spring, would have turned up a stiff furrow, and when worked, would have been cloddy and in a state most unfavourable for barley, yet, when ploughed into ridges after the beans in the autumn, laid as dry as possible, and exposed to the winter's frost, it never failed, by watching an opportunity to sow it when dry, to harrow down as mellow as possible, and to produce excellent crops; nor did the grass-seeds fail as they had been wont to do. The produce of the farm was quickly doubled, and although rents had fallen generally during the years that I occupied it, it has advanced in the interval from 500*l.* to 800*l.*, its present rent. The land had a good quantity of dung at each fallowing and a good liming during the first course, which was not repeated till the third, 14 years after. If the beans should be removed sufficiently early, and the autumn be dry enough, I should prefer to apply the lime after the bean-crop to any other time; both because the dung is spread upon the fallow, and because after the beans, the land contains in their roots, and in the kind of putrid fermentation arising from the decay of vegetable matter in a drilled crop, more material for the lime to operate upon; but as beans stand late upon the ground, it is only in some seasons that this can be effected so far north.

Farm-servants are engaged on the large farms in the northern parts of Northumberland, as in the southern counties of Scotland, in a manner very different from that of the same class in the more southern counties of England; and as the custom is little known in many parts, and has evidently a great influence upon the moral and social condition of the labouring classes, as well as being in a great measure essential to the system of turnip-husbandry, which gives so much occupation to females and young people in cleaning the land, gathering and burning couch, and hoeing turnips, I consider it deserving of particular notice. To conduct the operations of a turnip-farm in summer, and to keep at work an expeditious threshing-machine in winter, without laying all the ploughs

on the farm idle, when many hands are required for untying and carrying forward, to the man at the feeding-board, the sheaves before being threshed; and for removing and dressing the corn as it comes from the winnowing-machine,—a description of work which women are quite adequate to,—several hands are necessary besides the every-day labourers on the farm. In the absence of villages to supply occasional assistance, as is the case with a large portion of the farms in the district, each one must depend upon its own resources. A necessity is thus created for having a certain disposable force of women and boys at command, which has given rise to the custom of having no ploughmen or labourers living in the farm-houses. Each farm is provided with an adequate number of cottages with gardens attached, and every man who is engaged by the year has one of these cottages; his family, however numerous, commonly finds employment, but *one* he is *bound* to provide, to answer at all times his master's call, and to work at stipulated wages. To this engagement the odious name of *bondage* has been given; and I am induced to notice it the more particularly because it has of late years attracted attention, and because attempts were made a few years ago to stir up the hinds, as such hired householders are called, to a resistance to the measure. These attempts were, to a certain degree, successful, and resistance was made by the hinds to being *bound* to provide a girl, or boy as it may be, to work on the farm, but it was not yielded to by the farmers in any one case that I know of, except one, that of Mr. Jobson, of Chillingham Newtown, whose local situation rendered him independent of it; he hired his men at certain wages, with regular employment for the year; and, singular enough, before the end of it, they one and all desired to be placed on their former footing. Where the hind has one daughter or more there can be no hardship, because, when called to work out, which, during the summer months, is pretty constant, she is earning wages; and when she is not so employed she has the domestic occupation of the family to engage her. In the case of a hind who has no children sufficient for the purpose, there may be hardship in having a servant to hire, provided her services are not required at vacant times in his family. But even then where is the hardship in the case? If the advantage of the system be not equivalent to the hardship complained of, why does he not abandon it and betake himself to a more independent life, hiring a cottage in a village and taking his chance for piece-work, in the quantity of employment which is to be found in draining, embanking, fences, roads, &c., throughout the country? And why should that be called *bondage* which is an engagement for a year, terminable by either party at the end of it? The fact is, that the certain employment and the wages of the hind, and his settled

condition and abode, give him many advantages over the labourer who has to seek work by the piece or the day, in different parts, even when wages are good and work is plentiful; and it invariably happens after a hard winter, when labourers have been laid off work in snow-storms, that many of them seek to be engaged as hinds in the ensuing year. It cannot be said that the occupation of the females is unwholesome, or beyond their strength. The healthful and cheerful appearance of the girls in the turnip or hay-fields of the north, and their substantial dress, would bear a favourable comparison with those of any other class of female operatives in the kingdom; and their neat and respectable attire on attending their places of worship on Sundays would fill with astonishment, and perhaps envy, the female peasantry of Kent or Surrey.

Having so far explained and vindicated the system, I cannot perhaps better show its operation and effects, and bring the subject to a close, than by inserting a letter, which at the request of a friend I was induced to publish, along with others on agricultural subjects, in 1831, which letter contains the substance of evidence given by me in that year, before a Committee of the House of Lords, on the condition of the labouring poor.

"The manner of hiring and paying hinds, or farm-servants who are householders, in the north of England, is as follows:—

"Each man is provided with a cottage* and small garden upon the farm, free of rent, for himself and family; several of whom, in many cases, are engaged *for the year* upon the farm as well as himself. The wages of the hind are chiefly paid *in kind:* those of his son or sons, if he has any able to work, either in money, or partly in money and partly in grain, as best suits his convenience; but it is generally an object with him to have such a proportion of the earnings of his family paid in kind as will keep him out of the market for such articles as meal, potatoes, cheese, bacon, milk, &c.; and notwithstanding what the economists say about money being the only proper medium of exchange for labour, as well as other things, the custom of paying farm-labourers *in kind* works well for both master and servant. In times when grain sells at a high price, the conditions of the hind will cost his master more than the ordinary rate of wages for day-labourers at the same season; but, on the other hand, in times of great depression, the conditions are the same, though at such times the farmer would be compelled to sell nearly double the produce to enable him to pay his labourers in cash. He has also a benefit in paying for his labour in an article which otherwise would cause him some expense in sending to market, and in disposing of which he might incur the risk of making a bad debt with his corn-merchant.

* Many old cottages in the country were justly deserving of condemnation; but a laudable attention to the subject of late years has had the effect of adding much to the comfort and accommodation of the dwellings of the poor.

"The conditions of a hind (I adhere to the local term) vary with the price of grain from 30*l.* to 40*l.* a-year; and, at the present prices, are as under:—

	£.	s.	d.
36 bushels of oats	6	12	0
24 do. barley	5	12	0
12 do. peas	3	0	0
3 do. wheat	1	5	0
3 do. rye	0	15	0
36 to 40 do. potatoes	2	14	0
24 pounds of wool	1	0	0
A cow's keep for the year	£8 to 9	0	0
Cottage and garden	3	0	0
Coals carrying from the pit	2	0	0
Cash	4	0	0
	£38	18	0

In 1841, 36*l.**

Each hind being bound to supply the labour of one woman (or boy) whenever the farmer requires it, at 1*s.* per day in harvest, and 10*d.* per day at other seasons. The other females of the family receive 10*d.* or 1*s.* a-day generally, and 2*s.* 6*d.* in harvest.

"The food of the peasantry in the north of England, as in Scotland, consisting chiefly of porridge made of oatmeal with milk, for breakfast, and bread, made of barley and pea-meal mixed, regulates the above proportions to the demands of a family. Were the same mode adopted in the southern districts, although they could not probably get a more wholesome food, yet the kinds and proportions of grain would have to be regulated by the taste and habits of the people. These 'conditions' are proved, in innumerable instances, to be adequate, under a proper economy (which economy the system has a tendency to produce), to the support of a man, his wife, and any ordinary number of children; for the eldest are probably earning, at the same time, from three or four to eight or nine shillings per week; and the joint produce of their labour, under the management of a frugal housewife, renders their cottage a scene of comfort and contentment. It often happens, indeed, that a hind, with but few in family, has, at the end of the year, a good deal of corn to dispose of, for which, of course, his master is always willing to give him the market-price.

"The grain given to the hind is always of the best that the farm produces. He is paid in advance, at the beginning of each quarter, a fourth part of his conditions. It is sent to one of the many small mills which abound in the country, and ground at a cheap rate into the different kinds of meal; and thus the intermediate profits of retail

* In addition to the above, the steward on the farm receives 6*l.* or 7*l.* extra; and the shepherd has, besides, several sheep kept, of which he sells the produce, thereby possessing a particular interest in the safety and welfare of the flock.

dealers, meal-sellers, and bakers are saved to the consumer; and the corn, which would cost the farmer 16*l.* to pay his hind, is more valuable to the latter than 20*l.* paid in money-wages, to be expended in stones of meal or quartern loaves at the end of each week. One very obvious benefit arising to the hind from this mode of paying in kind, besides that of having a store of wholesome food always at command which has not been taxed with the profits of intermediate agents, is the absence of all temptation, which the receipt of weekly wages, and the necessity of resorting to a village or town to buy provisions, hold out, of spending some part of the money in the ale-house which ought to provide for the wants of the family; and to this circumstance, and to the domestic employment which their gardens afford in their leisure hours, we are probably much indebted for the remarkable sobriety and exemplary moral conduct of the peasantry of the north.

"The produce of his garden, his small potatoes, and the refuse of his dairy, enable the hind to fatten two pigs in the year. The keep of a cow, supplied entirely by his master, consists of pasturage in summer, and a ton of hay, or an equivalent in turnips, generally ten cart-loads of white turnips, or five of white and three of swedes, and as much straw as he chooses in winter. This is reckoned to cost the farmer eight or nine pounds; but if the cow be a good one, it is evident that the advantage must be much more than that to a family. The calf, if early in the season, sells for forty shillings, or thereabouts; if later, perhaps for thirty shillings; and if the good wife be a frugal manager, she will sell forty or fifty shillings' worth of butter, besides an ample supply of milk and cheese for the use of the family. The wool received gives employment to the females to spin, and knit it into stockings in the winter evenings, or it is sent, after being spun into yarn, to be made into blankets. In this way habits of industry and economy are promoted, and domestic and social virtues engendered and preserved, in a manner and to an extent unknown in those districts where the younger members of a family are early driven from the shelter of their paternal roof and the control of a parent's eye; or where the parents, deserted by their children, are forced to take refuge, under the infirmities of age or the pressure of want, in the corrupting atmosphere of a parish workhouse. Look into one of our north-country cottages during a winter's evening, and you will probably see assembled the family group round a cheerful coal-fire—which, by the way, is an inestimable blessing to all classes, but chiefly to the poor of this country,—females knitting or spinning—the father, perhaps, mending shoes—an art almost all acquire—and one of the young ones reading for the amusement of the whole circle; and contrast this with the condition of many young men employed as farm-servants in the southern counties, who, being paid board-wages, club together to have their comfortless meal cooked in a neighbouring cottage, with no house to call their home, left to sleep in an outhouse or hay-loft, subject to the contamination of idle companions, with no parent's eye to watch their actions and no parent's voice to warn them of their errors; and say which situation is best calculated to promote domestic comfort, family affection, and moral rectitude.

"The possession of a cow is to the northern hind an object of endea-

vour and ambition. He cannot marry and establish himself in life without one: at least he knows that he ought not to marry till he can purchase one—and this is the first step towards independence that is generally aimed at; salutary alike as a check and a stimulus. This point gained—a cottage respectably furnished, and a situation obtained under a good master—he brings home his bride; feeling that he is a useful and, comparatively, an independent man. The situation of a hind living upon the premises, and hired for the year, possesses this decided advantage—that in seasons when employment is scarce—when day-labourers are turned adrift—however unproductive his services may be to his master, his wages go on—even months of confinement from ill health produce no diminution in his income;—and thus it is, that though his wages per day may seem but small, yet, at the end of the year, he is found in better circumstances than those artisans or labourers by the piece, who, though obtaining nominally higher wages, are liable to much loss of time and uncertainty of employment. It may seem hard, at first sight, that the farmer, whose servant, after having entered upon his service for a year, has fallen ill and become unable to work, should still have to make good his bargain; but such is the custom; and were it otherwise, the family would soon, in many cases, be thrown on the parish funds. The farmer may as well then take the chance of supporting his own for a while as be compelled to contribute to the support of all who might fall into similar circumstances throughout the parish. But by far the best reason for the custom is, that it gives rise to a feeling of gratitude to a master for having afforded gratuitous relief, and a desire, which I have often heard expressed by servants, to make up for the loss he had sustained by the best services they could bestow; and surely the sacrifice is not too great, if it saves an honest man from the feeling of degradation, which ought, and still sometimes does attend the application for parochial support.

"This mode of engaging and paying farm-servants is not only more conducive to their welfare and social comfort than the weekly payment of money-wages, which go but a little way in purchasing the necessaries for a family—are injudiciously laid out, and sometimes wastefully squandered—but it has besides a strong and apparent influence upon their habits and moral character; it possesses the advantage of giving to the peasant the use of a garden and a cow, with the certainty of employment; it gives him a personal interest in the produce of his master's farm, and a desire to secure it in good condition; it produces a set of local attachments which often lead to connexions between master and servant of long continuance. It is not a comfortable or convenient thing for a man to move from place to place with his furniture and family; and, when he finds himself well situated, he has a strong inducement to conduct himself respectably, and give satisfaction to his employer. While, on the other hand, such removals being attended with expense and loss of time to the farmer, who always sends his carts to bring the family and furniture of a new comer, it is his interest to encourage and retain a respectable servant; and thus mutual accommodation and respect are produced. Orderly habits and respectable conduct on the part of the servants produce consideration and kind treat-

ment from their masters; and in this way the great majority of this class of our population come to the end of their days without having once suffered the degradation of being on the list of parish paupers.

"Perhaps the foregoing statements may be best proved by annexing a list of the servants, being householders, at this time resident upon a considerable farm* in Northumberland, with a table showing the length of time that each has lived under the same master, and the sum of money that remained due to each at the half-yearly settlement of their accounts at Martinmas last (11th November), being a surplus, arising from the labour of all the members of the families who remained at home, which they had not found it necessary to call for in the course of the half-year, but left in their master's hands till the final settlement of the half-year's account:—

	Years' Service.	Cash due upon his account at Martinmas. £.	s.	d.	£.	s.	d.
George Cranston . .	25	8	3	6½			
Alexander Tunnah . .	12	15	0	4½			
John Redpath . . .	1	9	7	11½			
Samuel Ewart . . .	30	5	5	9½			
Andrew Gray . . .	9	7	14	4½			
Andrew Elliott . . .	14	23	2	2			
Thomas Robson . .	4	4	3	11			
James Cranston . .	20	6	12	4½			
Andrew Young . .	12	7	2	5½			
Edward Davison . .	15	5	15	1			
George Chirnside . .	10	5	16	7			
John Middlemas . .	3	4	9	10½			
Thomas Fullerton . .	18 in debt to his master				7	9	8

Average 13 years.

"In the case of Thomas Fullerton, who, instead of having money due to him, stood indebted to his master in the sum of 7*l.* 9*s.* 8*d.*, it is necessary to remark, that he had had the misfortune to lose a valuable cow by death; and being unable to purchase another, having a large family, was favoured by his master with the loan of 10*l.* to enable him to do so, which loan, it is understood, he is to pay off by instalments, or as he can afford; which, as his family gets up to be useful, he will have it in

* "In the township in which the farm referred to is situated, the poor's and county-rates amount to 1*s.* 3*d.* per pound per annum on the rack-rent. The greatest portion of the poor's-rate, however, is occasioned by the inhabitants of a village, containing some tradespeople and artisans, who obtain settlements by servitude or occupation; and a very small proportion indeed by the agricultural population. The writer never knew an instance of a regularly-hired farm-servant, or hind, applying for parochial aid in time of health, however large his family; and though, in the case of widows and orphans, assistance must be given, we would say that in townships where the population is purely agricultural, 6*d.* in the pound would cover, on an average, the amount of the poor's-rate."

his power to do. The existence of this kind of confidence and accommodation may be adduced as one of the beneficial effects of the system herein explained. A master, in such case, frequently gives the servant the use of one of his cows until he can procure one for himself; but the servant is always anxious to have the credit of having a cow of his own, and it would be absurd not to give every encouragement to the maintenance of so laudable a spirit.*

"It may further be worthy of remark, that only two in the foregoing list ever received parochial aid—one, John Redpath, who was disabled by illness from working for nearly three years; and George Chirnside, whose father died, leaving a widow and four very young children, of whom he was the eldest; but since the time that he was sixteen years of age the whole family have been supported by their own industry. He was at first assisted by his master in the purchase of a cow, which is now cleared off, and the family are in good circumstances.

"In contrasting the condition of the peasantry in the southern with that of the northern parts of the kingdom, it would be highly improper to pass over unnoticed the superior education of the latter, and the effect which is produced by it upon their worldly circumstances, as well as upon their moral and religious character. No greater stigma can attach to parents than that of leaving their children without the means of ordinary education, and every nerve is strained to procure it. In the school attached to almost every village, one finds children not only able to read and write at a very early age, but most expert in all the common rules of arithmetic, and not unfrequently capable of extracting the square and cube root with great expedition and accuracy. And even the young men who labour in the fields all the day often spend a couple of hours in the evening in school, to advance themselves in such acquirements. If occupation alone is a valuable antidote against idle and vicious habits, the acquirement of useful knowledge and the cultivation of the mental faculties must be still more so. And when these are prosecuted, not by gratuitous means, but by the produce of economy and toil, it bespeaks a state of society where sobriety is habitual and intelligence is held in estimation."

Farm Buildings.—In consequence of the abundance of stone which the county everywhere affords, the buildings are all of a most substantial kind—brick being only used for chimneys and inside partitions. Blue slate from Wales or Westmoreland forms the universal covering of all buildings of recent date, and the homely thatch and unseemly red tiles are now the exception, though within the last sixty years little else was to be seen. Roofs of gray sandstone-slate are occasionally met with, but although they are more agreeable to the eye than red pantiles, they are much inferior to blue slate on account of their great weight, their

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* *Cow-clubs* are now established in various parts, to purchase cows for the members who have the misfortune to lose them. The farmers subscribe according to their number of hinds, and each hind, to enjoy the benefit, subscribes 1*s.* per quarter.

porous character, and the steeper pitch which they require. During that period a large proportion of the farm-offices in the districts treated of have been rebuilt, the old, insufficient, and patchwork accommodation of the former age having been replaced by buildings at once substantial and commodious, suited to the increased produce in corn and to the equally great increase in both the number and quality of live stock consequent upon an improved system of husbandry. The custom of letting farms on long leases has tended much to the improvement and perfection of farm-offices. A tenant for a short or uncertain term puts up with such accommodation as the place affords, or as he can obtain at the smallest cost and inconvenience for the present time; but the tenant who is entering upon a lease for twenty-one or nineteen years calculates the advantage which he would derive, and the labour he would save during that term, by having a set of offices more snug and more commodious for his cattle; more compact in form or more central in situation; in consideration of which he undertakes to convey (or *lead*, as the term is) all the materials for a new building, the landlord being at the cost of it in other respects; and in this way old and incongruous buildings are demolished and new ones erected convenient in arrangement and situation.

In selecting the site of farm-offices it is desirable to combine, in the greatest degree which circumstances admit of, the following objects:—proximity and easy access to a public road; a situation central, as regards the tillage-land, and so as to communicate with all parts of it by the levellest roads possible, as the intervention of a single hill that could be avoided may make the difference between two horses in a cart and one. A southerly aspect; as cattle are found to thrive better and to fatten sooner in folds open to the sun than in those from which his rays are excluded. A command of water; so that a supply may be conveyed through the different parts of the buildings, and if the grounds afford it in sufficient quantity, where it can be brought and collected to work the threshing-machine, and thence conveyed away, with little expense and without injury, or, it may be, with benefit to the adjoining lands; where a sufficient supply of water cannot be had, the cheapest and best power is steam, if coals be within a moderate distance; water enough for that purpose may be collected, if a spring is not at hand, from the roofs of the offices, if preserved in a tank made in a shady situation and lined with clay or bricks. If the economy of labour is to be studied in fixing the site of farm-buildings, it is not less to be attended to in their construction and arrangement: they commonly form three sides of a square open to the south; the highest buildings being on the north side, and those of a lower description filling up the

east and west. The stack-yard is on the north side of the square, and the barn containing the threshing-machine projects into it at right angles with the line of hovels, which constitute the northern side of the square, the straw being thrown from the rakes into a large barn or straw-house in the centre of that range, where it is piled up for use. It is of consequence that the barn be in the centre of the range, because the straw to supply the cattle is carried out right and left, and only to half the distance which much of it would require to be carried if the barn stood in any other situation; the same reason holds with regard to corn which is being threshed and intended to be laid up in granaries: grain keeps much better in granaries that are over open hovels than in those that are over close houses in which horses or cattle of any kind are tied up: and by this arrangement the granaries are made over the hovels, which extend from each side of the barn, and the corn is carried to them from the dressing-floor below, without being taken from under the same roof, or the sacks are drawn up by a pulley and tackle worked from the wheel of the threshing-machine, whether driven by water or steam, and conveyed on hand-barrows with wheels to all parts of the granaries; from which again they are loaded into carts through trap-doors in the floor, below which the carts are placed within the hovels. The saving of labour attending the laying up and removing of corn from granaries so situated, as compared with others at a distance from the threshing-barn, is very obvious. It is desirable for the same reason that the straw-barn should stand the cross way of the threshing-barn, and not in the same range with it, so that the rake of the machine may deliver the straw into the middle and not the end of it; in this way the straw has only to be carried half the length of the house instead of the whole; and when two kinds of straw are in use, one for fodder and another for litter, they can be kept quite distinct, and are easily taken out by leaving an open space between them. Peculiar situations may very properly render deviations from these general rules at times right and necessary, but where so important a consideration as the economy of labour is involved, and that for a long course of years, as in the erection of an extensive and permanent set of farm-buildings, too much attention cannot be paid to it in the arrangement to be adopted.

Dilston, 18*th February*, 1841.

XIX.—*Observations on the Natural History and Economy of the different Insects affecting the Turnip Crop.* By John Curtis, F.L.S., &c. Paper I.

Unless we collect facts on good authority, and conduct experiments with care and perseverance, our labour will be lost in studying the economy of the insect tribes; for in the investigation of such living atoms, as they often are, the slightest error may lead us far from the truth. It is not to be expected that a taste for such studies will be universal, though all who can appreciate the value of a good harvest will take, it may be fairly presumed, an interest in our researches. Such a taste, however, where it does exist, is easily improved; and it is a truth admitted by all who have indulged in such pursuits, that they never repented of the time that had been given up to these laudable objects; and independently of the amusement to be derived from the investigation of nature, any benefits conferred on man by such knowledge ought ever to be a source of real satisfaction, and of honest pride, to every cultivator of natural science, however trifling his contributions may be to the general stock of information.

Unimportant as insects may appear to the casual observer, they often prove awful visitations when employed by the Creator as his armies to fulfil his ends. No one suffers more from these hosts than the agriculturist; it is therefore impossible that he can remain an indifferent spectator whilst it may be in his own power to palliate, if not to avert, the evil. I therefore hope that these memoirs, by calling the attention of the farmer to so important a subject, may lead him to useful and profitable results; and should he derive as much advantage from their perusal as I anticipate of pleasure in their detail, it will prove to me a source of unfeigned gratification.

I am aware that one of the greatest difficulties the farmer has to contend with is that invariable law of nature which compels him to change his crops, from the exhaustion of certain elementary parts of the soil, which are absorbed or neutralised by the vegetable that is produced; and with all his art in selecting manure and resting the land, it will become tired at last, and by degrees refuse to produce certain crops nearly altogether: it is even asserted of the turnip, that it certainly does not grow so vigorously nor so readily as it did several years ago. It is natural to suppose that as this period approaches the crops will become, from feebleness, more susceptible of disease; and as insects are intimately connected with this subject, contributing in no small degree to the dissolution of vegetables, and the failure of our crops being frequently very justly attributed to them, this is a matter well

deserving of our attention, and in pursuance of this object we will first consider those insects which attack the turnip, a root of the greatest importance to us all: for without turnips our sheep and cattle would be deprived of one great resource, so that we should be almost unable to procure fresh meat in winter, most essential to the health of man; and the land again would lose that fertility which in feeding off the turnip we secure for the succeeding crops.

No crop is subject to the attacks of a greater number of noxious insects, &c., than the turnip. First, the ants run off with an incredible quantity of the seeds; then come two sorts of turnip-fly, the striped and the brassy, which destroy the tender leaves as soon as they burst from the ground; at the same time we have the maggot of a fly and the wire-worm, both living upon the young roots; and also a large caterpillar or grub, when they are more advanced; then follow armies of black caterpillars, reducing the leaves to skeletons, and the blight of the plant-louse, together with a minute moth; we may add also two weevils, which cause the lumps or excrescences on the bulbs; with slugs, snails, and mildew bringing up the rear.

Before entering upon their history it will be necessary to make a few observations relative to the economy of insects, which I beg may be borne in mind in the perusal of these papers, as they will be of service in the investigations I propose, and in which I hope every practical man will lend me a hand; they will also smooth the road to those who have not a scientific knowledge of insects, and are not skilled in the study of entomology.

Insects have been divided into large masses, named ORDERS; these are subdivided into lesser groups, called FAMILIES, which comprise smaller companies, designated GENERA; and each of these consists of more or fewer SPECIES, or different sorts, which occasionally vary in size and colour, and such are termed VARIETIES. Another still more important fact to be remembered is, that all insects progress through several stages:* *first,* the female lays an egg; this *egg* hatches and produces, *secondly,* a *larva,* which is a little animal called a maggot or gentle, a caterpillar or canker, a worm or grub, &c. Thus we have *maggots* in cheese and meat, called gentles by anglers; *caterpillars* on cabbages, *cankers* in roses, *wire-worms* and *silk-worms,* and all sorts of grubs. When any of these have fed until they are full-grown, having been compelled to cast their skins several times as they increase in size, they change, *thirdly,* to a *pupa,* chrysalis, aurelia, or nymph: they either enter the earth for this purpose,

* Plant-lice often bring forth young, instead of laying eggs, and so do blue-bottle flies, but not always; and there are a few other exceptions.

as most naked maggots do, or, like hairy caterpillars, they spin a web, in which they undergo their transformation or change; but the caterpillars of the cabbage-butterfly, and many others, merely suspend themselves to a wall or rail, and there remain unprotected during the winter. In this state they all rest without any symptoms of life, except when touched, until the substance of the enclosed larva has become perfected into the various members of its first parents, when, *fourthly,* out comes a flesh-fly, a butterfly, a rose-moth, a click-beetle, a turnip-fly, &c.; and this is called the *imago,* or perfect state.

The turnip-beetle, with whose history we will begin, belongs to the ORDER COLEOPTERA, from its wings, with which it flies, being folded beneath two horny cases. It is included in the FAMILY CHRYSOMELIDÆ, or golden beetles, for certain scientific reasons, in conformity with its structure, and is one of about one hundred species forming the GENUS ALTICA, sometimes written HALTICA.

The *striped turnip-beetle,* or, as it has been called, the turnip-fly, turnip-flea, earth flea-beetle, black-jack, &c., is named in our catalogues ALTICA NEMORUM.* The former word, derived from the Greek, alludes to the leaping powers of the genus, and the latter signifying that this species inhabits woods and groves, which were more especially its haunts before the cultivation of the turnip became general.

The economy of this little pest has puzzled the man of science, as well as the practical agriculturist, for many years; and for want of that rigid care which is indispensable in the investigation of natural history, numerous errors have been adopted, which have led to the promulgation of many false theories. Dr. Pearson believed at first that the white spots or dots observable on more than half the turnip-seeds were the eggs of the turnip-fly; but he was compelled to abandon that opinion, "having had no flies where the seed was sown in soil contained in pots covered with bell-glasses." "Rusticus," however, a contributor to the Entomological Magazine,† so strongly insisted upon it, that seeds steeped in brine, or otherwise prepared, have been sold in London at the seed-shops, to insure the grower against the attacks of the fly. It is exceedingly likely that the white dots are occasioned by minute flies alighting upon the seeds while they are drying, and depositing their excrement upon them, which is often white; or they may be particles of pollen from the flowers. It was, however, from the

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* Vide Curtis's Guide to an Arrangement of British Insects, second edition, column 74.

† Entomological Magazine, vol. i. p. 363.

careful investigations of Mr. H. Le Keux* that we were first made acquainted with the actual economy of this little beetle.

If the spring be warm the sexes pair from April to September, during which period the *eggs* are deposited by the female on the underside of the rough leaves of the turnips. She lays apparently about one egg daily; and ten pairs laid in a week only forty-three eggs. This indeed was under confinement; but the correctness of this estimate is supported by the fact, that in leaves taken from the field, containing as many as six larvæ, they were all of different sizes, indicating a variety of ages. The eggs are very minute, oval, smooth, and partaking of the colour of the leaf. See fig. 1. They are hatched in ten days; and the little maggots immediately begin to eat through the lower skin of the leaf, and to form winding burrows by feeding on the pulp. These burrows are visible enough to the naked eye when the larvæ leave them, and the cuticles are withered and discoloured; but in their early stage they are discovered with difficulty: indeed it is only by holding the leaf up to the light that they can be well detected.

The *larvæ* are pale, fleshy, and cylindrical, with six pectoral feet, and a proleg at the apex: the head is furnished with jaws and large dark eyes; and the first and last segments bear dark patches (fig. 2): they are full fed in about sixteen days, when they desert their burrows and bury themselves not quite two inches below the surface of the earth, selecting a spot near to the bulb, where the turnip-leaves protect them from wet and drought.

In the earth they become immoveable *chrysalides* (fig. 3), which are brought to maturity, I believe, in about a fortnight, when the beetle or fly, as it is called, emerges from its tomb, again to fulfil the laws of nature.

The *beetles* (figs. 4 and 5) are shining black, minutely punctured; the head is rather small, with two prominent orbicular eyes, finely granulated; the mouth projects a little, the upper lip and feelers being visible: just above the nose are placed two longish horns, each composed of eleven joints, the three next the head ochre-coloured, the first being the longest, the remainder dull black, the terminal one pointed: the thorax, or trunk, is broader than the head, narrowed a little before, with the sides rounded: the two wing-cases are moveable, and form an oval; they are twice as broad as the trunk, and four times as long; each has a distinct ochre-coloured stripe, sometimes approaching to white, running down the centre, generally winding a little on the outside, near the middle, and curved inward at the extremity: beneath are ample wings, twice as long as the body, and folded up

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

for protection when unemployed: the legs are of a rusty ochre, the thighs pitch-coloured, the hinder (fig. 8 *m*) being very thick and formed for leaping; their tibiæ, or shanks, are also the stoutest and thickly fringed on the outside towards the end (fig. 8 *n*): the feet are all composed of four joints (fig. 8 *o*), the tips as well as those of the shanks generally pitch-coloured; in the hinder pair the basal joint is considerably the longest; the third is formed of two slightly dilated lobes, roughened beneath with fine hairs, as well as the two preceding joints, for the sake of adhering to smooth surfaces, and they are thus enabled to ascend glass; the fourth joint is slender and club-shaped, and always furnished with two minute claws.

The mouth is composed of six parts (fig. 7); the upper lip or *labrum*, is large, broader than long, and a little narrowed before; the anterior margin is slightly concave, and furnished with two short bristles (fig. *e*). The *mandibles*, or teeth, form two sets, one placed on each side, so as to meet; they are strong, bony, and semilunate; one terminated by three, the other by four sharp strong teeth; the second being the longest, the lower one smallest (figs. *f f*). The *maxillæ*, or jaws, are two, placed on each side, beneath the teeth: they are small, terminating in two lobes, densely fringed with fine hairs at the apex; the inner lobe the largest, somewhat orbicular; the outer one smaller, being an articulated, somewhat ovate lobe (figs. *g g*): on the outside of each jaw is attached a moderately long and stout feeler or *palpus*, composed of four joints: the basal joint is clavate, the second is obovate and truncated, the third is much stouter and similar in form; the fourth is the longest, stout and conical, being somewhat pear-shaped. The *mentum*, or chin, is somewhat quadrate, the sides are convex, with the anterior angles acuminated (fig. *i*): the *labium*, or under lip, is somewhat quadrate, horny and truncated at the base, with a leathery oval lobe in front (fig. *k*); the sides are excavated to receive another pair of small feelers, or *palpi* (figs. *l l*); these are very short, stout, and composed of three joints only; the basal joint is cup-shaped and scarcely visible; the second stout and oval; and the third is very slender, with the apex pointed.

The length of the beetles varies from $\frac{3}{4}$ to $1\frac{1}{4}$ of a line; the line being the twelfth part of an inch: the longer ones are the females, which are considerably stouter than the males, and this is especially the case after impregnation.

When the beetle is feeding, the different parts of the mouth are all employed: the upper and under lips open to liberate the other organs; the two sets of teeth, or the toothed mandibles, as they are named, meet when closed, and from their strength and horizontal action they readily break the cuticle of the leaf. Indeed, some

that I put into a quill soon reduced the inside of the cork stopper to powder. The jaws seem to be adapted for keeping in the food during the short process of mastication, and the four feelers hold and steady any portion of the leaf to be eaten, and assist in conducting the detached morsels into the mouth.

From the experiments so successfully conducted by Mr. Le Keux, it appears that the female beetle lays but few eggs compared with most other insects, and that it requires a period of about thirty days to carry the animal through its various stages up to the time when it becomes a perfect beetle again, viz., it remains an egg ten days, a maggot six, and a chrysalis fourteen days: the beetles themselves are rather long-lived, for they have been kept in that state from July until the following February.

The turnip-beetle, and all the species of *Alticæ* related to it, are readily known by the great thickness of their hinder thighs, which gives them the power of leaping, like fleas, to a prodigious distance, considering their small size. Eighteen inches is about the greatest extent of their leap, which in a straight line would be, averaging their stature, 216 times their own length: and when it is remembered that this leap is performed in a curved line, it must be admitted that a considerably greater distance is achieved. They seldom walk, and when at rest sit with their hind legs folded under them (fig. 6*c*), ready to skip off in an instant, if disturbed, or when even approached: in warm weather, during sunshine, with the thermometer standing between 70° and 80° in the shade, they fly with facility.

This little plague is not confined to our island, for it is abundant in Germany, and common everywhere in Sweden, where it is very destructive in its perfect state. Probably in England no portion of the country is perfectly free from these insects, at least every bank and meadow harbours them to a greater or less extent, and they have been found also on grass lands which had not been ploughed for many years, and where there were no turnips within half a mile. It will be necessary to consider this part of their history before we enter upon a discussion of the remedies. The turnip-beetles hybernate, or live through the winter, in a torpid state, and may be found under the bark of trees, as well as beneath the fallen leaves, in the chinks of old timber and paling, the stumps of thorns and of other bushes, where the bark does not adhere close to the stem, and the hollow stalks of grass and stubble seem to afford them an asylum during the inclement months of winter; but inactive as they then are, the warmth of the hand is sufficient to revive them in a few minutes, so that an unusually mild day in January or March will partially seduce them from their retreats, and will render them almost as active as would the ardent sun of summer.

On the first indication of spring, if the weather prove fine, warmed by the sun and cheered by his rays, they arouse from their slumbers, and permanently leave their winter quarters for sunny situations, where they may be seen sitting on walls in considerable numbers, or sunning themselves on dry banks and on clods of earth, protected from the wind: they have been observed in gardens on turnips and cabbage-plants as early as March, and in April on the crops in the fields, but May and June appear to be the more usual periods of their first and most fatal attacks. The autumnal crops have been occasionally destroyed by them,* and in one instance I have seen recorded, as late as the middle of September. They may be said to be abundant from May to October amongst the grass, and in all fields, whether of wheat, oats, or barley: a friend of mine observed myriads on turnips in Surrey, on the 2nd of September, but they all disappeared in two or three days; and both sexes were common on the white turnips in Dorsetshire last October.

It seems that the taste of the turnip-beetle is far less fastidious than is generally imagined. This might be fairly inferred from its abounding in situations where the turnip does not grow: there can be little doubt, however, that it prefers those plants which are termed cruciferous, from the shape of their flowers, of which cabbages and turnips are examples; of these the leaves of the horse-radish, the common turnip, and the radish are its favourite food, but cabbages, cauliflowers, colewort, watercresses, ladies'-smocks, and hedge-mustard, called jack-by-the-hedge, are often attacked; the charlock or wild mustard is also sometimes covered with them at the end of April, and in May the leaves will be seen pierced with holes, but as soon as the turnips come up they desert other allied plants. Mr. Berry has recorded a remarkable exception, for he says that after consuming the cabbage-plants, the flies † attacked and destroyed the young hops, which belong to a very different tribe of plants. Köllar also states, that both summer and winter turnips left for seed suffer in warm and dry weather, from the attacks of the fly injuring the flowers, so as to spoil the produce of the seed.

The next subject to be considered is a remedy against the attacks of the turnip-beetle, which in some years must cause losses amounting to an enormous sum of money, for so long back as 1786 Mr. Young stated that the turnip-crop destroyed in Devonshire alone was valued at 100,000*l.* Now with regard to the *eggs*, we see that they are laid on the *under side* of the *rough leaf*, where they are pretty well secured from rain, and also protected

* In 1826 a crop was destroyed at Knutsford after the 21st of August.

† Might not these have been the *Altica concinna*, or some allied species?

by the strong and projecting ribs that support the leaf from any injury that might occur from the leaves being ruffled by the wind or other casualties; and the inferior skin being the most delicate, is best adapted for the entry of the infant and tender maggots into the substance of the leaf. It is not, therefore, at this stage that much could be done in destroying them.

The *maggots*, it is evident, live upon the *rough leaf*, and do little or no mischief to the growth of the plants; they dwell perfectly secure between the two cuticles, unless it be when they leave the burrows they had first commenced, probably not of common occurrence, to form new ones at a remote part of the same or upon another leaf. At this period they are most probably affected by parasitic enemies.

The *chrysalis* is buried only just beneath the surface of the earth, but it is probably protected in a slight web, forming a cradle for it to lie in free from pressure. I think some efforts might be successfully made for its destruction at this time.

It is, however, in its last and perfect state that the mischief is done. It is the *beetle* which destroys the two first *smooth leaves*, called the *cotyledons*, and the heart of the plant between them, by piercing them like a sieve, destroying the cellular tissue and stopping the growth of the plant. They also feed upon the rough leaves, drilling them full of round holes (fig. *d*), which are larger on the upper than the under side of the leaf; and if the appetite of the beetle be not satisfied, he enlarges the aperture, and thus gives it an irregular form, which dilates with the growth of the leaf: hence the large holes we see at a later period. After all, it is at this stage of their existence, I am inclined to believe, that we can attack them with the best prospect of success, if they cannot be kept off by other means.

In collecting the turnip-beetles by sweeping and various methods, large numbers of small carnivorous beetles, belonging to the *Carabidæ* and *Staphylinidæ*,* are found with them: these probably feed upon the larvæ; but, from the very recent discovery of the early stages of the turnip-beetle, we are yet ignorant of the *parasites*, of which it may be presumed there are more than one species, that prey upon the maggots and chrysalides; for it is a wise dispensation of Providence to keep every animal in check by some other that is either more powerful or more sagacious than itself, and this counteracting effect is produced in a degree equal, or eventually superior to the noxious animal, so that in a greater or less space of time the destructive power may be rendered no longer formidable, or be absolutely annihilated by the attacks of its parasites. This natural process, though never failing, is

* Curtis's British Entomology, folios 446, 758, &c.

often too slow in its operation to secure immediate relief; the farmer must, therefore, devise means, if possible, for the more speedy destruction of the enemy.

The beetles are seldom found in shady places, except during the winter season, and they cannot bear cold and wet, which are great protections against their increase; it consequently follows that warmth and sunshine are far more favourable to their multiplication, and in such seasons they are most to be dreaded. Showery weather, after a long drought, and cloudy days with gleams of sunshine, also render them abundant,* as such seasons do the greater portion of insects, but in a few instances they have been known to do much mischief even in cold weather.

That the turnip-beetle is endowed with an acute and powerful sense of smelling, is proved by his flying against the wind, and deserting all other plants as soon as a turnip-crop appears in his neighbourhood. Mr. Le Keux says, that in May, 1836, when the thermometer was at 75° in the shade, during a *south wind,* great numbers were on the wing, and all proceeding *southward;* and again, that eight acres, forming the summit of a hill in Devonshire, were sown with turnips, and when the young plants were just rising above the ground, the wind being for more than a week at south-east, wafting the scent to the north-west, they were so destroyed on this side, that nearly an acre was bare, whilst the south-east side was not touched, until the plants had attained a size to render the attacks of the beetle of little consequence.

From what has been stated, it appears that no season will secure us entirely against the attacks of the turnip-beetle, and that no soil is considered safe from them is evident upon the best testimony; it is very destructive upon strong lands, and not less so on light ones. Neither is the period of their attack limited, for as one pair of insects may produce five or six broods in a season, there is a constant succession, which renders any plan for extirpating the beetle in any of its three early stages scarcely practicable. As the turnip when in rough leaf is not in any danger from the attacks of the beetle, it is evident that our first care must be to preserve the young plant, and this can only be done by the preparation of the soil, or using such speedy means the instant the beetles appear, as will destroy or drive them away. The primary object will be to discover the best manure for that purpose, and a dressing that will render, if possible, the soil obnoxious to the insect.

It has been correctly said, "that the manure which most effectually promotes the growth of the plant will be the best defence

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* A field of turnips is stated to have been destroyed by the fly in a few hours before a thunder-storm at Rockingham.

from the insect; and that when the growth is slowest, the danger from the insect is most serious." This arises in a great measure from the advantage that insects have over vegetation; a gleam of sunshine is almost sufficient to call them into active life, as we have before observed, and as is evident from the swarms of delicate gnats that may often be seen dancing in the air when frost is on the ground even in January; but it requires the accumulated rays of the sun, and a much longer duration of warmth, to set in action the fluids of plants.

It will not be irrelevant to the subject to take a cursory view of the recommendations suggested by various eminent agriculturists; and as the results derived from some of their experiments have been greatly at variance, I may venture occasionally to offer an opinion; but as it is not strictly within my province to *determine* such practical points of difference, I can only hope that they may be encouraged to prosecute their valuable researches until such variations are satisfactorily explained.

Whether any *direct* protection against the beetle can be expected from manure, since it is ascertained that it is not upon the seeds that the eggs are laid, now becomes a question; for when the maggots escape from their burrows in the leaves, and enter the earth, in order to become chrysalides, before changing to beetles, the manure, I should think, seldom contains sufficient ammonia to destroy them, and, if I mistake not, any moderate fermentation would rather facilitate than retard their metamorphoses; moreover, the instinct of insects is so perfect, that the maggot would most assuredly avoid obnoxious spots, so that, if any manure were spread that would injure them, unless it formed a very uniform stratum, it would not insure success, although great advantages might be derived from its use.

Burning has been found the best preventive against the beetle by some, which is readily accounted for, since it would destroy any chrysalides in the land, and as the beetles may be in abundance in the field when it is preparing for turnips, burning would, of course, be destruction to them, and spreading the ashes afterwards over the ground will prove an additional security; but such a system does not suit sandy soils, neither can it be followed up regularly on any land.

Feeding off the turnips is strongly recommended as an antidote to the beetle, as well as from its peculiar advantages of manuring and preparing the land for the barley-crop and succeeding seeds. I am disposed to attribute the advantages derived from sheep-folding, as regards the beetle, to the perfect stamping down of the soil and herbage, by which all insect life is destroyed, rather than to any peculiar quality in sheep-manure, unless it be contained in their urine.

However Mr. Sutton's "plan of preparing the fallows for the seed, and leaving the land for ten days or a fortnight before sowing," may have answered occasionally, as his hypothesis is not correct, we must look to other causes for his success, and this is probably the exposure of the chrysalides to drought and changes of temperature, which would naturally destroy them; the opportunity the weeds have of growing up and overpowering the crop seems to be a fatal objection to this process. I quite coincide, however, with Mr. Cowdry, that the destruction of the beetle may be greatly facilitated by the mode of ploughing he suggests, for if the chrysalides be deeply buried under the furrow, they will perish for want of sufficient sun and moisture to bring forth the little beetles, or even if they hatched, they would not be able to extricate themselves from the earth heaped upon them; this is taking it for granted that the chrysalides are in the soil, which would depend upon the character of the preceding crop. And here again we require information, for if the maggot of the turnip-beetle will live in the leaves of clover and other artificial grasses, then such a process as deep ploughing becomes an effective remedy; if not, it would only be useful where the first crop had failed from the land being infested with the turnip-beetles.

If the turnip-beetle were not common everywhere in Sweden, it might be presumed that northern latitudes were uncongenial to its habits, for it did not appear to be known in Scotland until 1826, and it has done but little mischief, I believe, since; but this is attributed by Dr. Fleming and others to the turnips being drilled in; indeed, broadcast is generally considered inferior to drilling, and the system of ridging for the drill is recommended by most farmers. Cold and wet we know do not agree with the perfect insect, and such seasons may be still more pernicious to it in its earlier states, which may account for its rarity in Scotland, where I do not remember to have noticed it, and in parts of Forfarshire and in East Lothian the fly is said to be scarcely known. Mr. Bowie, however, of Arbroath, seems to be well acquainted with the effects of the fly, although he only remembered its attacking the plants once in rough leaf, and that was during the hot and dry summer of 1826. I see also that at Cramond, near Edinburgh, it is now abundant. No notice has been taken of it in Scotland, except on the eastern side, where it may be expected, as in the eastern counties of England, that the fly would be most fatal to the crops, as there is a much less fall of rain on that side than in the western and south-western quarters of the kingdom; we see, however, from the destruction recorded in Devonshire, that in a warm district, although subject to a great deal of wet, its progress is not always impeded.

It is the opinion of a great many agriculturists, that raw and

long manure harbours the beetle, and if turnips be sown on a stubble-crop, they are often completely destroyed. I see Mr. Webb Hall states that he has had to sow stubble-crops three times over, and seed sown on stubble late in August has been taken off by the beetle in more than one instance. Whether this arises from the hollow straws affording a retreat for the beetles, or that the weeds had supported them or the maggots, so that the chrysalides were lying undisturbed in the land, is not easily explained.

Mr. Linton and many others recommend drilling-in, not less than three or even four pounds of seed to the acre, and six or seven pounds broadcast; for he very justly observes, that thick sowing causes the plants to grow much more rapidly when young than thin sowing; and by drilling in with the seed a peculiar compost, containing the strongest animal manures, the fly, he says, has never yet disappointed him of obtaining a good crop.* I think it probable that the ammonia in this potent manure may be disagreeable, if not destructive, to the insect, and the rapid growth of the plant, from its stimulating effects, defies their attacks. The vegetation of the seed may be accelerated by steeping it in water for twenty-four hours; and the surest way to obtain a strong crop is to sow seed of the same age, otherwise the plants do not come up simultaneously, and the fly will attack and destroy the crop in detail.

Mr. Linton also adds that he has found more benefit from the manure he describes in the succeeding crops of clover-seeds than from three or four chaldrons of lime to the acre. With regard to the use of lime, a great deal must depend upon the soil on which it is used, which may account for the conflicting opinions respecting its effects in protecting the turnips against the fly. From six to eight bushels of quicklime per acre may be sown over the young plants successfully in dry weather; but it must be repeated after rain or dew; and this, as well as soot, requires to be regularly and evenly dusted over the plants. Mr. Birk says that he used slaked lime with perfect success; and although profusely, it did not at all injure the plants. It should be slaked at the time of use, and ought to be spread in the very hot state, when it burns the fly. Some danger to the plant seems to attend this process, arising from the heat generated by the lime; at least so I presume; but some little explanation is required in these statements to distinguish clearly between slaked and quick or unslaked lime. Very different were the results from Mr. Le Keux's experiments. Forty bushels of lime per acre were spread, he says, immediately before the seeds were sown, and did no good;

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* Journal of Royal Agr. Soc., vol. i. p. 452.

and when the plants came up, and the fly was observed attacking them, lime-dust was thrown over them, so that many of the plants were quite white with a coat of it; after which as many flies were found upon those as upon any that were free, and they were eventually devoured. This is again quite at variance with the opinion, that repeated dustings of ashes and soot, when the plants are wet with dew, will keep off the fly, and prevent their feeding. In another place he states, that the upper part of a field in a sheltered situation, with a south aspect, which had been sown with barley, was well dressed with lime, and sown early in May with whitestone turnips, which were destroyed as soon as they appeared above ground; the land was sown again, and harrowed, the surface being thickly strewed over with wood-ashes; the plants were, however, devoured as rapidly as before.

The growth of the turnips being stunted by too frequent repetitions, they become fingery on light sandy soils, and are then more likely to fall a sacrifice to the fly. A good coat of clay or chalk has the effect in Norfolk and Suffolk of invigorating the land, and giving it the power of again producing good crops once in four years. The culture of mangold-wurtzel is well deserving the attention of the farmer, when the land gets tired of turnips; and it has the additional recommendation of not encouraging the increase of the turnip-beetles. As it is quite certain, I should say, that the beetles are attracted by scent, it appears to me likely that, if a field of turnips were planted round with a belt of mangold-wurtzel, the turnips might escape their attacks, if not entirely, to a very considerable extent; especially when the insects are believed to come from a distance; for at the early stage of the plants a few hours of respite may be of vital importance. The Swedish turnip, or *Ruta-baga*, whether it be a hybrid produced by the turnip and cabbage, or a distinct species, has not the strong scent at an advanced period which is so perceptible in the English turnip when in rough leaf; and if there be as marked a difference of smell in the seed-leaves, it would give the former a decided advantage in exposed situations, where the beetles are attracted from distant localities: being sown in May or June, however, is, I conceive, not a recommendation, as I believe that to be a period of the year when the first principal brood is generally at its maximum, as the second is in August or September; but the temperature of the seasons may in this respect make a variation of a fortnight or three weeks on either side of the average: however this may be, it is admitted on all sides that the beetle is weakest in July.

I fear, on the other hand, that no early sowing can insure the turnip-crop; for as the beetles hybernate, the same warmth and sunshine that make the seed vegetate will bring the swarms of

beetles from their retreats; and it is worth considering whether by early sowing we do not entice a hungry horde from their winter quarters, or from the banks and meadows where they are at first supported; whereas by not sowing until Midsummer the beetles may in the mean while be starved and drawn off to more favourable localities, or have fallen a sacrifice to small birds and the casualties of the wet and cold of our spring. Such seasons we know do not agree with the beetles; and I have observed that when the dew is upon the turnips in the autumn, they keep under the leaves, and appear to be asleep; and windy weather has a similar effect in rendering them quiescent. The crops being attacked and destroyed in the autumn, does not altogether militate against good success at Midsummer, especially in forward seasons. Similar objections to the above may be urged against sowing the white turnips with the swedes; for if the quantity of beetles be small, the swedes may be preserved in consequence of the turnip being their favourite food; but on the other hand multitudes may sometimes be thus attracted from a distance, which would not otherwise, it may be presumed, have detected the swedes, from their scent being less perceptible.

It is now three years since I intimated that "some benefit might be derived from destroying those cruciferous plants, *Erysimum alliaria* and *Cardamine pratensis*,* to which these *Alticæ* are so strongly attached, for they grow in abundance in every hedge and meadow: they appear long before the turnips come up, and attract and give support to the parents of the future swarms that are to sweep away the crops of the farmer." † As these plants often flower at the beginning of April, and produce their leaves at a much earlier period, it is almost certain that they nurse the fly, and are its great resources for food and nourishment in the earliest days of spring; but how to eradicate the *Cardamine* is for future consideration. The hedge-mustard, and other cruciferous plants on banks and road-sides, are quite under our control; and it is a duty which we owe to our neighbour as well as to ourselves, to keep our fields and hedges clear of charlock and every allied weed of that family, all of which harbour the turnip-beetle.

Before dismissing this portion of the subject, two or three remarks will be useful. It is certain that manure gives strength to the turnip-plant, but it is doubtful if it will destroy the beetles. Hoeing and rolling may harass and kill many of them; and as this process promotes the more rapid growth of the plants, it must be attended with no slight advantages. I expect also that if it

* Curtis's Brit. Ent., pls. 569 and 179, called sauce alone, or hedge-mustard, and common ladies'-smock.

† Ibid., folio 630.

were performed in damp days, or after heavy dews, the benefit would be increased; for if the beetles leap in moist weather they often fall upon their backs, where they stick, and, after being exhausted, become torpid and apparently dead, if the air be cold; but they reanimate as they are dried by the sun. In cold and wet weather it might not prove less efficient; for multitudes of the flies are then sheltered under and about the clods, which being broken down, the insects must perish by the pressure; and if there were any chrysalides in the earth, they would in all probability suffer the same fate.

There are many who consider that turnips should be sown immediately after ploughing, and that much of the success attending a crop depends upon the diligence employed in getting in the manure and seed; whilst some maintain that the land should lie undisturbed for a fortnight before sowing. Such conflicting opinions, as far as the fly is concerned, may often be reconciled by the difference of the seasons when the observations were made.* We know that turnips must not be sown in too dry nor too wet a state of the soil, yet this is precisely the state most fitted for the production of the fly; for it is well ascertained that a moderate degree of moisture is necessary to bring forth or to hatch almost all insects, and if this be accompanied by a mild air it is the better suited to them; it is therefore reasonable to expect that after a fine early spring the turnip-beetles will be found most abundant.

From the dislike the fly has to repeated wet, I have always thought that watering the turnips would be highly useful; and this opinion is supported by Mr. Bayldon, who recommends them to be watered every other day, four, five, and six times, if necessary.† Irrigating the land would not have so good an effect, I think, as watering, because the beetles would only be floated off the leaves, if they were detached at all; and if they were left thus for two or three days, there would be a great chance of their recovering when the plants were left dry, whereas by the watering they would be forcibly brushed off, and get set fast in the earth and die. The benefit would be most felt, I conceive, on heavy lands, with regard to the annihilation of the beetles; but it would everywhere have the advantage of destroying the chrysalis, by

* The perusal of the report in the Transactions of the Doncaster Agricultural Society is strongly recommended, and in their "Analysis of the Returns," the date of every year is alone wanting to make it invaluable.

† How is this to be done? In a garden it might probably have a good effect, but on a score of acres? If, indeed, a water-cart filled with brine could be conveniently once run over a field, it might, as there stated, prove a partial remedy, and it certainly is worth trying; for even should it not be effectual on that point, it would, no doubt, prove beneficial to the growth of the crop.—F. Burke.

stopping up the pores of the soil, and so preventing the exit of the fly.

Nitrate of soda has been tried in two instances on crops of swedish turnips with very beneficial effects; and it probably assists, from its peculiar qualities, in checking the increase of the beetles. The nitrate was sown two or three days after the seed; and it may be used on all soils excepting on chalk. It should be sown broad cast, mixed with wood-ashes, which enable the sower to spread it more regularly.

We now come to what may be termed direct remedies.

The Paul-net, as it is called, after its inventor, although it has been considered as a toy, yet I am of opinion might be usefully employed; for I have seen a quart bottle filled with the little turnip-beetles that were all caught with this net. If I remember correctly, Mr. Paul's plan was to sow a small spot with white turnips early, as a decoy, and over that space to draw his net.* It always struck me that vast quantities made their escape by skipping out of the net, which was its greatest defect, but this might be remedied by placing some sawdust at the extremity of the bag, mixed with lumps of common ammonia, or sprinkled with spirits of turpentine, which perhaps would be better; but either of these would kill a great many, and stupify the remainder, until the contents of the net were subjected to sufficient heat to deprive them of life. This process is no doubt troublesome, and requires to be repeated; and unless, perhaps, some alterations were made, it would not answer on an extensive scale. This, however, is no fatal objection to the principle.

A board newly painted or tarred, and drawn over the turnips, will catch multitudes of the beetles; for on being disturbed they leap against it, and cannot release themselves. I should recommend white paint; and the brighter it is the better, as all insects are attracted by light colours. Neither wet nor windy weather would be suited to these operations; for it is ascertained that the beetles are at such seasons disinclined to move; neither would mid-day in fine weather do, as they are then active, and fly well; for it is a well-known fact, corroborated also by the flight of swallows, that in hot days and sunshine insects fly high, whilst in damp weather they keep upon or near the ground.

Fumigation by burning stubble, weeds, &c., to windward of the field, so that the smoke drives along the ground, has proved effectual; but I should prefer burning to leeward as a preventive, for as the beetles are attracted by the scent of the turnips, and fly towards the wind, they would be baffled by such a manœuvre.

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* A very good representation of this net will be seen in Kirby and Spence's Introduction to Entomology. pl. 24, fig. 3.

Watering the plants with brine sufficiently strong to affect the insects, but not strong enough to injure the young plants, would, I expect, prove a most successful remedy; and when in rough leaf it would also kill the larvæ, and even destroy the eggs that were exposed to its influence.

In Hanover fields of white turnips have been preserved from the fly by thickly sprinkling the *dust of chalky roads* on the young plants at night, when a heavy dew is falling, until they appeared covered with the powder. The fly, it is said, will at once disappear, especially if the next day be a bright sunshine, and the dust is dried upon the leaves, which prevents their little teeth from gnawing the leaf, or disgusts them in some other way, and they depart to more agreeable quarters. If the sprinkling be immediately succeeded by heavy rains, so that the dust is washed off, the operation must be repeated. Several other means are suggested by M. Wundram, which have proved to be useless in this country; and his reasoning induces a belief that he is not well acquainted with the habits of the turnip-fly. An infusion of wormwood sprinkled over the young plants and seed-beds will, he says, secure them from the attacks of the flies, as they dislike the bitterness thus conveyed.

Drawing boughs of the elder over the field is supposed to annoy the beetles, and drive them away; and the leaves of the alder, when fresh gathered, being covered with a glutinous liquor, and those of the lime, &c., when the honey-dew is upon them, are recommended to be strewed in gardens for the purpose of catching the turnip-beetles.

I confess that I have no faith in the plants being rendered obnoxious to the fly from steeping the seeds in oil, brine, brimstone, or milk, as practised by many. Such immersions may render the plants stronger, or cause more of the seeds to vegetate, which will at once account for the success that is said to be derived from this process. If, indeed, the eggs of the insect were laid upon the seed, the oil and brine would be most efficacious; but that notion is exploded.

Mr. Le Keux says that washing over the plants with sulphate of potash had no effect; and he very justly observes, that if the upper surface of the leaf could be poisoned, the *beetles* might feed upon the under side with impunity. Powdered sulphur, strewed one-tenth of an inch thick, did not deter the flies from attacking the plants, but it improved their appearance. Snuff, asafœtida, a powder called *anti-tinea,* for preserving furs, proved equally powerless. They did retire from smelling-salts (Carb. am.), and died immediately on being exposed to the effluvia from it; but a small bit placed an inch from the plant would destroy it also. This, or something that would overpower the scent of the turnips, might

perhaps be advantageously employed in driving away or deceiving the fly. One ounce of tar, one ounce of olive oil, and two ounces of strong caustic potash, well mixed together, and shaken up with the requisite quantity of water, were next poured, the fourth day after sowing, over a patch on a hill swarming with the fly, at the end of August. Not many of the seeds came up, but the few plants from them were of a healthy colour, and acquired the rough leaf; a few only on the windward side being punctured; but several days' rain occurred at the most critical time, which might be their best protection.

Such are the remedies proposed; but I fear it is not by the experiments of a few philosophic men that we can hope to discover any positive antidote to so great an evil. We want correct data from every sort of soil under the various influences of climate and effects of cultivation, before we can fairly grasp the subject. Until we became acquainted with the *economy* of the beetle we were groping in the dark. That important discovery has brought us a few steps towards the light; and those who wish to follow in the path of truth should try and examine Mr. Le Keux's experiments, which it is easy to do, by filling a garden-pot with earth, carefully sifted to take out all worms, centipedes, or other living animals, which might destroy the chrysalides. When this is done, plant in it a small turnip, in rough leaf, having a fine wire-gauze guard, large enough to enclose the plant, and fitting just inside the top of the pot. One or more pairs of the beetles must be placed, with a fresh turnip leaf, in a large-mouthed transparent bottle, then tie over the end a piece of muslin, to prevent the escape of the insects; for if the cork or stopper be put in, the bottle will become wet inside, which will prevent the females from laying any eggs. I imagine they will not adhere to the damp leaf. The leaf may be examined daily through a magnifying-glass, and as soon as any eggs are discovered they may be placed in the pot where the turnip is growing, that the little maggots may be able to get at the living leaves as soon as they hatch. The progress of the insect may thus be traced through its different stages; and it will only be necessary to place the garden-pot in a saucer, into which water should be daily poured, if necessary, to nourish and refresh the plant.

Let us not forget that amongst our best friends are the small birds, a great number of which, such as the grey and yellow wagtails, no doubt destroy incredible numbers of these insects in their various stages. Their nests ought to be protected, and the birds themselves defended from persecution.

There is another species of *Altica*, whose habits are similar to those of *Altica nemorum*, which materially assists in injuring the turnip-crops. The habits of the brassy or tooth-legged turnip-

beetle are not known, but may be expected to resemble those of the striped turnip-fly. I will now describe this insect, the *Altica concinna,* which is the same as the *Altica dentipes* of foreign authors (fig. 9).

It is more oval, convex, and shining than *Altica nemorum*, of a greenish-black colour, more or less tinged with a brassy or copper hue. The horns are only half as long as the body, and thickest towards the extremity, of a pitchy colour, with a few rust-coloured joints next the head: the trunk or thorax is thickly but very finely punctured: the wing-cases are scarcely twice as broad as the trunk, but three times as long, having ten lines of strongly-impressed dots down each. The wings are ample; the legs are black, the shanks or tibiæ are bright rust colour at the base; the hinder thighs are very stout (fig. 10 *m*); the intermediate and hinder shanks are armed outside with a short acute tooth, below the middle,* and fringed with hairs and toothed with spines (fig. *n*); the feet are dusky, with four joints (fig. *o*) similar to those of *A. nemorum.* Length from $\frac{3}{4}$ to 1 line.

It inhabits hedges, nettles, grass and turnip-fields; and is abundant throughout England and the south of Scotland in the spring and summer.

I had nearly forgotten to remark that there is another little beetle of the same genus, far from uncommon upon the turnips, named *Altica obscurella;* but as I am ignorant of its economy, I refrain for the present from describing it.

In the investigation of this subject I have thought it necessary to consider every bearing that connects the beetle or fly with the turnip-crop, that neither its habits nor any circumstance affecting its economy might be overlooked; but in treating of the other insects I shall not have such a variety of materials to digest, which will allow me to render their history more concise. I am now induced to recapitulate the leading features contained in the foregoing account, that they may be brought at one view before the reader.

There are at least two species of turnip-flies or beetles, the *striped* and the *brassy.*

The habits of the latter are not known.

The *eggs* of the former are laid upon the under side of the rough leaf, from April to September: they hatch in ten days.

The *maggots* live between the two skins or cuticles of the rough leaf, and arrive at maturity in sixteen days.

The *chrysalis* is buried just beneath the surface of the earth, where it remains about a fortnight.

The *beetles* live through the winter in a torpid state, and revive

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* From this circumstance it has been recently named *Chætocnema concinna.*

in the spring, when they destroy the two first leaves, called the cotyledons, or seed leaves.

There are five or six *broods* in a season.

These insects are most to be feared in fine seasons.

Heavy rains, cold springs, and long droughts, destroy them.

Their *scent* is very perfect: the beetles fly against the wind, and are attracted from a distance.

To extirpate them during the first three stages is apparently most difficult.

The beetles are sheltered in hedges, banks, under bark of trees, &c.

Their *parasites* have not yet been discovered.

First appearance of the beetles to be punctually observed, as affording the best chance in applying remedies.

Manure to render soil obnoxious to the insects scarcely to be expected.

Rapid growth of the plant the best security:

To secure which *sow plenty* of *seed,* and of the same age.

Burning beneficial, by destroying the chrysalides.

Sheep-folding must destroy the insects in every state.

Deep-ploughing excellent when the chrysalides are in the soil.

Drilling far superior to broad cast, and believed in Scotland to keep away the beetles.

Dangerous to sow on a *stubble-crop;* and *long raw manure* harbours the beetles.

Lime and soot, the benefit derived from them in this way very doubtful.

Mangold wurtzel not favourable to the beetles; and *swedes* probably less attractive than white turnips.

Mixing white turnips with swedes not desirable, as the beetles may be attracted by the strong scent of the former.

Early sowing attended with disadvantages.

Destroy charlock, and all cruciferous weeds in fields and hedges, as they afford support to the beetles before the turnips come up.

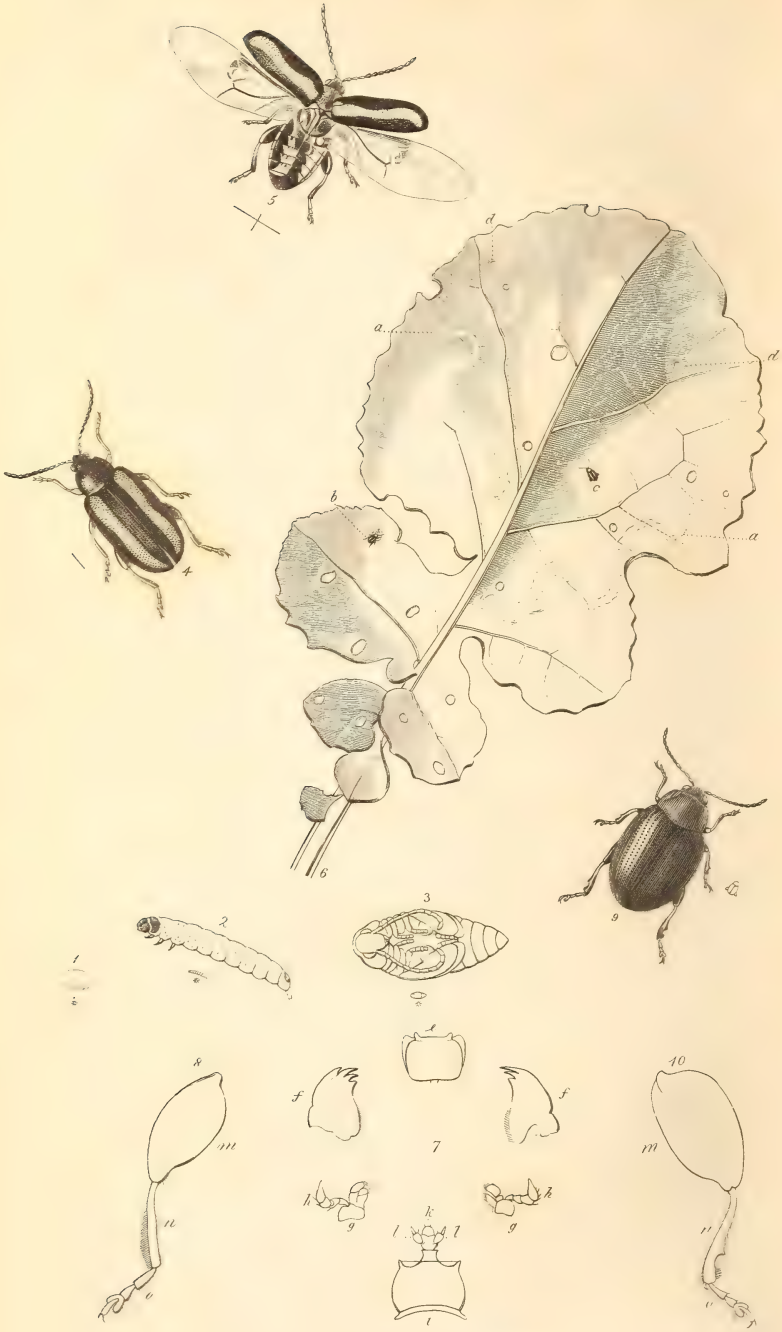
Hoeing and rolling harass and destroy the beetles.

Watering the crops, especially with weak brine, beneficial.

Paul-net and *painted boards* useful in destroying the beetles.

Fumigation by burning stubble, &c., will keep off the beetles.

There are many other remedies proposed, some of which it might be well worth trying; and if we be defeated in our endeavours to vanquish this insect enemy, we must take the field again with fresh vigour until our efforts are crowned with success, and neither despair from disappointments, nor rest in listless security from the apparent inertness of our foes. If we look back for one instant to experience, we shall find that after violent attacks of disease in the animal, or of blights in the vegetable king-



J. Curtis v. & sculp. Jan. 1841

doms, they are generally succeeded by a respite of many years, which throws us so much off our guard, that when they return we are not prepared with any proper remedies, and not unfrequently they are altogether forgotten; thus after a lengthened interval of tranquillity, when we think the hordes of hostile insects have departed for ever, they suddenly make their appearance, and take us by surprise and at advantage. The intelligent farmer must therefore be up and stirring, to detect the first breath of infection, and be instantly prepared with his remedy.

EXPLANATION OF THE PLATE.

Fig. 1. The egg of the striped turnip-beetle or fly, *Altica nemorum.*
Fig. 2. The larva or caterpillar.
Fig. 3. The pupa or chrysalis.
Fig. 4. The beetle or fly represented walking.
Fig. 5. The same flying.
Fig. 6. A turnip-leaf:
- *a* The burrows formed by the caterpillars.
- *b* A male beetle feeding, of its natural size.
- *c* A female beetle at rest.
- *d* Holes recently eaten by the beetles.

Fig. 7. Six organs of the mouth:
- *e* The labrum or upper-lip.
- *f* The two toothed mandibles.
- *g* The two maxillæ or jaws.
- *h* Their palpi or feelers.
- *i* The mentum or chin.
- *k* The labium or under-lip.
- *l* The labial palpi or feelers.

Fig. 8. A hind-leg:
- *m* The thigh.
- *n* The tibia or shank.
- *o* The tarsus or foot.

Fig. 9. *Altica concinna*, the brassy or tooth-legged turnip-beetle; the smaller figure shows the natural size.

Fig. 10. A hind-leg of the same:
- *m* The thigh.
- *n* The tibia or shank, with the tooth and spines.
- *o* The tarsus or foot.

Obs. All the figures are highly magnified, excepting those upon the leaf, and they are all drawn from nature; but Nos. 1, 2, and 3 were furnished by a friend; their natural sizes are given beneath each object, and marked with a *; the line and crossed lines also added to figures 4 and 5, give the length and breadth of the living insects.

XX.—*On the Culture and Usefulness of the Italian Rye-grass (Folium Trefolium).* By J. Rodwell.

The following results are deduced from a field of six acres of alluvial sandy loam, with a subsoil of crag :—

The preparation of the field was beet-root, sown in May, 1838, followed by wheat drilled in November.

On the 4th of May, 1839, four pecks an acre of the Italian rye-grass were sown with "Bennett's" seed-engine, and hoed in with the wheat then growing. The wheat, a heavy crop, was harvested the last week in September, leaving a very good plant of rye-grass which, after removing the wheat, soon became vigorous and strong. This autumnal crop was fed by sheep from October 20th to November 18th, carrying eight sheep to the acre four weeks.

March 26, 1840.—The plants of rye-grass now very luxuriant, the blades 14 to 16 inches long, with the seed formed.

This growth fed with sheep until the 1st of May, and carried twenty sheep, with their lambs, to the acre five weeks ; thus affording a healthy and very nutritious food ; sheep and lambs thriving well upon it at the most trying season of the year.

From this period, May 1st, the field was saved up for seed, and mown July 5th, its growth having been most rapid in comparison with other grasses. The plant in its then stage was 4½ feet long, the growth of sixty-five days ; its produce 32 bushels of seed to the acre ; and the straw after threshing eaten by every kind of cattle—sheep very fond of it.

The succeeding crop was again fed with sheep, and carried ten sheep to the acre, fourteen weeks, to November. The field was then ploughed up, and is in preparation for oats.

On another field of four acres of stiff loam, with a subsoil crag, it was sown in May, 1839, and hoed in with wheat, the rye-grass being mixed with red clover. The first growth was fed in March and April with sheep ; the second growth was mown with the clover for hay July 8th ; and the third growth was mown August 30th, when it was 4 feet long, the growth of fifty-four days. This crop was used in its green state for soiling horses and cows in the yard.

Thus I have shown not only the rapid growth and luxuriance of this grass as an early spring food, as well as its great productiveness during the summer, but in every case where it has been tested the preference given to it by every kind of cattle.

Alderton, near Woodbridge,
March 10, 1841.

XXI.—*On Early Spring Feed.* By Matthew M. Milburn.

PRIZE ESSAY.)

The increased quantity of stock which the farmer is enabled to keep by the introduction and successful cultivation of green crops, requires his best attention to furnish them with a constant supply of green food, especially such portion of his stock as are not intended for fattening. The use of the artificial grasses on arable land in summer, and of turnips in the winter, has been brought as near perfection as may be; but it is quite certain that the wants of the sheep and cattle, from the time when the turnips are consumed to that when the grasses become available, are not equally well provided for. In order, as far as possible, to remedy this deficiency, recourse has been had to the cultivation of turnips which long retain their nutritious qualities, and the swede has been truly invaluable for this purpose. But while these roots have furnished very palatable and nutritious food for one portion of the stock, they have altogether failed for the young—the principal object of the breeder's anxiety. For as well as having an abundant flow of milk from the dam, every breeder is desirous of training the young stock to help themselves as soon as there is food of a proper quality available for them; and if the young lambs in particular are kept from green food until they are turned into the gross clover leys with their dams, there is great danger that a portion of them will be lost. It is generally desirable to keep the clover leys free at least until May, and long before that time the young stock should be trained to eat a considerable portion of green food.

With the view of supplying this want, several crops have been cultivated for early feed in the spring, with greater or less success, and under greater or less disadvantage, according to circumstances, but the farmer who occupies a poor soil is, more than any other, under the necessity of grappling with the difficulties he may have to contend with; for lateness of vegetation and certain destruction of his crops of grass are sure to be the consequence if he break into them before they attain a proper degree of maturation, and yet he has also the greatest difficulties to surmount in cultivating any spring crop.

The farmer, on the other hand, who cultivates rich fertile land where he has a deep alluvial soil, growing every crop luxuriantly, can easily free a pasture early in the autumn, and have it full of young grass as early as he may require it, and knows nothing of the difficulties which attend his less favoured neighbour.

The avidity with which any new variety of grass or plant

promising early growth is tried indicates how desirable a point it is to secure an early supply of succulent food. At one time it was hoped that this desideratum was discovered in the crimson trefoil. The writer of this paper made a trial of it at its first introduction. It was sown upon a wheat stubble, on land intended for turnips, and got in the first week of September, after one ploughing and a very slight dressing of compost. The greatest part of it went off by the frosts during winter—one plot was eaten with the ewes and lambs in April, but the produce was so trifling as to be a mere mockery to the animals. The remainder was allowed to remain to see whether it would afterwards be available. It was not broken into until the latter end of May, indeed after the sheep were shorn, and was so thin and stunted as to be scarcely worth the trouble of cultivation. Owing to the lateness of the season when the land was broken up the turnips on the trifolium piece failed—the barley which succeeded was overrun with weeds, and the red clover from this too rapid succession of the *trifoliums* was unusually bad.

The writer was scarcely satisfied with these experiments, and imagined he had met with foreign-grown seed too tender for our country, and determined to endeavour to procure English seed. The introducer of it, J. Foaker, Esq., very kindly sent him a small parcel for a trial, but though very carefully tried under the most advantageous circumstances he had to pronounce it most decidedly unsuccessful.

Some farmers tell us of the success of feeding the ewes at yeaning time with young *furze,* portions of which they annually burn, to have it of the requisite growth. As this however can apply only to sheep of constitutions peculiarly strong, it is scarcely worth notice.

The winter tare is one of the most valuable esculents for stock in possession of the cultivator, and affords the greatest bulk of nutriment of any cultivated green crop, turnips perhaps excepted, and is relished at all seasons and by every kind of stock. It is sometimes resorted to for depasturation in the spring, with a view to subsequent soiling, but it is after all rather a *summer* than a *spring* crop ; and it is more than problematical that the injury done to the crop by spring feeding upon it is greater than the amount of spring food thus obtained. If it be worth while to have a supply of early feed, it is worth while clearly to provide a crop specially for that purpose. As a *spring* crop, according to the writer's observation and experience, it is decidedly inferior to other cultivated plants.

The writer of this paper has seen rye-grass very successfully cultivated as early spring-feed sown alone. It requires to be sown a whole year before it is fit to consume, and thus lies open

to the objection of interfering with good husbandry, particularly the hoeing of the corn crop, with which it is sown a whole year before, as well as preventing the ploughing of the land for the same period; thus encouraging the growth of quitch and weeds, while the adhesion of the soil which it produces, and the accumulation of roots, &c. very materially prevent its kindly working for the crop intended to follow.

The above remarks are made on the supposition that the rye-grass is introduced as a half-crop, for it must be quite clear to every practical farmer that there is no sound practice in throwing away a whole year's crop for the sake of one month's feed in the spring, valuable as it undoubtedly is. The trials above mentioned which the writer has seen have been with Pacey's rye-grass, and though the Italian rye-grass would furnish a greater portion of food, supposing it tillered as much as Pacey's, which is not the case, yet it is liable to all the above objections, and from the observation of the writer it appears exceedingly doubtful whether it will bear an equal degree of frost to Pacey's.

It is the intention of the writer now to state his experience, and offer his recommendation of a crop embracing all the advantages of the preceding, and several peculiar to itself. It is that of *rye*, eaten in the early stages of its growth. It is intended to intervene between the last crop of the four-course system, which is generally wheat, and to be eaten, and the land ploughed and worked for a crop of turnips. It is equally applicable to all kinds of rotations, and would well precede a fallow or a crop of rape. As it is generally upon farms where the four-course system is pursued that spring-feed is most wanted, the writer will confine his observations to that rotation.

So soon as the wheat is cut in the autumn, the plough should be set to work. This may be done even before it is carted, during the mornings of harvest. A single ploughing is given, and a very slight dressing of any kind of short manure. In some cases where the farmer lays on his manure in the autumn, for turnips the ensuing year, it might be better to lay it on before the ploughing. It should be remembered that the slight dressing should not all be considered as given to the rye; in reality it becomes incorporated with the soil, and more intimately mixed with it than by the ordinary mode of spreading it on in the autumn, and any part of it which the rye may abstract, will be more than compensated by the droppings of the stock, and the carbonic acid gas which they evolve while consuming it; and which the soil more readily absorbs in the spring than in any other part of the year, evaporation going on at that period to a much smaller extent than in any other.

The seed must be sown upon the plough-seam broadcast, at the

rate of 2½ bushels per acre, and if of that year's growth so much the better, as it is earlier, and more certain of germination. To this a peck of rapeseed per acre should be added; for although the latter is not able to stand a winter when the frost sets in early and severe, in many cases it will get sufficiently vigorous to resist any ordinary frost, and will much improve the feed in the spring. Should the rape not be sown, a peck of winter-tares per acre will improve the feed, or an additional peck of rye may be added; as a fuller bite and excited growth in its early stages will be secured —a point gained when wanted to depasture, although it might be injurious if sown for a crop.

In cultivating rye as feed there need be no fears entertained of its becoming "winter proud," for as that only affects the ears of the corn, it is a circumstance of no importance, and therefore the earlier it is sown the better able it is to resist the early frosts, as well as having a better cover and more feed when wanted. When sown it should be thoroughly harrowed, but not rolled—a *double* with a pair of fine harrows is sufficient, and the surface-weeds should be gathered off, or the whole raked with the hand, which will more efficiently cover the seed. An advantage is gained to the soil by this ploughing, which cannot be obtained when the land is sown with the vetches. The annual weeds on the old surface are prevented from running to seed, and a new surface is exposed to the air and frost.

The rye will be fit for consuming the last week in March or the first in April, or if allowed to remain until the middle of the latter month, it will carry a greater quantity of stock. After it is thoroughly eaten up, it should be freed, and by the first week in May will afford another pasture of fine young nutritious feed; at least, in ordinary seasons. It is bad management, though sometimes practised, to allow the rye to remain uneaten until the seed-stalk begins to shoot, for in that case it will become much less palatable and useful. By consuming it young it is much more valuable, and the succession crop equally so as the first.

The second crop being consumed, the plough must be put into operation, and the soil prepared for the succeeding crop; and the advantage of its cultivation, by no means a small one, is, that it interferes with no other crop. Perhaps a short digression may be pardoned on the subsequent preparation of the soil. The writer's practice is different to that of most other persons. Usually it is cross-ploughed a fortnight after its first ploughing. Time is thus lost, and the slices are cut into squares difficult to be acted upon by the harrow. The writer begins to harrow as soon as the newly turned up surface of the first ploughing is sufficiently dry. This brings up the lowest part of the roots of the weeds and closes the interstices of the furrows, so that the

remains of vegetation being covered, deprived of air, and gathering moisture, begin to decompose. Instead of cross-ploughing, it is again ploughed lengthways, and the old surface again brought up and harrowed. The weeds separate much more easily by this process, and much time and labour is saved; the same practice is applied to bastard fallows with the same good effects.

Rye has the decided advantage of being capable of resisting *any conceivable* degree of frost, and when even the hardy wheat is carried off by an ungenial season, it will escape injury, and even thrive. At this time (Feb. 21, 1840) the writer has a plot growing for feed which would now afford more eating than almost any mixture of artificial grasses in the middle of April, and that on a thin light soil not worth more to rent than 25*s.* per acre. Some of the rape has succeeded, even in this season of incessant rain, which prevailed not only in the early stages of its growth, but ever since it was sown. It can bear so much and constant wet, worse even than frost.

The expense of this crop will be somewhere as under. Say per acre:—

	s.	*d.*
2½ bushels of rye at 4*s.* 6*d.*	11	3
½ peck of rape	0	10½
	12	1½

It should be remembered that this interferes with no operation of husbandry, and prevents no crop, so that no rent of land or other extras are to be reckoned—the ploughings would be nearly the same if the rye were not sown. Nothing is better relished by stock at the season when it is intended to be used; a guide by no means unsafe as to its nutritious qualities, and which is borne out by the condition of the stock feeding on it.

To recapitulate the advantages of its cultivation.

I. Provision of excellent green food is made at a season of the year when of all others it is most wanted.

II. It is produced without sacrificing any portion of the usual rotations pursued on a farm, and with little extra labour, nor does it interfere with the management of any preceding or succeeding crops.

III. It will grow on any soil, but is especially calculated for poor loose sand,* when every other green esculent is more or less uncertain.

IV. It will bear any degree of frost to which our climate is

* Sowing rye, and feeding it off in the spring, has long been practised in the neighbourhood of Saffron Walden, and is very useful when the turnip crop fails; but it does not answer on our poor light soils.—BRAYBROOKE.

subject, and is sufficiently hardy to defy the effects of the coldest situations in the country, being there cultivated instead of wheat for a corn crop from necessity.

V. It is as inexpensive or more so than any grass or leguminous plant.

VI. It is readily consumed by stock, especially young animals.

VII. It improves rather than deteriorates the soil upon which it is grown.

Thorpfield, near Thirsk, Yorkshire,
Feb. 21, 1840.

XXII.—*On the Specific Identity of the Fungi producing Rust and Mildew.* By Rev. J. S. Henslow, M.A., Professor of Botany in the University of Cambridge, and Rector of Hitcham, Suffolk.

In my Report on the Diseases of Wheat (p. 9, sect. v.), I have thrown out a conjecture that rust, or redgum, and mildew, are possibly produced by two or three forms of spore generally considered as distinct, but in reality belonging to only one species of parasitic fungus. I had not seen Philippar's valuable and recent treatise* on the diseases of corn at the time I wrote my Report; but I now find this author has expressed an opinion that *Uredo linearis* is identical with *Puccinia graminis;* though he still considers *Uredo rubigo* to be a distinct species. I believe that botanists have hitherto universally supposed *Uredo rubigo* (rust) to be a distinct plant from *Puccinia graminis* (mildew). In a lecture which I had the honour of delivering during last December to some members of the Royal Agricultural Society, I mentioned my having established (as I conceived) the specific identity of the three fungi here alluded to. I stated that I had transmitted some of the specimens upon which this proof depended to my hitherto sceptical friend Mr. Berkeley, and that I had received from him the following reply:—"Your specimens of *Uredo rubigo* and *Puccinia graminis* are very satisfactory. There can be no doubt that the former is only an earlier stage of growth." A notice of my lecture appeared in the first number of the Gardener's Chronicle (p. 5); and M. Vilmorin, of Paris, inserted a communication in the fifth number of the same periodical (p. 70), in which he endeavours to prove, from his own observations, that my assertions were probably ill-founded. The purport of his

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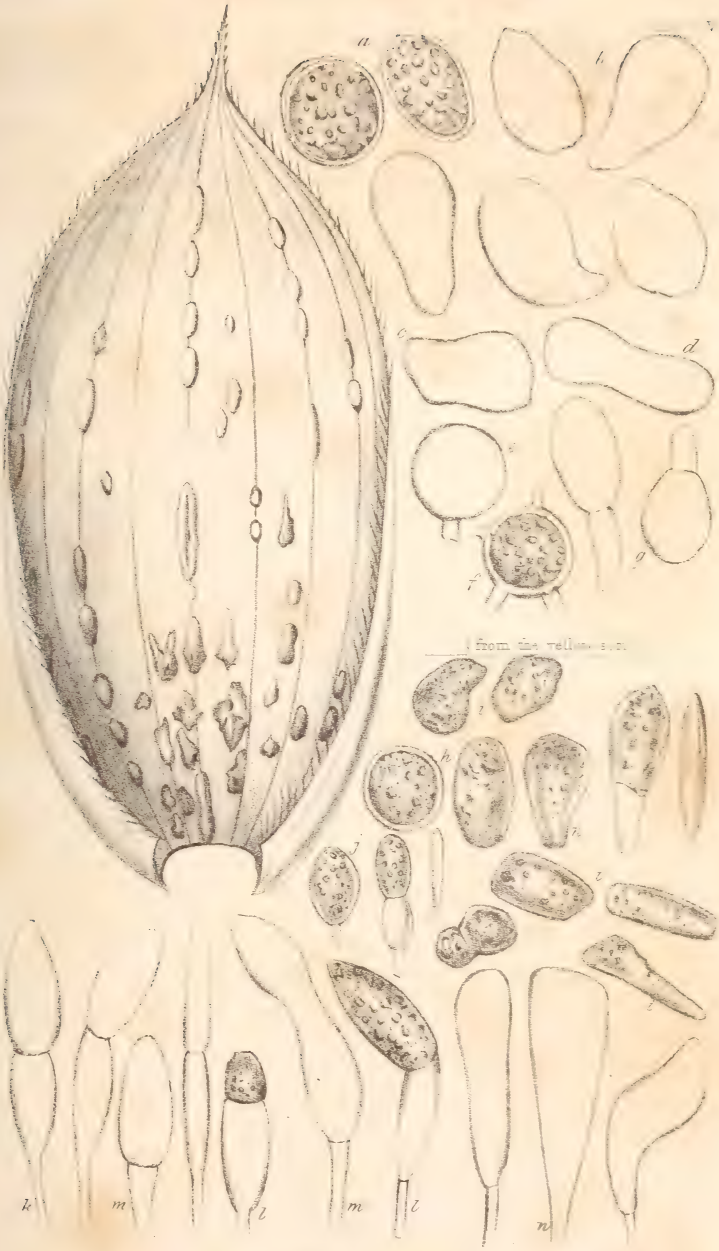
* "Traité Organographique et Physiologico-Agricole sur la Carie, le Charbon, l'Ergot, la Rouille, et autres Maladies du même genre qui ravagent les Céréales." Versailles, 1837.



(from the brown soil)

IDENTITY OF RUST & MILDEW.

J. S. Henslow del.

remarks tends to show that each form of spore (I mean the sporidia of *Uredo rubigo* and *Puccinia graminis*) had been traced by himself from its earliest stage to a complete state of development, without his observing any transformation of one form into the other. He admits, however, that the two forms do occur together, and that those of the *Puccinia* are frequently found in the very spots previously occupied by those of the *Uredo*. I do not entertain the least doubt of the accuracy of M. Vilmorin's observations; but I do not consider them conclusive evidence against my own opinions, which are founded on observations of another class. If it be true that both forms of spore may be developed from the same spawn (*mycelium*), then we may suppose that the precise circumstances which induce the development of one form, must vary in some respects from those upon which the production of the other form depends. The two forms, then, may not always appear simultaneously, or even exactly in the same places, on a plant infected by the fungus. If, however, there should chance to be such a combination of circumstances as is more or less favourable to the development of both forms, then we might not only expect to find them intermixed, but might even hope to meet with certain intermediate forms which would establish their connexion and prove the identity of their origin. Now this, as I conceive, is precisely what I have had an opportunity of witnessing. I propose, therefore, with as little technicality as possible, to lay the result of these observations before the Society; but I must still recommend botanists to re-examine the subject. All microscopic observations should be repeated by more than one pair of eyes, so liable is every one to misapprehension and deception when using lenses of high powers. I would also suggest our making diligent search for analogous cases, in order to see whether there may not be other *Uredines* which are reducible to imperfect states of *Pucciniæ* or to species of other allied genera. I have already stated my own convictions with respect to the identity of *Uredo Rosæ* and *Aregma mucronata*.

All the little patches or masses of spores (*i. e.*, the *sori* composed of *sporidia*) in the specimens to which I am referring, were developed on the inner surface of the chaff-scales (*glumæ* and *paleæ*). In plate V. I have given an enlarged representation of an outer scale (*palea inferior*) of a flower of wheat. The *sori* scattered over it have raised the skin (*epidermis*) into blisters, which are most frequently of an oval form.

In an early stage of the disease these were all of a pale yellow, varying to an orange tint: later in the season blisters were raised, varying from brownish-yellow to a dark-brown; many had a peculiar waxy appearance; some of the blisters were partly yellow and partly brown; most of the early formed yellow blisters burst,

and an orange powder escaped from them; few, if any, of the brown blisters burst, the further progress of the fungus having been checked (as I suppose) by a change in the weather. After this, many of the scales became filled with a mouldiness, which I believe was occasioned by the discharged spores of the *Uredo* germinating; but I am not perfectly satisfied of the fact. The orange spores which proceeded from the yellow blisters were those universally recognised by the name of *Uredo rubigo;* and I have represented the forms which they generally assume, at fig. *a*. When my attention had become more particularly directed to the inquiry, I soon found several other anomalous forms scattered here and there among the more usual and regular states of these spores. Repeated examinations of the yellow sori, even where there was no trace of brown sori, have confirmed the observations, and I have selected a few of these anomalous forms, and have figured them in the upper division of the plate. In several instances the spores were lengthened, or drawn out into a short pedicel (as at *b*). The existence of a distinctly formed transparent pedicel was repeatedly recognised (as at *e*), though this was most generally wanting. It frequently happened, however, that certain spores appeared to be furnished with one or more appendages resembling pedicels, when in fact there was not one: this appearance arises from an optical illusion, produced by slight linear depressions in the surface of the water, when a spore is floating (as at *f*). These illusory pedicels often appear to proceed from a spot which seems to have been the real point of attachment, and where there is a slight flattening or truncation of the curvilinear surface of the spore. Some of the spores are very irregular and amorphous (as at *e*); and in one instance I observed a sort of double spore (as at *d*). Lastly, and by no means so unfrequently as to render the observations at all doubtful, there were several forms which manifested a decided approach to the usual form of the spore of *Puccinia graminis* (as at *g*).

Turning next to the examination of the brown *sori;* on opening the blisters in which they were enclosed, I found a partial repetition of those forms which were most abundant in the yellow *sori,* viz., spheres and spheroids (as at *h*); but there were also a vast number of anomalous forms (as at *i*), as though (from some disturbing cause or other) the usual regularity of their development had been checked, or interfered with. Many of the spores possessed the true character of *Puccinia graminis* (as at *k*), but the great majority might be considered as abortions and monstrosities, intermediate to the forms of *Uredo* and *Puccinia.* Some had one cell (*j, m*), others two. In some one of the cells only (*l*), and in others both of them were filled with

granular matter. In some cases there was no distinct transparent pedicel, and the granules filled the entire body of a one-celled club-shaped spore (as at *n*). I have not thought it necessary to give more than the mere outline of some of the forms, nor is it worth while to dilate any further upon them. A glance at the plate will be sufficient to explain their appearances better than any description.

Although these details are perhaps more strictly suited to botanical than to an agricultural journal, I trust they are not entirely foreign to the objects which the Royal Agricultural Society have proposed to themselves—the union of science and practice. Whatever interest may be attached, in a scientific point of view, to determining the specific identity of certain parasitic fungi which had previously been considered to belong to distinct genera, the practical agriculturist must clearly be interested in learning that two of the most fatal diseases to which his wheat crop is liable are in fact only modifications of one and the same disorder. He may then reasonably hope that if he is ever able to find a remedy or palliative for one of the states of this disease, he will not need to search further for any different corrective of the other state. The similarity in the general economy of the bunt and smut fungi (their sporules being introduced at the roots of the plants which they attack) renders it extremely probable that the most efficacious remedy (I mean the sulphate of copper) hitherto discovered for destroying the former will be found equally active in destroying the latter. Much more, then, is it likely that we may be able to check the progress of both rust and mildew by some common treatment applicable to both forms of this one disease. But a better knowledge of the exact economy of the parasite which produces this disease, and especially of its mode of propagation, is required, before we can hope to suggest any means of resisting its attack with much probability of success.

It is remarkable that the rust seems to be more common and more dreaded on the Continent than the mildew, whilst with us the mildew is considered a far greater pest than the rust. Is it that our climate is better suited to the more complete development of the spores of these parasitic fungi, and that our continental neighbours are more rarely favoured with the opportunity of seeing them in their most perfect form?

As the fact of the berberry occasioning some sort of blight in wheat, but more especially mildew, has been forcibly brought before me from several quarters since my report was written, I am bound to suppose that there must occasionally exist some relation between the presence of this shrub and the occurrence

of mildew in wheat.* At present I have met with no evidence which can explain the nature of this relation. Is it that the soil, or that some ingredient partially present in the soil, may be favourable to the growth of the berberry, and at the same time deleterious to that of wheat: and thus reducing the latter plant to the sickly state suited to the attack of *Puccinia graminis?*—Is it (what I presume no botanist will at present be prepared to admit) that one of the berberry-blights (*Æcidium berberidis*) can only be a different form of development belonging to the same species of fungus which produces the mildew?—or may we suppose that the disgusting odour of the flowers is due to some subtile emanation which sickens the wheat-plant? I do not feel myself competent to offer even a suspicion of what may be the truth. Philippar (in the work I have already referred to) alludes to an opinion prevalent in some parts of the Continent, that bunt also is occasioned by the presence of the berberry; but he considers this opinion to be without any sort of foundation, and that it had most probably originated in the still more prevalent opinion in favour of the mildew. He also admits the testimony to the latter fact to be too strong for him absolutely to reject it, although he had never himself been able to meet with sufficiently conclusive evidence to convict the berberry. On the contrary, he states that there are many instances in which he has seen hedges filled with berberry, without the corn which was near them having sustained the slightest injury.

Hitcham, Bildeston, Suffolk, April 2, 1841.

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* The following case has been furnished me by Mr. W. Edmunds, of Bowers Farm, near Wantage:—"During my occupation of a farm at Kelmscott, in Oxfordshire, I had a field which, when sown with wheat, a certain part of it was generally infected with mildew. The field was surrounded with a young and healthy quickset-hedge, with the exception of about two hundred yards on the north-west side, which was an old hedge with several berberry and other bushes, and some elm-trees. It is true the current of air was somewhat impeded by the trees. On examining my wheat about three weeks previous to its being ripe (now some years since), I found that next to this hedge the wheat was considerably infected with mildew. I then examined the remainder of the field, but found the injury did not extend beyond about twenty yards from the hedge in question. The berberry bushes being at some little distance from each other, I discovered that the wheat-straw was more injured in the immediate vicinity of each bush than at a distance. This led me to believe that the mischief was occasioned by the berberry. I then directed one of my labourers to cut up and remove all the berberry he could find in this hedge; while this was in operation, I took one of the largest bushes and placed it in the middle of the field. On examining the wheat where the berberry had been placed previous to reaping it, I found both the straw and grain for two or three yards round evidently injured by mildew, but not to the extent as compared with the part where the bushes had grown."—Ph. Pusey.

XXIII.—*An Account, founded on experience, of the Best Mode of Storing Turnips, by which they may be preserved in their natural state till the April or May succeeding the period of their being taken up.* By W. E. Geach, Tywardreath, near Lostwithiel, Cornwall.

(prize essay.)

Every day's experience more clearly shows the advantages derived from improved and better systems of management in agriculture, as well as in the other arts. Prejudices may exist against new systems on their first introduction, yet none are more willing to adopt them when proved by practice than the sons of the soil.

To abolish, indeed, ancient customs in the practice of husbandry, for the adoption of others as yet only on trial, would be rash; but caution on the other hand may be carried too far. It cannot be doubted that, if the course of husbandry which our forefathers pursued were still universally practised, the wants of an increasing population would be but inadequately provided for: they, however, considered that their systems were good, and that the course they pursued could receive little or no improvement; and we again, with the same limited vision, are led to believe that we have also arrived almost at the point of perfection in agricultural art; but what farmer in the past century would have believed had he been told that the population, which has since that distant period nearly doubled, could be provided for by an improved system of husbandry on the same land he then partly cultivated; that cattle would one day be fattened on those arable farms where fodder was then scarcely to be grown in sufficient quantities to support the animals required to perform the ordinary labours thereon, and that large stores of turnips would be provided for their winter's use on those farms?—yet we have lived to see these and many other equally great improvements carried into effect, and have enjoyed a share in the advantages. Our farms are now, through the cultivation of the turnip, well supplied with provender and with cattle to eat it, and the demand for well-fed beasts has also increased in proportion to the quantity fattened.

That the growth of the turnip is of considerable advantage to the farmer must be obvious to all, particularly where it is practised on those thin lands that are to be found in all hilly counties. The system usually practised, before its introduction, of growing two white crops in succession, has now become of little profit to the farmer; indeed it has been found that on some soils, without an intermediate crop of turnips, little or no corn can be grown.

On some farms in the hilly districts of the western counties, particularly those bordering on the sea-coast, scarcely any pasture-lands are to be found, consequently but few cattle were reared, and fewer fattened; the principal part of the land was sown with corn, and produced large quantities of straw, which, before the growth of the turnip was practised to any considerable extent, was thrown in large masses into the lanes and farm-yards to rot for manure; but now on these farms, and on many others where a head of cattle was but seldom, or perhaps never, fed, are to be seen during the winter months large stores of turnips that have been taken in the autumn and winter months from the lands which either have been sown to wheat or thereby prepared for a barley crop, and the cattle, which are partially fed on the moorlands during the summer, are bought up by the farmer of the arable lands, and thus by means of the turnip are "finished out" and in a proper state for the butcher in the spring of the year, and the straw, which formerly would have been rotted as described, has been converted into a valuable manure. It is then by this method that the farmer has been enabled not only to turn out a large stock of fat cattle in the spring, but also, by having at his command a greater supply of more valuable manure of his own making without additional cost, to effect an improvement of the soil, and to grow a larger quantity of the necessaries of life, in order to supply the wants of an increasing population.

That so valuable a root, conferring such benefits on the land, and through the land to the public, should have caused the attention of the Agricultural Society to be directed to the best means of storing it during the winter months, has prompted me to make these preliminary observations by way of introduction to some remarks on the question proposed; and although they will appear in the author's "rustic style," not much in the shape of an essay, he having no such pretensions, being a farmer, not an essayist, he feels assured that, although his observations may not present to the Society much original matter, they are derived from careful observation and practical experience, and that they will receive from so practical a body before whom they will appear, and by whom they will be tested, whatever share of attention they may be found to deserve.

Under these impressions the author has broken a barrier which he, in common with many others amongst his brother farmers, had hitherto considered as almost insurmountable, that of severe criticism, which now, under the favourable auspices of the Society, they need no longer fear, but may with confidence commit their thoughts and experience to paper for the benefit of those engaged in the pursuits of agriculture.

The preservation of the turnip during the winter months has

no doubt engaged the attention of the farmer in most counties, therefore it cannot be doubted but that there are many plans in operation for the purpose of effecting so desirable an object. Like many others, I was induced to try the experiment; and by repeated trials have succeeded in effecting it in a useful and economical manner. At first, by way of trial, the produce of a small field was taken up in November and carefully carted from the field to the farm-yard, and there placed in a spare house, which appeared to be well adapted for the purpose; all light was excluded, and as much air as possible. In the March following I commenced using the turnips, and found that on the top part of the pile they had vegetated about 3 or 4 inches in length, but towards the central part of the heap the shoot was much longer and more delicate and slender, owing, as I conjectured, to the small space through which it had to make its way between the turnips to the surface of the pile: on arriving at the bottom I found that they had not vegetated, indeed, but that, through the confined state of the air, the greater part were decayed and of no use whatever as food for cattle. The following year a different method was adopted, which, having been practised by a neighbour with success, held forth prospects of a different nature from those of the preceding year. The turnips were taken up as before in the month of November, and were carted to the rick-yard or mowhay, and emptied out on the surface of the ground and formed into a pile about 7 feet wide at the base, and terminating with a sharp top, resembling a triangle standing on its base: the piles were made of such length as the place admitted, and were covered with straw about 4 inches thick, and secured by ropes placed longitudinally, with others across, intersecting each other at right angles, and fastened to pins of wood driven into the ground. In the March and April following they were opened, and the turnips were in a tolerably perfect state; vegetation had not made such rapid progress as in the former year, and comparatively but few were decayed. Although this plan proved far superior to that of housing, yet the expense and labour of thatching proved too great, and on small farms, where thatched buildings are still unfortunately standing, the straw alone would be an object of serious consideration. The idea occurred to me that, by making the piles much higher on the same base, having their sides supported by stakes driven into the ground, a much larger quantity could be secured on the same piece of ground and with the same quantity of covering. Having in one part of the rick-yard the back of a garden-wall, which would answer the purpose of one side, a line of stakes was driven into the ground parallel with the wall, and about 4 feet from it, and 3 feet high above the surface of the ground; the stakes were woven together

with twigs of wood and furze, and between them and the wall the turnips were placed to the height of the stakes in front, and so much higher against the wall as to admit of being covered in a lean-to position; they were thatched with straw about 4 inches thick, and secured by ropes of the same material, which were fastened by *spears*, whose points were thrust into the turnips. On opening them in the spring those nearest the stakes had pushed forth a little short shoot of a greenish colour; further in the shoot was more bleached and still longer; whilst close to the wall the shoot was still longer and more slender; at the bottom nearest the wall, at the greatest depth from the surface, where no air could circulate, a large quantity came out quite rotten.

Having now ascertained that it mattered not how high the piles might be made, so long as they admitted a free circulation of air, and that the saving in reed by this method would be considerable, I considered that by a little improvement the plan would ultimately prove of great advantage over any other mode of storing. Accordingly, the following year a piece of ground was selected for the purpose, and two lines of stakes were driven into the ground about 2½ feet high above the surface and 6 feet apart in the rows: the stakes were wattled as before on both sides and at one end, the other end being left open for the purpose of backing the carts to empty the turnips into their proper position; the space between the two rows of stakes was thus filled up, and the top sharpened up, in the same manner as before described. Close alongside another enclosure was made, leaving only room to pass between them, and as many more as were required. To prevent the water that falls from the roof from running under the piles, drains were cut between each, which effectually carried it off. As usual in the following spring they were opened for use, when the turnips were in a more perfect state than any stored in the manner before described; vegetation had made but little progress, the length of the shoot was not near so long as from those in the pile made against the garden-wall, and scarcely any rotten turnips were found; indeed the expectations which were formed were more than satisfactorily realised. This mode has been continued ever since, and continues to prove equally successful; its advantages over any other are many, particularly where room is rather limited in the rick-yard, for one pile of this description will contain three times as much as one of those placed on the ground of a triangular shape; the saving in thatch is also considerable, and there is the still greater advantage of having turnips well preserved until the months of April and May, and even June, until which latter month I have seen the cattle eat them with eagerness.

Some objections may possibly be raised against the system,

particularly in districts where stakes, and brushwood, and furze are but seldom found in sufficient quantities; but this difficulty can easily be overcome by the use of hurdles made of the required height, and used instead, which could be removed and housed for another year as the turnips are consumed. Other methods have been practised by me, but to no great extent, and most of these have given place to those already described, particularly to the two last. A description of one or two other plans may not, however, be considered out of place.

On the first introduction into the neighbourhood of storing turnips, some farmers had a dislike to the loss of the top and root of the turnip, of which it was necessarily deprived before it can be placed in the stores: they adopted the following plan. The turnips were taken up and carted in their entire state from the field to some convenient meadow or part of a field near the farm-yard, and there placed close to each other on the surface of the land, just in the same state as when growing; this they called "pitching." The white and yellow turnips that I saw pitched had grown in strong land, and their tops were luxuriant, which for want of the usual support drooped and died, and having rotted adhered to the turnip, which was consequently refused by the cattle. One chief advantage, too, of storing, namely, the having turnips in a fit state for the cattle during all weather in the winter months, and particularly during a continuance of snow and frost, cannot be effected by that mode; nor can placing them on the surface of the land after their removal from their original position, add anything to their size, whilst the weight will be diminished; for the top, which has been so anxiously preserved, proves injurious to the root, since young shoots of a considerable length which are pushed forth without deriving from the soil a corresponding degree of nourishment, must diminish the substance of the root.

A neighbour of mine put some of his turnips in pits, which he dug about 18 inches deep and about 6 feet in width; the turnips were filled in the pit to the surface of the ground, built up to a ridge, and thatched with straw about 3 inches in thickness, over which was placed the soil that came out of the pit and more from the adjoining ground, so as to put on a layer about 6 inches thick. In the spring, when they were opened, the turnips were not in a better state than those in the other piles adjoining; they were, for want of air, in rather a moist state, and at the bottom many were quite rotten, owing to the drainage from the surface. The labour required by this method is greater than in any other described; besides, the rick-yard not generally having a sufficient depth of soil for the pits, some field must be resorted to for the purpose, which will necessarily be further off from the

farm-yard, and consequently be more expensive for removing the turnips to the houses in which the cattle are fed.

Having thus far observed the different modes of storing the turnip, it will also be necessary to consider the covering best adapted to preserve them when stored from the action of the elements. In Cornwall and Devon, where the greater part of the wheat-stalks are made into reed, that is the principal article of covering. It is laid on in a temporary manner about 4 inches in thickness, and is secured by ropes spun from the same material, and placed across the reed and fastened with short spears made of wood and twisted near the centre, and thus forming two points between which the rope is taken, the spear being thrust into the turnip, or by placing ropes longitudinally across the reed, over which other ropes are placed in a transverse direction, intersecting the longitudinal ones at right angles, and the ends fastened to the sides of the pile, or to stakes driven into the ground. As the turnips are consumed, the covering is applied to the purposes of making manure.

The various sorts of turnip, like most other substances of the vegetable kingdom, appear naturally disposed to decay in proportion to the time they occupy in arriving at maturity. The white turnip, which grows fastest of all, is soonest past for use; although it does not rot as some other sorts do, yet its tendency to get spongy is equally bad, for so soon as it has acquired that defect it is refused by the cattle. The green is very little better, and is but seldom grown with us, being considered inferior to the white; these sorts do not answer well for storing, except for a short time. The yellow is far superior to either, and will keep well for some time; they ought not to be kept after February, for they then become spongy like the whites, and are refused by the cattle after that period, whilst the swede, from its solid substance and the close texture of the rind, resists the action of the air for a much longer period, and by being stored in the manner described and recommended will keep until the months of May or June, in which last month the writer has seen them sought after by the cattle and eaten with avidity.

The system which has been in use for taking up the turnips and removing them from the ground has undergone but little alteration since it was first introduced.

The sowing of the seed in raised drills is but little practised here. The ground, after having been well manured, is ploughed down and well worked, and thereby brought into a sufficient state to receive seed; the drill deposits it into little furrows which it makes in its progress, the seed is covered with a brush made with the tops of wood fixed into a hurdle, which is drawn close after the drill, and in the same direction. In the autumn, when

the turnips are to be removed from the land, they are drawn in the following manner. A man takes three rows of turnips, which he draws and places on the ground just where they grew; two other men, one on either side of the fore-man, follow close after, each drawing his three rows, and placing them on the row already made by the man who precedes them; by this means nine rows are placed in one, which, being continued throughout the field, leaves about nine feet of clear space; in that space the carts pass, and the turnips after being topped and bottomed are thrown into them and carted to the place prepared for their reception.

The manner of cleaning the turnip is simple, and is performed by women and boys, each being supplied with a knife about a foot long and two inches in breadth: they take the turnip by the top, and carefully paring off all the side shoots, remove the tap root at one cut in an oblique direction; by then taking the turnip in the hand they cut off the top in the same manner, taking care not to cut either the tap root or the top too near the bulb, for by so doing it is very apt to rot. I have frequently observed that most of the turnips which have rotted in the caves or piles have been those the roots and tops of which have either been cut off too close to the bulb, or removed in a careless manner, by cutting or rather breaking them off at right angles, which often bruises the part, and appears to cause its decay from the injury thus received.

The tops and roots are either eaten on the ground, or removed to another field for that purpose, as may be most convenient; if the land is about to be ploughed down for wheat, and the weather is dry, the former is generally practised, for by consuming it on the land the cattle by treading the ground render it firmer and in a better state for a wheat-crop, particularly in some parts of Devon and Cornwall, where the soil is of a light loose nature, lying on a subsoil of granite or light killas. These modes of storing and cleaning having answered beyond my expectations, I have no desire to adopt others in their place, nor to recommend new ones, feeling assured that, if those recommended be carried into practice by the farmer, he will also feel satisfied with the results.

XXIV.—*On the Scientific Principles by which the Application of Manures ought to be regulated.* A Lecture, delivered at Oxford by Charles Daubeny, M.D., F.R.S., M.R.I.A., &c., Sibthorpian Professor of Rural Economy.

It may assist us, perhaps, in understanding the mode in which the various matters intermixed with the soil, with the view of improving its quality, may be supposed to operate, if we begin with tracing the successive steps by which mankind have advanced from the simplicity of early practice to that more complicated and artificial system of husbandry which prevails in most civilized countries at the present day.

In order to become acquainted with the rude methods adopted in the first ages of the world, it is scarcely necessary to go back to the records or traditions of that period: without giving ourselves this trouble, we may obtain a sufficiently just idea of their mode of procedure by referring to the practice of husbandry adopted by the early colonists in the wilds of America, or by that in use amongst those who in the present day emigrate from the eastern portions of the United States into the regions of the far west.

In the virgin land on which the labours of these first settlers were expended, whether it were in Virginia and the Carolinas in the last century, or in Kentucky and Michigan in the present, the expedients for refreshing and invigorating the soil which are resorted to in older countries are found to be wholly superfluous.

Judging indeed from the crops obtained for several years after it has been first reduced to cultivation, the ground might in many instances be pronounced to possess an inexhaustible store of fertility, since the same crops admit of being repeated year after year, with no apparent diminution in the amount of produce, and with no further care on the part of the colonist than that of simply turning up the soil and introducing seed.

Such is represented to have been the case even with the tobacco when first cultivated by the early settlers in Virginia, where, on land now requiring careful tillage, and yielding but a scanty return, this exhausting species of crop is said to have been repeated year after year without any perceptible diminution.

In Kentucky we are told of soil that has yielded the finest crops of wheat or of maize for twenty-five or even for fifty successive years, and that without the addition of any kind of manure, whilst in the State of Illinois some portions of the territory are said to have been cultivated with profit in this same way from the first period at which the country was settled.

During my late tour through the western portions of the United States I had frequent opportunities of witnessing the system adopted by those who first established themselves in a new settlement.

In these wild regions, unlike to those portions of the globe with which we Europeans are familiar, forest and pasture land are seldom found intermixed, but we meet at one time with vast tracts altogether destitute of timber, and at another with forests taking such entire possession of the soil as to leave no intervals for any sort of culture for many hundreds of miles.

The former description of country constitutes the prairies, the latter the woodlands, of North America.

With regard to the former, various theories have been propounded to account for the entire absence of timber over such extensive tracts.

Monsieur Decandolle offers the following solution:—"The right of prior occupation," he says,* "explains how it happens that forests and prairies are found mutually to exclude each other. For if by any cause a forest is established in a given place, the shade of the trees, together with the greediness with which their roots absorb the nutriment, and the manner in which the fibres of the latter are interlaced, will prevent the grasses from shooting up underneath. If, on the contrary, the prairie is first developed, then, even supposing that the seeds of the trees do from time to time germinate, yet their roots in the young state cannot easily pierce the close network of roots and stems already existing on the spot, and even if they succeed in doing so, are starved by the voracity of the grass roots, which are more numerous and more developed than their own."

But still the question occurs, What has given to the forest in the one case, and to the meadow in the other, that prior occupancy, to which their power of maintaining entire possession of an extensive tract may perhaps be justly attributed?

It is probable, I think, that in the climate and latitude alluded to, forests would usurp dominion over the greater portion of the country, if no extraneous cause interfered to arrest them. It is only necessary therefore to explain why large tracts should be found wholly denuded of timber; and this it seems most reasonable to attribute to the practice that prevails amongst the aborigines of annually setting fire during summer to the plains in order the more readily to take deer and other wild game.

For the extreme dryness which prevails at that season causes a fire, when once kindled, to spread in all directions, until it is either stopped by the intervention of a river or put out by meet-

* Physiologie, vol. iii.

ing with a ridge or tract so entirely destitute of vegetation as to afford no combustible matter to maintain it.

Hence those vast plains that lie to the west of the Mississippi, not being intersected by any barren range of hills, nor yet traversed by large rivers, have in the course of years been converted into prairies, the growth of timber being from time to time prevented by the cause assigned, until the luxuriant herbage at length so pre-occupies the soil as itself to stifle all other kind of vegetation; whereas, over a wide tract extending along either side of that great stream, the numerous tributaries that pour their waters into it oppose a limit to the progress of such fires as may occur, and thus enable the forests to maintain their ascendency.

Be this however as it may, we can at least assure ourselves that the absence of timber in the prairie country is by no means an evidence of sterility—on the contrary, the immense accumulation of decayed vegetable matter, which has resulted from the growth of herbaceous plants during so many centuries, is found to constitute a soil of almost unrivalled productiveness.

The colonist, therefore, in first settling down in such a region, has little room for the exertion of any extraordinary skill or industry, having around him an unlimited extent of land, which in its actual condition affords the richest pasturage for his flocks and herds, and which, whenever he takes the trouble of turning it up, and scattering seed over it, will generally repay him largely for the labour expended.

Harder indeed is the lot of him who takes up his abode within the precincts of the primeval forests of the western world, since, before he can reap any advantage from the land he calls his own, he must undertake the severe task of clearing it of the timber with which it is encumbered.

This, however, being accomplished, it is seldom that he is disappointed in the quality of the soil that lies underneath; and for the most part his rude and imperfect methods of culture afford him for several years as ample a return as the utmost exertion of skill and experience can secure in the older countries from which he has migrated.

> "Aut unde iratus silvam devexit arator,
> Et nemora evertit multos ignava per annos,
> Antiquasque domos avium cum stirpibus imis
> Eruit: illæ altum nidis petiere relictis,
> At rudis enituit impulso vomere campus."

And this was even the case in parts of the Union which are by no means remarkable for their fertility at present, as for instance in the States of New England.

"When the tract on the green mountains in Massachusetts

was first settled," (says Dr. Dwight,) "the same exuberant fertility was attributed to it which has since characterized Kentucky. From those regions the paradise has travelled to the western parts of the State of New York, to New Connecticut, to Upper Canada, to the countries on the Ohio, to the south-western territory, and is now making its progress over the Mississippi, into the newly-purchased regions of Louisiana. In consequence of the long accumulation of vegetable mould, regions, even if naturally sterile, hold out at first the promise of an abundant return to the cultivator."

Now there is little reason to doubt, that the first Egyptian and Phœnician settlers in Greece, or the first Greeks who peopled the shores of Italy or of Spain, would find themselves placed under circumstances as favourable to husbandry as the present emigrants in the far west.

It would seem, indeed, that the extraordinary exuberance of newly-peopled countries, wherever at least the subsoil and climate are such as in any degree to allow of the spontaneous growth of timber, may have given countenance to those visions respecting the Golden Age in which the teeming imaginations of the inhabitants of early Greece delighted to indulge, when

> . . . . . καρπὸν ἔφερε ζείδωρος ἄρουρα
> Αὐτομάτη, πολλόν τε καὶ ἄφθονον·

But in the case of the colonist of antiquity, as in that of the settler in the new world at the present day, a period at length must arrive when the ground, exhausted by unintermitted tillage, would cease to yield him a profitable return, in which case, so long as abundance of good land remained unoccupied, the most obvious course for him to pursue would be that of abandoning his present possessions, and of advancing further into the vacant territory until he lighted upon a tract better suited to his purpose.

This accordingly is the practice often adopted in the United States, not only in the newly-settled countries of the west, but even in the older States of Georgia and the Carolinas, where the cultivation of cotton, however profitable it may be at first, speedily exhausts the land, and reduces it to sterility; so that in passing through these districts we frequently see estates which had once yielded an abundant return, since abandoned by their possessor, and becoming again a portion of the original wilderness.

And disheartening as it may at first sight appear to him to submit to the Sisyphean labour of bringing continually fresh land under his dominion, and again to relinquish his conquests after so short a period of occupation, the plan alluded to is the only one which presents itself to the settler in a new country for re-

storing to the earth that fertility of which it has thus been deprived.

It is in fact a substitute for the method of fallowing, which constitutes the first step in an artificial system of culture; and it seems probable that the early colonists in the old world may have been led to introduce this latter practice, from having observed that soil which had become unfruitful in consequence of excessive cropping gradually resumed its pristine productiveness when abandoned for some time to itself.

For although in the first ages of the world the colonists may have adopted the same custom which we find now prevalent in America, and may have pushed farther and farther into the wilderness in proportion as the land already in their possession became exhausted, yet it is evident that the period for such unrestrained emigration would have long passed away, at the time when, as history informs us, the Pelasgi emigrated into Italy, the Egyptians under Danaus established themselves in the Morea, and the Israelites took possession of the Holy Land.

In all these cases the colonists were not only destitute of those facilities for moving to great distances which steam navigation and the other improvements of modern times afford to the settler in the United States, but were circumscribed in their movements by the hostile tribes that hemmed them in, which, if somewhat lower in the scale of civilization than themselves, were at least not so utterly unable to cope with them in the arts of war as the wild Indian of the present day finds himself, under ordinary circumstances, to be with the back-woodsman of European extraction.

Hence, being more generally obliged to remain stationary upon the spot in which they had at first established themselves, the colonists of old would soon be driven to resort to a system of fallowing, in order to give back to the land a portion of that fertility of which their mode of culture had in the first instance deprived it.

Accordingly we find in the Hebrew law every seventh year set apart as a period of entire rest,—a command, it is observed, grounded, not only on religious, but also on political and civil considerations, with the view, that is, of preventing the soil from being worn out by continual tillage.

That which in the Mosaic dispensation had been enjoined as a religious duty was adopted also in the early times of Greece and Rome from motives of expediency.

Even so late as the time of Virgil it seems to have been the practice to allow the arable land to lie fallow every alternate year.

> "Alternis igitur tonsas cessare novales,
> Et segnem patiere situ durescere campum."

From which it might seem as if no very marked advance in the principles of husbandry had been made since the Homeric age, considering the lapse of time that had intervened, since it had not yet been fully understood that a judicious rotation of crops would stand in the place of fallowing, whilst the practice of manuring land, which is the next step in the system of improving it, had already been adopted in the earlier period alluded to.

Thus Homer describes the faithful dog, who alone recognises his master on his return to Ithaca, as lying neglected on a heap of dung with which the labourers were about to manure the farm.

> Δὴ τότε κεῖτ' ἀπόθεστος, ἀποιχομένοιο ἄνακτος,
> Ἐν πολλῇ κόπρῳ, ἥ οἱ προπάροιθε θυράων,
> Ἡμιόνων τε, βοῶντε, ἄλις κέχυτ'· ὄφρ' ἂν ἄγοιεν
> Δμῶες Ὀδυσσῆος τέμενος μέγα κοπρήσοντες·

No notice, it is observed by Cicero,* is made of manuring by Hesiod, so that we may perhaps conclude that the practice was of recent introduction at the period when Homer lived.

In the age of Virgil, however, some progress seems to have been made towards that which constitutes perhaps the grand improvement of modern times—I mean the rotation of crops; for the Roman poet, immediately after the lines above quoted, in which he recommends the arable land to lie fallow every alternate year, adds,

> "Aut ibi flava seres, mutato sidere, farra,
> Unde prius lætum siliqua quassante legumen,
> Aut tenuis fœtus viciæ, tristisque lupini
> Sustuleris fragiles calamos, sylvamque sonantem."

Showing his acquaintance with the fact that the substitution of pulse or other leguminous plants will refresh the soil as well as the practice of fallowing, "for thus too," says he, "by a change of crop, the ground is made to rest."

> "Sic quoque mutatis requiescunt fœtibus arva."

This passage of Virgil, Pliny explains in a manner which proves that the Romans, though conscious of the utility of alternating leguminous with farinaceous crops, or, as we now express ourselves, restorative with exhausting ones, did not seem to know that a rotation might be introduced which should entirely supersede the necessity of fallowing in many soils, and render its recurrence much less frequent in all.

"Virgilius," he says, "alternis cessare arva suadet, et hoc, si patiantur ruris spatia, utilissimum procul dubio est. Quod si neget conditio,

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* De Senectute, ch. xv.

far serendum, unde lupinum, aut vicia, aut faba, sublata sunt, et quæ terram faciant lætiorem."

He also says in another place that a crop of beans enriches the ground like manure,

"Solum, in quo sata est, lætificat, stercoris vice."

Whatever, therefore, may be the comparative merits of the ancient and modern systems of husbandry in other respects, it would seem that in this one at least a vast step has been gained since the days of Virgil and Columella. Nor are we less in advance of these writers in the article of manures, which, no longer limited, as with them, to animal and vegetable matters in a state of decomposition, or to lime and certain kinds of marl, comprehends at present a great variety of mineral substances with which the ancients were wholly unacquainted.

Amongst these we may enumerate, 1. phosphate of lime or bone-dust, so useful in the turnip, potato, and grass land of this country; 2. the nitrates of potass and of soda, which are said to increase our crops of wheat and other cereal grasses in a remarkable manner; 3. barilla, or kelp, which has also been employed with success for corn-crops; 4. common salt, which is considered beneficial to the same on light soils; and 5. gypsum, the efficacy of which is admitted in leguminous crops, and will probably be found to extend to others also.

None of the above manures, it is probable, were known by the ancients, though Virgil recommends nitrum* (which appears to have been carbonate of soda or potass, and not, as commonly translated, saltpetre) mixed with the dregs of oil, as a steep to make the seed-grain swell:

"Semina vidi equidem multos medicare serentes,
Et nitro prius et nigra perfundere amurca,
Grandior ut fetus siliquis fallacibus esset,"

and suggests our scattering over the exhausted land ashes, which probably derived their fertilizing property in great measure from the gypsum they contain,

"——————————— neve
Effetos cinerem immundum jactare per agros."

The great advance indeed which has been made within two centuries only in the art of husbandry, may be calculated from this one fact alone, namely, that the population of England in the time of Queen Elizabeth amounted, according to the estimate of

* See Beckman's History of Inventions.

Guicciardini, to not more than two millions, whereas at present it probably exceeds fourteen; yet there is no question but that the present inhabitants are better fed than were their ancestors, although it can hardly be supposed that the quantity of land now in cultivation exceeds seven times that which had already been brought under tillage in the year 1600.*

Something indeed must be allowed for the amount of corn introduced into England from foreign countries, which in 1831 (in which year a larger quantity had been imported than at any period before or subsequent) was estimated at 3,541,809 quarters, being less than one-fourteenth of the whole quantity consumed in the United Kingdom.† But even with this deduction there will remain a sufficient overplus to evince the greater productiveness of the soil under its present management than under that of our ancestors.

Let us not, however, indulge too much in a feeling of self-satisfaction when contemplating our proficiency in the art of husbandry, for considerable as the advances may be which have been made from the first rude efforts of the earliest occupants of the soil, yet still greater, it may be suspected, is the distance which separates us from that ideal goal, towards which the efforts of the agriculturist ought to be directed, at which empiricism would give place to principle, and theory direct with ease and certainty the operations of the husbandman.

"As there is no profession," says Liebig,‡ "which can be compared in importance to that of agriculture, so there is none in which the application of correct principle would be productive of more beneficial effects. Hence it appears quite unaccountable that we may vainly search for a single leading principle relative to this subject in all the writings of agriculture and of vegetable physiologists."

"The methods employed in the cultivation of land are different in every country and in every district; and when we inquire the causes of these differences the answer we receive is, that they depend upon circumstances (*les circonstances font les assolements*). No answer could show ignorance more plainly, since no one has ever troubled himself to ascertain what these circumstances are. Thus also, when we inquire in what manner manure acts, we are answered by the most intelligent men, that its action is covered by the veil of Isis; and when we further demand what this means, we discover merely that the excrements of man and animals are supposed to contain an incomprehensible something

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* See Appendix. † See Macculloch's Comm. Dict., p. 417.
‡ Organic Chemistry in its Applications to Agriculture, p. 138.

which assists in the nutrition of plants, and increases their size. This opinion is embraced without even an attempt being made to discover the component parts of manure, or to become acquainted with its nature."

Whilst an eminent chemist expresses himself in these terms with respect to the labours of physiologists, the judgment passed upon the researches of chemists by a distinguished botanist of our own country is not more favourable, since he quotes with approbation a remark which had been made to him by a friend, to the effect "that chemistry has hardly advanced the art of agriculture a single step, but that the latter remains, after all the investigations of the chemists, a mere empirical art." *

I trust what I have said in my former lecture will convince you that both these general statements must be received with some grains of allowance, and that both chemistry and vegetable physiology have already rendered good service to agriculture; but it cannot be denied that experience and tradition are still the main sources to which the farmer usually looks for information, and that science is as yet far from having shed any steady light over the obscurity in which his processes are veiled.

It is evident, that in order to determine in what precise manner the different kinds of manure can improve the condition and increase the quantity of the plants exposed to their influence, it will be necessary in the first place to ascertain from what source or sources vegetable substances obtain their nourishment; and it is certainly somewhat humiliating to reflect, that notwithstanding the attention paid to the elucidation of this subject by many distinguished men of science, a question so fundamental should have remained in part unanswered, until the celebrated German chemist, Liebig, applied himself to its investigation.

The elements of which the structure of every perfect plant consists may be referred to two distinct classes: namely, such as are capable of being received into the vegetable organisation in the condition of a gas, and such as are not.

The former class of elements comprehends oxygen and hydrogen, which, either separately or in the condition of water, enter into the constitution of every plant; carbon, which, though of a fixed nature when alone, is converted into a gaseous state when combined either with oxygen or with hydrogen; and nitrogen, which is volatile both when alone and when in combination with hydrogen, as ammonia.

The three former are universally present in plants, the latter more commonly so than was formerly supposed, although in

* Lindley's Introduction to Botany.

smaller proportion than the rest; and as all four, though present in the soil, are also capable of volatilisation, or, in other words, of existing permanently in the atmosphere, it is quite open to conjecture, whether plants obtain their elements from the one source or from the other.

The second class of constituents, comprehending substances found in plants, which are incapable of being converted into vapour at such temperatures as they are exposed to in nature, consists of the alkalies, earths, and metallic oxides, which by their presence give firmness and solidity to the vegetable structure, and, perhaps, by being interposed between the particles of living fibre, may contribute in some other manner, as yet imperfectly understood, to impart to it the properties it possesses.*

These of course cannot be conveyed through the medium of the atmosphere, and hence the natural inference would seem to be that they are derived from the soil in which the plants are fixed.

Yet this conclusion has been combated by many physiologists, who allege that the above ingredients are found in plants even when not present in the soil from which they proceed; and a German chemist, Schrader, was honoured with a prize from the Berlin Academy for having, as was thought, established this position.

Saussure, however, has shown that the same plant, when grown upon a calcareous soil, contains more calcareous matter than it does in a siliceous one, and I have myself instituted a series of experiments which tend to demonstrate that, in proportion as you deprive a vegetable of all external means of obtaining its fixed constituents, in that degree you diminish the quantity of them which it will contain; whence the natural inference would seem to be, that if it were possible to intercept completely all the channels by which it could derive these principles, none such would be present in its composition.†

Thus the latest experiments confirm what both reason and

* See Dr. Prout's Treatise on the Stomach, &c., introduction; and my Introduction to the Atomic Theory, p. 30.

† The following were the results obtained in the experiments alluded to:—In Experiment I. the object was merely to determine the variation in the amount of solid ingredients obtained, which might be referred to differences in the soil or to different exposure to atmospheric influences. In Experiments II. and III. it was also intended to ascertain, by watering the plants with a solution of nitrate of strontian, whether the quality of the earthy ingredients might be made to vary *ad libitum* according to the nature of those presented to their roots in a soluble form. In the tabulated results given underneath, the portion soluble in water represents the amount of carbonates—that soluble in acid the amount of sulphates and of phosphates present.

EXPERIMENT

analogy tend to suggest, and relieve us from the necessity of resorting to a supposition so paradoxical as that of attributing to

EXPERIMENT I.

LOTUS TETRAGONOLOBUS.	Ashes.	Portion soluble In water.	Portion soluble Nitric acid.	Portion insoluble in these menstrua.
780 grs. of the seeds containing ...	30	5·2	3·4	only a trace
Being planted in a greenhouse.				
1. In sulphate of strontian.* Produce when dried 4002 grs.	60·0	very small	17·15	not estimated
2. In Carrara marble. Produce dried being 2233 grs.	67·5	1·8	20·9	not estimated
3. Sea-sand. Produce when dried 1135 grs.	34·3	4·1	6·0	not estimated
In a garden.				
1. In sulphate of strontian. Produce when dried 4862 grs.	94·0	0·72	27·2	not estimated
2. Carrara marble. Produce when dried 3267 grs.	64·5	a trace	28·2	1·5
3. Sea sand. Produce when dried 2957 grs.	67·0	a trace	16·0	8·8
4. Common garden mould. Produce when dried 5267 grs.	82·25	16·8	13·85	5·0

* The sulphate of strontian was far from pure, and therefore might easily furnish the earthy ingredients which the plants contained.

EXPERIMENT II.

LOTUS TETRAGONOLOBUS.	Ashes.	Portion soluble In water.	Portion soluble Nitric acid.
600 grs. of the seeds	23·0	4·0	2·6
Planted in a greenhouse, and watered with a solution of nitrate of strontian, containing 2 ounces of the salt to 10 gallons of water.			
1. In sulphate of strontian.			
Produce dried { Parts above ground 170	22	6·65	2·65
Produce dried { Roots, &c..... 107	40	0·48	5·60
277	62	7·13	8·25
2. In Carrara marble.			
Produce dried { Parts above ground 150	19	3·70	16·3
Produce dried { Roots, &c. 152	34	3·20	37·0
302	53	6·90	53·3
3. In washed sea-sand.			
Produce dried { Parts above ground 34	5	2·3	1·4
Produce dried { Roots, &c. 100	6	1·4	1·7
134	11	3·7	3·1
4. In flowers of sulphur.			
Produce dried { Parts above ground 100	6	2·6	2·9
Produce dried { Roots, &c. 108	5	2·6	1·9
208	11	5·2	4·8

the vegetable organization the power of itself elaborating the alkaline or earthy matters which it may chance to contain.*

It follows, then, that whichever of this class of constituents enters necessarily into the fabric of the vegetable, must be present also in the soil in which it grows, and hence we may derive an important lesson as to the application of the substances employed as mineral manures in encouraging the growth of particular plants, and also as to the injurious effects of certain crops upon the growth of those which are to succeed them.

Every known vegetable seems to contain a given proportion of alkali—soda near the sea, potass in places more inland.

The former of these may readily be referred to the salts present in the waters of the ocean, whilst the latter may be supplied

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EXPERIMENT III.

HORDEUM VULGARE.	Weight of its ashes.	Soluble portion of these ashes: In water.	In nitric acid. Without previous treatment.	After being treated with an alkaline carbonate. Earthy phosphate.	Earthy sulphate.	Portion insoluble in these menstrua.
300 grs. containing	7·7	1·53	1·68	....	0·45	2·01
Planted in a greenhouse, and watered with a solution of nitrate of strontian, containing 2 ounces of the salt to 10 gallons of water.						
1. In sulphate of strontian. Produce dried 383 grs.	61·0	13·3	17·0	3·6	1·3	0·9
2. In Carrara marble. Produce dried 230 grs.	34·0	7·8	14·5	....	2·5	0·8
3. In washed sand. Produce dried 260 grs.	45·0	10·5	5·9	0·9	2·5	2·1
4. In flowers of sulphur. Produce dried 78 grs.	7·0	0·9	4·0	none	none	0·1

See Linnæan Trans., vol. xvii. part II.

* Lampadius has lately instituted some experiments, which seem at first sight to militate against the notion, that the inorganic constituents are dependant on the nature of the soil in which they grow. He divided a piece of ground into five equal parts, each 20 feet square; after measuring them equally, he strewed over the first 5lbs. of finely-powdered quartz; over the second, the same quantity of ammonia; over the third, as much chalk; over the fourth, as much of carbonate of magnesia; the fifth being left without any addition. A certain quantity of wheat was sown in it and the crop analysed, but no difference in their respective fixed ingredients was discoverable. Mayer, however, justly observes, that these experiments prove nothing, because the earths added were not in a soluble condition, and therefore could not affect the constitution of the plants.

by the decomposition of those rocks into which it enters as an ingredient.

But the decomposition of a rock proceeds only at a certain and that a very slow rate, and until it is complete the alkali will be retained by an affinity much too powerful to allow of its being extracted by the absorbing surfaces of the roots.

Hence, supposing the crop already raised on a field to have absorbed all the alkali which the subsoil at the time contains, it is evident that no second crop of the same description can succeed until the ground has lain fallow long enough to admit of a fresh supply of alkali being obtained by a continuance of the process of disintegration, or until this necessary ingredient has been added to it from without.

Hence the advantage in these cases of such manures as wood-ashes, because they contain much potass, and even of the excrements of animals, since these also are not destitute of that principle.

Another ingredient present in all vegetables that yield nourishment to man, and especially so in the different kinds of bread-corn, is phosphoric acid.

This substance is found in many minerals and mineral waters, and even, according to Liebig, in all land anywise capable of cultivation, so that the barren heath of Luneburg contains an appreciable quantity of it.

I recollect some years ago, when Dr. Buckland was pursuing his researches on coprolites, which consist chiefly of phosphate of lime, that I endeavoured to assist him by searching for this substance in a variety of rock specimens taken from different localities, but that I soon gave up the pursuit, finding traces of its presence so generally as to be led to conclude that no inference as to the presence of coprolitic matter could be satisfactorily deduced from the mere existence of phosphate of lime in the containing rock.

Under the circumstances stated, we cannot wonder either that bone-dust, which mainly consists of this material, should prove so excellent a manure when applied for the first time upon land, or that it should lose its efficacy on repetition; that is, when the soil has become already sufficiently charged with this principle to furnish to the plants all of it which they require.

The necessity of deriving from the ground whatever fixed ingredients enter into the constitution of any particular plant, explains in part the advantage of a due admixture in the subsoil of all the more common earths. A certain quantity of silex, of lime, of magnesia, seems to be essential, and hence a soil consisting wholly of one of these earths is generally found to be unproductive.

I have likewise shown in some experiments which I made some years ago,* that when an earth which does not naturally enter into the constitution of a plant, such as strontian, is presented to it, even to the exclusion of others, little or none can be detected within the vegetable tissue, so that it either is not absorbed, or is again excreted, by the roots; and this conclusion I find to be corroborated by Liebig in the volume already referred to.

It may appear singular, that under these circumstances a substance having such a resemblance to lime as strontian possesses, cannot be substituted for it, especially when it has been found that the proportions of the several earths and alkalies which enter into the composition of a plant vary according to external conditions. Thus I have already stated that the same plant grown on a calcareous soil contains more lime, and less silex, than it does in a siliceous one, and *vice versâ.*

But it has been shown by Liebig that the total amount of the bases present never varies, the excess of one making up for the deficiency of the rest. Thus, according to Saussure, one hundred parts of the ashes of a fir, growing on the magnesian soil of Mount Breven, contained :—

Carbonate of potass	3·60	Sum of oxygen in the potass	0·41
,, lime	46·34	,, lime	7·33
,, magnesia	6·77	,, magnesia	1·27
Sum of the carbonates	56·71	Sum of the oxygen in the bases	9·01

whilst one hundred parts of the ashes of the same tree grown on the soil of Mount La Salle, which contained no magnesia, consisted as follows, of,—

Carbonate of potass	7·36	Sum of oxygen present in potass	0·85
,, lime	51·19	,, lime	8·10
,, magnesia	00·00	,, magnesia	0·00
Sum of the carbonates	58·55	Sum of the oxygen in the bases	8·95

Again, Berthier has analysed the ashes from two fir-trees, one growing in Norway, the other in France (Départ. de l'Isère).

That from Norway contained, in one hundred parts,—

Potass	14·10	of which	2·4	parts would be oxygen
Soda	20·70	,,	5·3	,,
Lime	12·30	,,	3·45	,,
Magnesia	4·35	,,	1·69	,,
	51·45		12·84	

That from France, on the contrary, contained in one hundred parts,—

Potass and soda	16·8	in which	3·42	parts would be oxygen
Lime	29·5	,,	8·20	,,
Magnesia	3·2	,,	1·20	,,
	49·5		12·82	

* Linnæan Trans., vol. xvii.

Thus in both cases, variable as the proportions of the different bases were, the amount of oxygen present in them collectively was as nearly as possible the same.

And what renders the last result more remarkable is, that in the fir-wood from Norway the amount of soluble salts was fifty, in that from France only twenty-five per cent. The bases in the former were in combination wholly with organic acids, those in the latter partly with organic and partly with mineral ones, such as the sulphuric, phosphoric, and muriatic. Yet even here, as we have seen, the amount of oxygen present in the bases collectively, and in consequence their saturating power, corresponded almost precisely.

Why then, it may be asked, cannot a new earth, like strontian, take the place in a plant of those which form a part of its ordinary constitution?

It is possible that the difference of crystalline form which exists between the substances under consideration may render the substitution of one for the other in the structure of the living plant impossible. Lime, it is to be remarked, is *isomorphous* with magnesia, and even in some cases replaces potass and soda. We can therefore understand how it happens that one of these bases may be substituted for the others in plants, as well as in minerals; but between them and strontian no isomorphism exists, and hence there may be some mechanical reason why this substance is unsuitable to the vegetable organisation,* and therefore cannot replace the bases in question.

There would seem, however, to be a limit to this power of substitution, even in the case of substances which enter naturally into the constitution of the vegetable, and which are isomorphous one with the other,—for we cannot otherwise explain why it is that

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* Von Buch has offered some ingenious remarks in a memoir on the silicification of organic bodies, published in the "Transactions of the Berlin Academy," which seem to illustrate this latter position. "The skeleton of animals," he remarks, "would have become very different had nature had another substance to work with than phosphate of lime, the axes of which are unequal. Such minerals only as have unequal axes, *i. e.*, in which there is one axis of greatest contraction, can become fibrous or extend themselves in rays. They are those minerals in which the axis of the ray is always at the same time the axis of the greatest contraction. This axis even decides the predominant direction of the shooting out of the rays. It is only in such minerals that these rays can so arrange themselves together as to form a thin covering."

"Were the secreted substance one having equal axes, like fluor-spar, for instance, the organic life would have had thus great difficulty in arranging the particles of fluor-spar when formed. Instead of rays and plates, masses would have been produced; and the skeleton, and with it the entire animal and its capabilities, would have been completely different from what they actually are"

wheat will not flourish in a sandy or even in a calcareous soil, unless a considerable quantity of clay be also present, the latter being required to furnish a sufficient proportion of alkali, which the other earths do not contain.

Accordingly, fir-trees and other evergreens grow well in sandstone and in limestone, whilst those which shed their leaves thrive better on rocks of a granitic character; for the latter require more alkali, and can procure a larger supply of that constituent from felspathic materials.

But the inorganic matters already alluded to constitute, after all, an inconsiderable part of the vegetable structure, when compared with those volatilisable principles which accompany them in plants.

It becomes therefore a still more important inquiry, from whence do the latter derive the carbon, the hydrogen, the oxygen, the nitrogen, which they all appear to contain? Do these principles proceed from the soil, or from the atmosphere, or must we conclude that both the one and the other contribute to supply them?

Until within the last century it would have been taken for granted that the soil was the source from whence proceeded all the solid matter at least which entered into the constitution of a plant; and there were several circumstances which tended to countenance such an opinion. No plants, it was observed, would continue long to thrive in earth unmixed with some proportion of vegetable mould; and the fertility of the latter is greatly enhanced by the addition of animal or vegetable matter in that state of decay in which it becomes soluble in water, and therefore fitted to obtain admission into the vessels of plants.

Hence, when Priestley had demonstrated that leaves decompose the carbonic acid of the atmosphere, giving out its oxygen and assimilating its carbon, the doctrine alluded to still to a certain extent maintained its ground; and it was even questioned by Ellis and others, whether, in fact, if we were to strike the balance between the opposite influence of a plant during the day and the night, as much carbonic acid might not be exhaled by it at one period as had been decomposed at another.

I was therefore induced myself to undertake some experiments,* the results of which appear to establish that plants, even in a confined atmosphere, do in reality add a great deal more oxygen to the air than they abstract from it, whilst the amount of carbonic acid which may be introduced undergoes at the same time a corresponding diminution.

This effect I even found to take place in diffused light, as well

* See Philosophical Transactions for 1836.

as under the direct influence of the solar rays, and to be no less common in aquatic than in terrestrial plants.

I also showed that when a branch loaded with flowers as well as with leaves was introduced into a jar containing a certain proportion of carbonic acid, the balance still continued to be in favour of the purifying influence of the vegetable.

The apparatus I made use of consisted of a large bell-glass jar, containing in one case 600, in another 800, cubic inches of air,* and suspended by pulleys; its edges dipped into quicksilver, contained in a double iron cylinder of corresponding dimensions to the jar, which, being closed at bottom, constituted a well of about 6 inches in depth, calculated to receive a fluid, and to admit of the glass vessel moving freely in it. The inner margin of this hollow cylinder was cemented air-tight, according as circumstances required, either to a plate of iron, or to a pot of the same material upon or in which the plant operated on might be placed; and the jar was then let down upon it until its edges were sunk a little beneath the surface of the mercury.

Thus all communication with external atmosphere was cut off, and the effect of the plant upon the air enclosed in the jar was readily measured, by simply pressing down the latter, and thus expelling a portion of its contents through a tube communicating with its interior, and introduced at its outer extremity under a pneumatic trough, wherein the air might be collected and examined. By connecting this extremity with a vessel containing a measured quantity of carbonic acid, and raising the jar a little in the well of mercury, it was easy to draw in any proportion of that gas with which it was thought proper that the plant should be supplied. A portion of the air was always tested immediately after the introduction of every fresh portion of carbonic acid, and again after an interval of some hours, and the proportion of this gas and of oxygen present was each time carefully registered. The amount of carbonic acid was determined by a solution of potass, that of oxygen by the rapid combustion of phosphorus with a portion of it introduced into a bent tube.

Such was the mode of procedure when an entire plant became the subject of experiment; but some of the most satisfactory trials were with branches of certain shrubs, themselves too large to be admitted under the jar. These branches, without being detached from the parent trunk, were introduced through a hole in the centre of two corresponding semicircular plates of iron, which were cemented, air-tight, to the inner margin of the iron cylinder on the one hand, and to the stem of the branch on the

* Larger jars, containing from 1200 to 1300 cubic inches, were latterly employed.

other. In this manner, when the jar came to be placed over them, and to dip beneath the surface of the mercury, the external air was as effectually excluded as when the whole of the plant had been enclosed.

The results of several experiments, conducted after this plan, are given in a tabular form in the Memoir; but it may be sufficient here to specify one of the most satisfactory of those undertaken. In this case the jar itself contained about 600 cubic inches of air, and the plant experimented on was the common lilac (*Syringa vulgaris*). The proportion of carbonic acid in the jar was each morning made equivalent to 5 or 6 per cent. by additions through the tube.

The first day no great alteration in the air was detected, but on the second day, by eight in the evening, the oxygen had risen to 26·5 per cent. In the morning it had sunk to 26·0, but by two P.M. it had again risen to no less than 29·75, and by sunset it had reached 30·0 per cent. At night it sunk ½ per cent.; but the effect during the following day was not estimated, as the sickly appearance which the plant now began to assume induced me to suspend the experiment.

In a second trial, however, the branch of a healthy lilac, growing in the garden, was introduced into the same jar, where it was suffered to remain until its leaves became entirely withered.

The first day the increase of oxygen in the jar was no more than 0·25 per cent., but on the second it rose to 25·0. At night it sunk to nearly 22·0 per cent., but the next evening it had again risen to 27·0. This was the maximum of its increase, for at night it sunk to 26·0, and in the morning exhibited signs of incipient decay. Accordingly, in the evening the oxygen amounted only to 26·5; the next evening to 25·5; the following one to 24·75; and the one next succeeding it had fallen to the point at which it stood at the commencement, or to 21·0 per cent.

The reason of this decrease was, however, very manifest from the decay and falling off of the leaves; so that this circumstance does not invalidate the conclusion which the preceding experiments concur in establishing—namely, that in fine weather, a plant, so long at least as it continues healthy, adds considerably to the oxygen of the air when carbonic acid is freely supplied.

In the last instance quoted, the exposed surface of all the leaves enclosed in the jar, which were about fifty in number, was calculated at not more than 300 square inches, and yet there must have been added to the air of the jar as much as 26·0 cubic inches of oxygen, in consequence of the action of this surface upon the carbonic acid introduced.

But there is reason to believe that, even under the circum-

stances above stated (which appear more favourable to the due performance of the functions of life than those to which Mr. Ellis's plants were subjected), the amount of oxygen evolved was much smaller than it would have been in the open air; for I have succeeded, by introducing several plants into the same jar of air in pretty quick succession, in raising the amount of oxygen contained from 21 to 39 per cent.; and probably had not even then attained the limit to which the increase of this constituent might have been brought.

How great then must be the effect of an entire tree in the open air, under favourable circumstances! And we must recollect that, *cæteris paribus*, the circumstances will be favourable to the exertion of the vital energies of the plant, within certain limits at least, in proportion as animal respiration and animal putrefaction furnish to it a supply of carbonic acid.

These experiments were published in the 'Philosophical Transactions for 1836,' and have been noticed in Dr. Lindley's popular 'Introduction to Botany;' neither am I aware that the deductions which were drawn from them have anywhere been disputed: I know not, therefore, to what class of physiologists Professor Liebig can allude when he asserts* that the source from whence plants obtain their carbon is still doubted; nor to whom he may address the arguments by which he thinks it necessary to support a doctrine which, in this country at least, is considered so fully established.

We are, however, indebted to him for explaining more clearly than had hitherto been done how it happens that, if the atmosphere be the source of the carbon present in the constitution of a plant, the growth of the latter is so materially influenced by the quality of the mould with which its roots are in contact, and also why it is that without the presence of this substance it speedily languishes and dies.

In order to account for this, Professor Liebig begins by showing that vegetable mould contains in general two principles, both of which have often been confounded under the common designation of *humus*.

The first of these, which is soluble in alkalies and in certain of the earths, has been termed *humic acid*, although, correctly speaking, the latter is the substance produced from that description of humus which is in a state to be acted upon by alkalies in consequence of their operation upon it.

The second principle, which should be distinguished by the term *coal of humus*, is indeed derived from the former by the gradual process of decay, but is already advanced to that con-

* Chemistry applied to Agriculture, p. 26.

dition in which neither alkalies nor earths can convert it into humic acid, nor render it soluble.

Now humus, in common with all carbonaceous substances which contain a small proportion of hydrogen, undergoes, when slightly moistened, a process of slow combustion, which may consist, either simply in an absorption of oxygen, in which case nothing will be given off, or in the production of carbonic acid, when of course that gas will be disengaged.

The slowness with which the latter takes place, and the absence of that sensible heat and light which accompany ordinary combustion, have led Professor Liebig to distinguish this process by the term *erema-causis*, from ηρεμα by degrees, and καυσις burning.

Now this slow combustion goes on in woody fibre, from the first commencement of its decay till it passes into that description of humus before described, which is insoluble in earths and alkalies.

During the intermediate stages it constitutes humus of the former description, which, as already stated, when acted upon by these substances, is converted into humic acid, and combines with them.

During the whole period of its decay, until it has reached that ultimate point at which it ceases to be soluble, and has become a kind of *caput mortuum*, it goes on continually disengaging carbonic acid; so that the roots of plants fixed in humus of this quality are surrounded by an atmosphere of the gas in question, which is therefore held in solution by the water taken up by them as sap.

Humus, then, by means of the carbonic acid which it emits, does supply food indirectly to the plant; but that it communicates nothing to it directly appears from the fact that it is itself almost wholly insoluble in water, and can only be dissolved by it when in union with an alkali or an earth. Hence the amount of humus, or humic acid, which enters the vegetable tissue, must at least be limited by the quantity of earthy and alkaline matters which are absorbed; and how small that quantity is may be seen by reference to the statement I have already made, as to the weight of ashes in a given portion of a plant.

We seem, therefore, to be justified in attributing the carbon which plants contain exclusively to the decomposition of carbonic acid, which, before the leaves are developed, is introduced together with the sap by the roots, but afterwards is obtained directly from the air itself. Hence the larger tribes of the vegetable kingdom draw little from the soil, or rather excrete by their roots more carbon than they absorb, whilst the extensive surface exposed to the atmosphere by their leaves enables them to perform

that important office which is assigned to them in the economy of nature—of purifying the atmosphere polluted by the breath of so many millions of animals, as well as by other operations connected with the existence of the human species.

It is remarked by Liebig that, in early periods of the earth's history, the gigantic monocotyledonous plants—the ferns, palms, and reeds, with which the surface of the globe was overspread—belonged to a class to which nature has given the power, by means of an immense extension of their leaves, to dispense with nourishment from the soil. Hence the enormous amount of carbon locked up within the earth in the shape of coal, the whole of which was originally obtained from the carbonic acid afforded by the atmosphere.

But it would seem necessary to attribute to the living vegetable the power of decomposing not merely carbonic acid, but also water.

This indeed has been shown by MM. Colin and Edwards, in their experiments on the respiration of plants, and likewise by M. Boussingault; nor can we otherwise account for the fact that wax, resin, and several other vegetable products, contain an excess of hydrogen over and above that required to constitute water with the oxygen present.

It would seem, I think, from the late important researches of M. Payen, that the decomposition of water commences subsequently to that of carbonic acid; whether it be that the former process requires a greater development and energy in the vegetable functions, or that it takes place in organs of a different description and of later growth.

M. Payen seems to have established, that under the general term of ligneous fibre, or lignin, we have hitherto confounded at least two distinct substances—namely, that which constitutes the walls of the cells, and that which, by being deposited afterwards on the surfaces of the latter, imparts to them the solidity of texture which woody fibre possesses.

He has succeeded in isolating the two by chemical means, and has found that, whilst the cellular matter has exactly the same composition as starch—being composed of 44·9 carbon, 6·1 hydrogen, 49 oxygen, or 44·9 carbon and 55·1 of water—the incrusting matter afterwards formed consists of 53·76 carbon, 40·2 oxygen, and 6 of hydrogen; or of 53·76 carbon, 45 of water, and 1 of hydrogen.*

The composition of the ligneous matter of different kinds of wood will therefore vary according to the relative proportion

* Payen has since stated that this incrusting matter probably consists of two or three different principles.

of these two ingredients, as is shown in the following table of M. Payen:—

Ligneous Bodies.	Carbon.	Hydrogen.	Oxygen.	Incrusting Matter.
Incrusting matter of the wood	53·76	6·00	40·20	100
Wood of Saint Lucia	52·90	6·07	41·03	90
Ebony	52·85	6·00	41·15	89
Walnut	51·92	5·96	42·12	82
Oak	50·00	6·20	43·80	61
Ditto, according to Gay-Lussac and Thenard	51·45	5·82	42·73	
Beech	49·25	6·10	44·65	52
Cellular matter	44·90	6·10	49·00	00

This then proves that, in the formation of the matter which incrusts and fortifies the walls of the cellular tissue in wood, though not in that of the cellular tissue itself, a decomposition of water must have taken place; since the 1 per cent. of hydrogen which Payen has found in excess can only have arisen in this manner.

This increase of hydrogen becomes still greater when in the progress of vegetation the plant begins to secrete oils, camphors, and other analogous bodies—products which, it is to be remarked, abound most within the tropics, where the light of the sun is most intense.

Hence the decomposition of water, no less than that of carbonic acid, seems due to solar influence, and accordingly the greater sweetness of subacid fruits in a warm than in a cold summer arises from the transformation of a larger amount of tartaric or other vegetable acids into sugar, owing to that separation of oxygen from the former which is accomplished by the agency of light.

The process of assimilation of plants in its most simple form may therefore be stated as consisting in the extrication of hydrogen from water, and of carbon from carbonic acid, in consequence of which one of three things must happen—either all the oxygen of the water and of the carbonic acid are separated, as in those bodies which, like caoutchouc, volatile oils, &c., consist of nothing else but carbon and hydrogen; or, secondly, only a part of it is exhaled, as in the case of the incrusting matter of wood, and in sugar; or, thirdly, that belonging to the carbonic acid alone is decomposed, whilst the water remains, as in starch and cellular tissue.

But there is yet another ingredient which is present, although generally in minute proportions, in many vegetable principles, and which therefore must be furnished to them from without, in

order that their remaining constituents may become assimilated; for it is evident, that however small the amount of any one of the component parts of a compound may be, still its presence is just as essential as that of the rest.

This ingredient is nitrogen, which exists in the seeds of most plants, and seems essential to all those vegetable principles that afford the staple from which animal life obtains its support.

The dependence of the nutritive qualities of various articles of food upon the proportion of nitrogen is well shown in a recent Memoir of Monsieur Boussingault,* who gives, on the authority of the celebrated agriculturist Von Thaer, a scale of the relative degree of nutriment afforded by various plants to cattle, and then places by the side of it a statement of the proportion of azote present in them, from which it appears that the nutritious quality of each bears a pretty constant ratio to the quantity of nitrogen they contain.

This may be seen by the following table:—

	Equiv.	
Ordinary hay	100	its azote being 0·0118
Red clover	90	0·0176
Beans	83	0·0141
Wheat-straw	400	0·0020
Potatoes	200	0·0037
Beet	397	0·0026
Maize	59	0·0164
Barley	54	0·0176
Wheat	27	0·0213

When we reflect, indeed, that animal matter, which so abounds in nitrogen, is nevertheless derived, either directly or indirectly, from vegetable, it follows, as a necessary consequence, that existence can only be maintained by the aid of those principles in plants which contain a certain proportion of the element alluded to.

And this has been shown by the experiments of Magendie upon dogs which were fed on sugar, starch, gum, and other substances destitute of nitrogen, and in a very short time pined away and died.

Now, in inquiring as to the source from which plants derive their nitrogen, it might at first sight strike us, that the atmosphere itself, which contains as much as 80. per cent. of this gas, would supply it. To this supposition, however, there appear to be grave objections, from the indisposition which nitrogen evinces to enter into combination with any elementary substances, excepting oxygen and hydrogen.† With the latter, indeed, it is only when

* Annales de Chimie, vol. lxiii.

† It unites indeed with carbon, chlorine, &c., but only through the intervention of other substances.

in what is called a *nascent* state that it will unite, nor do bodies containing either hydrogen or oxygen in combination exert for it the smallest affinity.

Liebig therefore concludes that it is furnished to plants by the decomposition of ammonia,*—a compound of nitrogen with hydrogen,—which, from its solubility in water and in acids, together with the facility with which it is resolved into various and opposite forms, seems exactly calculated to enter into the vegetable organization, and to supply the nitrogen which it requires.

But is ammonia so uniformly present wherever plants are to be found, as the foregoing explanation appears to assume?

Considering that this gas is the constant result of animal decomposition, its presence in recently-manured soil, or even generally near the great resorts of man, may perhaps be readily conceded; but are we authorized to regard it as the source of nitrogen in plants that grow in places remote from human habitation, where decaying animal matter cannot so constantly present itself?

This question, which had embarrassed all those who formerly indulged in speculations on the subject, seems at length to have been set at rest by the researches of Liebig.

"Experiments made," he says, "in his laboratory at Giessen, with the greatest care and exactness, have placed the presence of ammonia in rain-water beyond all doubt. It had hitherto escaped observation, merely because no one thought of searching for it." All the rain-water which he examined was collected 600 paces west of Giessen, whilst the wind was blowing towards the town in that direction. It could not therefore have been derived from any animal exhalations proceeding from that source. When several hundred pounds of this water were distilled in a copper still, and the first two or three pounds that came over had been evaporated with the addition of a little muriatic acid, very distinct crystals of sal ammoniac were obtained.

Hence there can be no doubt that ammonia must be constantly present, combined probably with carbonic acid, in the atmosphere we breathe, although in quantities too minute to be appreciable.

Its amount, as inferred from the indications afforded by the rain or snow-water that has been examined, appears to be very variable, being greater in summer than in winter, during long-protracted drought than after a continuance of wet; but this is no more than

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* May it not also be true that the converse likewise occurs in some cases, and that hydrogen is assimilated whilst nitrogen is disengaged? This I am inclined to suspect, from having observed, in the course of my experiments with respect to the action of light upon plants, that certain cruciferæ, which, from requiring animal manure, would seem to absorb a large amount of ammonia, sometimes exhale pure nitrogen.

See my Memoir in the Philos. Transactions for 1836.

might be expected when we reflect that it must be principally derived from the decomposition proceeding in various parts of the globe of all kinds of animal exuviæ, the volatile products of which, until otherwise appropriated, will be retained in the general body of the atmosphere as in a common reservoir.

> "Semper enim quodcunque fluit de rebus, id omne
> Aeris in magnum fertur mare: qui nisi contra
> Corpora retribuat rebus, recreetque fluenteis,
> Omnia jam resoluta forent, et in Aera versa."

Thus ammonia will be constantly presented to the roots of plants in union with the rain-water that has descended from the heavens, even where the vegetable mould is so entirely destitute of animal matter as to be incapable itself of supplying it.

There is also another principle which may be called in to explain the manner in which gaseous matters are brought into contact with the absorbing surfaces of plants.

It was originally shown by Saussure that charcoal has the property of absorbing and even condensing within its pores various gaseous matters; and Faraday observed, not many years ago, the singular facility with which earthy and metallic powders of all descriptions absorb ammonia, when present either in the air or in the bodies with which they are brought into contact.

Reasoning upon these facts, I was myself led last spring to undertake a few experiments with the view of ascertaining whether vegetable mould had not the same property, and I found accordingly that both carbonic acid and ammoniacal gases were condensed within its pores, as they would be within those of a lump of charcoal.

Liebig in his late volume has made the same remark, and has extended it to the oxides of iron, to pipe-clay, &c., and hence we have a mode of accounting for the absorption of ammonia by plants, even in countries where the absence or the rare occurrence of rain might otherwise deprive them of a due supply of this necessary ingredient.

Nor are we any longer at a loss to trace the ammonia into the substance of the plant, which derives from it its nitrogen.

That it does actually find its way into the vegetable organization, we are assured by the researches of Professor Liebig, who ascertained that the saccharine juice which flows from the different varieties of maple, even when growing in soils that were not manured, contains a large proportion of ammonia.

The same is the case with the juice extracted from beet-root for the purpose of preparing sugar, and the products of the distillation of herbs, flowers, and roots, with water, contain ammoniacal salts.

So also does the juice of the fresh tobacco leaf, and that which exudes from the vine, when an incision is made into it during the period that the sap is flowing.

Its occurrence in short in the juices of plants seems not less certain than its existence in the atmosphere, and there can be little doubt that it is the decomposition of this compound which mainly supplies the nitrogen present in the constitution of organic bodies.

It may be inferred, however, from some experiments made by Boussingault, that a great difference exists between plants in their power of assimilating nitrogen, and to this difference that chemist is disposed to attribute the advantage of alternately growing what are called fallow-crops, for the purpose of refreshing the soil.

"During germination," he remarks, "the quantity of azote which seeds contain appears to be on the increase, but there is this curious difference between different kinds, that whilst those of leguminous plants, sown in pure earth and moistened with nothing but distilled water, obtained an increase of nitrogen which the atmosphere alone could have afforded, those of barley and other cerealia remained in that respect stationary, unless manure were afforded."

Boussingault also shows, in a subsequent memoir, that peas, clover, and other legumes, absorb azote, even when planted in a soil that contains no decomposing animal or vegetable matter, but that the cerealia, although, if so placed, they may grow, do not appear to secrete this principle.

Boussingault, however, does not go so far as to maintain that the latter in no stage of their existence are capable of discharging this function, but only that the plant must have already arrived at a higher state of vigour, in order to derive its supply from such a source.

It is on the same principle, that although the animal in general obtains its food from the various organic bodies on which he subsists, yet that in an early stage of existence, before his organs are fitted for undergoing the labour of assimilating such materials, nature has provided him in his mother's milk with aliment already almost elaborated.

It is thus, too, that in the seed the embryo is surrounded with a mass of albumen, from which it derives its support, until its roots become sufficiently vigorous to extract nourishment from the ground.

Hence it becomes in most cases necessary that crops cultivated as articles of food should have access to vegetable or animal manure from which they may derive their azote; but as this supply would soon be exhausted, were it not at the same time regenerated from the atmosphere, we see the advantage of intercalating a green

fallow-crop ploughed into the ground with others, as leguminous plants, according to the experiments of Boussingault, have the greatest power of absorbing nitrogen from the air.

On the same principle this chemist suggests the introduction of the Jerusalem artichoke into light soils, which, owing to the entire absence of mould, appear irreclaimably barren; this vegetable, the tubers of which afford nourishment to cattle almost equal to potatoes, having great power of absorbing both carbon and nitrogen from the air, and thus by degrees generating a certain amount of soil.*

I have seen this vegetable very commonly cultivated for the use of cattle in the light lands of the Grand Duchy of Baden, and in certain parts of Alsace.

But if it be true, as Liebig has endeavoured to establish, that plants obtain everything except their alkaline and earthy constituents from the atmosphere, what, it may be asked, becomes of the theory of which mention was made in the preceding lecture, that attributes the unfitness of a soil for yielding several successive crops of the same plant to the excretions given out by its roots?

For if plants receive the whole of their volatilisable ingredients from the atmosphere, these excrementitious matters, being composed chiefly of carbon, hydrogen, and oxygen, will not be absorbed, and therefore cannot affect the succeeding vegetation.

The above inference would seem unavoidable, if it were considered absolutely proved that nothing but the fixed ingredients of a plant were derived from the earth; but this is not fully established even with respect to the humus, much less with respect to the more soluble matters which the soil contains.

These latter, there seems no reason for doubting, may be taken up by the spongioles of the roots dissolved in water, together with the alkaline and earthy ingredients which are derived from the soil, nor am I aware of any proof that they may not likewise be assimilated when so introduced.

The theory of M. Decandolle, therefore, is not affected by the above experiments, but must rest on its own merits, and continue to afford a subject for inquiry to the scientific agriculturist.

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* It is to be observed, that Boussingault attributes to plants the power of absorbing nitrogen from the air, but he alleges no proof that they have that power, and his results may be just as well explained by supposing them to have different powers of absorbing ammonia. It is to be remarked, that the helianthus tuberosus belongs to a tribe of plants remarkable for their power of absorbing and exhaling water, and hence it is evident that they will be brought into contact within a given time with a larger amount of ammonia than other plants which possess a less degree of energy in that respect.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

V—1. *Experiments on Nitrate of Soda and Saltpetre.* By W. Stratford Dugdale, M.P.

Many communications having been forwarded to the Society on the value of saltpetre and nitrate of soda as manures, perhaps the result of an experiment I have made upon two fields of wheat, eight miles distant from each other, may not be uninteresting. One field is of a light gravelly soil, which was manured with a coat of marl in the autumn before the wheat was sown.

The other field is of a stiff clayey soil, and was manured with lime in the autumn. About the middle of last April I measured off three quarters of an acre in the field of gravelly soil, and sowed one quarter with saltpetre, one with nitrate of soda, and left the remaining quarter with nothing but the marl.

I also measured off four quarters of an acre in the clayey field, and sowed one quarter with saltpetre, one with nitrate of soda, one with soot, and left the remaining quarter with lime only. In both cases the quantity of saltpetre and soda was as one hundred weight to the acre. In the gravelly field the produce of the quarter of an acre with nitrate of soda was, of—

Wheat . . .	13 bushels 2 pecks, weighing 63⅔ lbs. per bush.
Straw . . .	9 cwt. 72 lbs.
Chaff and waste .	2 qrs. 27 lbs.

Saltpetre,—

Wheat . . .	10 bushels 2½ pecks, weighing 64¼ lbs. per bush.
Straw . . .	8 cwt. 56 lbs.
Chaff and waste .	3 qrs. 24 lbs.

Marl only,—

Wheat . . .	10 bushels 2 pecks, weighing 64 lbs. per bush.
Straw . . .	8 cwt. 54 lbs.
Chaff and waste .	1 cwt.

In the clayey field:—The produce of half an acre, manured with—

	Bsh.	pk.		lbs.
Nitrate of soda, Wheat . .	18	1	weighing	64 per bush.
Do. with Saltpetre . . .	17	2		63
Do. with Soot	17	1		63⅓
Do. with Lime only . .	16	0		62⅔

In this experiment my bailiff did not measure the quantities of straw and waste.

I also sowed some soda and saltpetre, to the same amount per acre, on some grass-land.

I was not at home when the hay was cut; but am informed that the crop was greatly increased, particularly by the nitrate of soda.

2. *Trial of Nitrate of Soda.* By Joshua Rodwell, Esq.

1839, July 12.—1 cwt. per acre upon lucerne, after the first mowing, the first year.	Benefit not equal to the cost, and much inferior to the same cost in soot, by which it was tested: the soot at 8*d.* per bushel.
July 20.—1 cwt. per acre upon beet-root; every alternate stetch 6 acres. Hoed in with the second hoeing.	Benefit not equivalent to the cost; scarcely apparent, except in the colour of the leaves.
July 29.—1 cwt. per acre for Swedish turnips; part after the first, and some after the second hoeing. 4 acres.	The effect scarcely apparent; by no means equal to the cost.
July and August.—1 cwt. per acre for white turnips, in every stage of their growth after being well up, before and after hoeing.	No benefit.
1840, May 23.—1 cwt. per acre upon pease, 2 acres; barley, 2 acres; wheat, 2 acres. N.B. The white clover after the barley failed where the nitrate was used.	Benefit not equivalent to the cost, but the greatest upon the barley.
June 1.—Wheat, 2 acres; barley, 10 acres. 1 cwt. an acre.	The barley increased in quantity equal to the cost, but layer not so good as where no soda was sown; the wheat increased in quantity, but not equal in quality. I have since found that the layer of white clover is almost destroyed.

N.B. In the above the experiments are made upon dry soils, with sand, sandy loams, and crag subsoils, and the lands in the common course of husbandry. The nitrate of soda 26*s.* per cwt.; and expenses of carriage and sowing 2*s.* per acre: and the experiments tested by very close observation, but not in weight or measure.

Alderton Woodbridge,
May 10, 1841.

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3. *Trials of Nitrate of Soda.* By Charles Newman.

To the Secretary.

Sir,—I am induced to offer you a few observations and a statement of the result of my experiments on nitrate of soda, as, though not extensive, they may tend in some degree to confirm the interesting reports on the same subject in the last and former numbers of the Society's

Journal. The first trial I made of it was in 1839, on wheat, oats, and grass; as far as the eye could discover, each of them made a very satisfactory progress in a few days after it was applied. Thus encouraged, I determined to make another trial, on a larger scale, the following year. I purchased my nitrate of soda at 21*l.* per ton, including cartage, and used it on all my crops:—

1. On part of a field of barley; in which I could perceive but little difference, the whole of the field being a heavy crop, and much laid.
2. On clover: the result was the same, which I attributed to the high condition of the land.
3. On spring-tares: two weeks after they were up the crop increased considerably, and was cut green for the horses.
4. On meadow: not quite so satisfactory as in the former year; this I considered arose also from the high condition of the land.
5. On wheat: this was an exceedingly thin crop, produced by the unfavourable autumn, the land being so wet when the seed was sown that half of it rotted; indeed the plant was so thin that I had determined to plough it up, but considered it an excellent opportunity to try the merits of the nitrate. Having sown it on a part of the field, I was much surprised at seeing not only the wheat improve, but also the wire-weed, which continued to increase up to the time of harvest, and was so strong as to render reaping difficult. Considerably more than a load of this weed to the acre was left on the land. I mention this circumstance merely to prove the power of the nitrate to force even weeds, the natural produce of the soil, when the corn is not sufficiently thick on the ground to take up its nutritive properties.
6. On a field of oats which had been under the process of draining, but where, in consequence of a continuation of rain, the operation had been suspended for a considerable time; the land, being continually saturated, was much out of condition. This I considered an excellent opportunity for experiments. In six days after the nitrate was sown it began to surpass the other part of the field, and continued to do so until harvest.

On each of the two last crops I housed and threshed, separately, one acre that was sown with nitrate, and one that was not so sown, and I found the result as follows:—

	bl. pk.		bl. pk.	£.	s.	d.
One acre of wheat sown with nitrate of soda . . .	20	0				
One ditto without . . .	14	3	Increase 5 1 at 8*s.* 6*d.* per bus.	2	4	7½
	truss.		truss.			
Ditto straw with nitrate .	72					
Ditto without	51½		Increase 20½ at 11*d.* per truss .	0	18	9½
				3	3	5
Expense of nitrate and sowing				1	7	0
Profit on nitrate per acre of wheat				1	16	5

	bl. pk.		bl. pk.			
One acre of oats sown with nitrate of soda . . .	60	3				
Ditto without . . .	46	0	Increase 14 3 at 3*s.* 6*d.* per bus.	2	11	7½
	truss.		truss.			
Ditto straw with nitrate .	120					
Ditto without . . .	84		Increase 36 at 10*d.* per truss . .	1	10	0
				4	1	7½
Expense of nitrate and sowing				1	7	0
Profit on nitrate per acre of oats				2	14	7½

By this statement it will be seen that the increase on the wheat and on the wheat-straw is more than one-fourth; on the oats nearly the same, and on the oat-straw almost one-third.

In my experiments the nitrate of soda was only beneficial on land that was out of condition; if this should prove to be its general character, it will indeed be a valuable auxiliary as a top-dressing in the spring. There are but few farmers who have not a small portion of their land to which it may become useful. You are aware that a very great breadth of land in this island requires a stimulus to produce even a moderate crop, while, to land which is naturally fertile and in a high state of cultivation, such assistance would prove injurious.

I purpose using a greater quantity of nitrate this season, with a view of trying its properties; and as it is very important not only to know how far it may prove beneficial to the first crop, but to examine the state of the land in the following season, I trust every member who may have the opportunity will not fail to make a report accordingly.

Yours, most respectfully,

Court Farm, Hayes,
March 13, 1841.

CHAS. NEWMAN.

VI.—*Some Account of the Cultivation of a Cold-Clay Farm.* By the Rev. G. F. HOLCOMB.

To Ph. Pusey, Esq.

SIR,—The conversation which took place between our Secretary, Mr. Hudson, and myself relative to the cultivation of heavy land, was in consequence of my observation of the successful practice of Mr. R. W. King, a considerable landed proprietor of this parish, in growing turnips upon cold soil, ill calculated naturally for the purpose. The part of his farm to which I alluded is situated upon the highest point of Cambridgeshire, twelve miles distant from Cambridge, and bordering upon the county of Suffolk; the surface of the soil is tenacious loam, shallow, upon a subsoil of cold clay.

Mr. King's method is, in the first place, to drain his land, which is done with dried turf procured for the purpose from the fens, similar in appearance to what used to be consumed instead of coal in the cottages; the length varies from 12 to 16 inches, according to the goodness of its quality, some being more brittle and more easily broken in carriage than others; the width and depth of the best turves is about 3 inches; the retail price is now 7*s.* per thousand: 4 horses in a waggon easily bring 3000. Supposing the drains to be a rod, *i.e.* 5½ yards, asunder, the usual distance, 2000 turves amply suffice for one acre of land; the durability of the drainage depends upon the soundness of the clay, the depth in the earth at which the turf is buried, and the goodness of turf, which varies in different parts of the fen. I have myself been a tile-maker for my own consumption, and used many thousands, but after twenty years of practical experience of tile and turf, prefer the latter; it is two-thirds cheaper than tiles, and, where sheep-folds are

set, not so liable to have the drains broken in, the turf giving way to the drift, whereas the tile breaks and the earth follows. I now cut across the old tile-drains to make turf ones in opposite directions, and deeper in the ground. The tile-drains are frequently found to be destroyed—rats, rabbits, moles, or narrow-wheeled carriages passing over them are all injurious. Turf is found to be sound which has been laid 16 years, but it pays well to renovate the drains every eight seasons. The *shape* of the drains corresponds with the turf. I send a slight sketch. The first operation is with a double-breasted plough, which makes a deep impression in the land: the labourer then takes a shovel to clear out the loose earth; afterwards he uses the spade; lastly he uses the land-ditch tool, with which the lower part of the drain is excavated to the depth of 12 inches more: the width of this aperture is about 3 inches at the top, and is gradually reduced by the shape of the implement to 1 at the bottom. The drain is perfectly cleared by a drawing-tool or hoe. The turf is then pressed into the drain by the foot to its depth, which is about 3 inches, leaving an open course for the water of about 9 inches deep underneath; when expanded by moisture, with the earth filled in open, it will bear any weight of horse or cart. The party of men who undertake the job generally carry to the field a small iron drift, with which they break or remove any stone that may interrupt the spade; if a large one they dig it out, filling the space with clay out of which the drain is formed for the turf. A little boy or girl, from six to eight years old, commonly attends each drainer, with a tin mug, often an old powder-tin, attached by a bit of string to the end of a stick, and filled frequently with water out of a pail, with which the child follows the spade, and by pouring it out when necessary loosens any stiff piece of clay or earth; when not wanted, the boy shovels out the moulds, previous to the operation of the spade, or collects the stones cast out, for which he is paid per load. The price of draining varies from 3*s.* 6*d.* to 5*s.* per score rod, including boy's wages; a good hand will execute 14 rod, some more, in the day. Sometimes 2, or even 3, spades' depth is taken out to get a proper level, or to penetrate the clay, when the price of course rises in proportion. If the shoulders of the drain give way in a gravelly or galty place, bushes or stubble are placed under the turf, which is doubled to fill a larger aperture.

Land-ditching, as it is here termed, is a work in which labourers take an interest: families work together; there is a competition between different parties, which is a stimulus to all; the work is never too hard for children, their attention must be always engaged; and the advantages arising to landlord, tenant, and labourer, are so abundant, that I hope I may be excused in prolonging this communication, as well as in earnestly recommending this simple and economical method to all classes not convinced by experience of the benefits arising from frequent drainage of surface-water in a heavy country.

For the growth of turnips on this heavy soil, Mr. King's method is to plough his land after wheat upon 8 furrow ridges, twice if necessary, during winter: early in the spring, about April, these ridges are split by the plough; the manure is ploughed in as upon the Northumberland system. These ridges are not disturbed till the time of sowing turnips,

when he takes a shim, which is a sharp piece of iron about 3½ feet long and 3 feet wide, with a sharp edge, attached to a pair of wheels like Kentish ploughwheels, and cuts under every ridge and manure, ridge after ridge, throughout the field; this operation destroys annual weeds as well as ploughing. The earth in a pulverised state, and manure which has had time to work, are mixed together, and the seed which is drilled upon it grows with astonishing rapidity, and for two years has produced such a crop of turnips as I never saw upon such a description of soil. Sometimes they are drawn off, at others fed upon the land, when good weather permits.

Brinkley Rectory, Newmarket,
Feb. 15, 1841.

VII.—1. *Experiments on Manures and on the Growth of Turnips.* By W. Miles, M.P.

Dear Pusey,

I regret much that, having last year proposed the experiment of turnips which was adopted by the Council, I should have failed in complying with the conditions: but Poittevin's manure was unfortunately detained on the road until it was too late; and a mistake was also made in the measurement of the land. So that neither have the three manures been used, nor the proper quantities of even the two distributed according to the regulations.

As, however, I have myself, as much as my different avocations permitted, inspected the growth of the turnips, and taken peculiar interest in the trial, I will give you my details and observations; premising that (Poittevin failing), in its place, I made use of a composition of one-third glue-dross (*i.e.* the remains of the pot after the glue has been extracted, consisting of pelt, horns, hoofs, and small bones), mixed with one-third fine ashes, and one-third road-scrapings; which I applied at the rate of 20 tons per acre; barring my man's miscalculation, which is as fair for one as the other. This, with dung at 20 tons per acre, and bones at 20 bushels per acre, form my experiment for the year.

I never recollect so fine a season for roots: every description seemed to flourish; and very few of the plants which appeared above ground in any way failed previously to storing.

The seed from Messrs. Gibbs, Halfmoon Street, was put in on the 28th of May, at the rate of 4 lbs. per acre. On the 8th of June the swedes were coming up well. On the 27th I find this note relative to the appearance of the experiment:—"Dung 1, bones 2, glue-dross 3; the glue-dross too hot for the turnips, and a failure of plant—turnips showed well, and were singled out at 9 inches." On Friday, the 10th of July, experiment was progressing in precise ratio as before stated. I transplanted some turnips into the vacancies occurring in that part of the experiment manured with glue-dross. On Monday, July 27th,

hoed turnips the second time; appearance much the same, except in the bones, put in at 27 inches, in which the greatest improvement was visible; this part had been ridged up similarly to the remainder of the experiment, but owing to the turnip-drill being in use at a distance, which deposits the bone-dust in required quantities immediately previous to the seed, my farming-man, to be accurate, split the ridge with the bean-plough, deposited the bones with the hand, and then run the common drill, with the roller attached, over the bones. Consequently, the appearance is exactly as if the turnip was sown in the furrow, the intervening ground between the rows standing higher than the turnips in the rows. For a fortnight previous to the 29th of August, in the west we had most delightful rains; and I find the following note in my farm-book: — "The experiment looking very well; but the turnips manured with the glue-dross most come on—the luxuriance of the foliage wonderful, having assumed that fine purple appearance which I have before observed in other roots similarly manured." About the 10th of September the crop was attacked by mildew: the swedes manured with the glue-dross, however, were scarcely injured, whilst all the others were hard hit. The consequence of which was that the roots of these went on swelling, whilst the others were for some time at a complete stand-still. I weighed and stored the turnips on the 25th of November; the result I enclose, from which you will perceive that, except with bones, the 18-inch distance has the largest produce: as far as the experiment with bones is concerned, I think the greater weight produced at 27 inches is to be attributed solely to the mode of putting them in, as, in the heat of summer, the plant, by being placed in a hollow, enjoyed every particle of moisture, not only that which fell on the foliage, but that which fell on the intervening ground, as each drill acted as a water-furrow to the adjoining land. The roots when stored were very perfect, but in many of them I found an unusual quantity of worm-holes. I had, fortunately, two fields of purple-top swedes immediately adjoining me, rented by two of my father's tenants; the three fields formed an acute triangle, of precisely similar soil; mine was the apex, and situated on higher ground, the two others on precisely similar elevations the one with the other. One neighbour sowed a fortnight before me, broad-cast, and a very good crop of turnips he had; the other drilled a fortnight after me, with a like result. My early neighbour's crop was attacked by mildew a fortnight before mine, and I was infected by the blight an exact fortnight before my later neighbour. The crop first sown was most injured by the blight; the turnips last put in scarcely suffered.

Thus it appears that the turnip, at a particular time of its growth, is predisposed to this blight; or, otherwise, there could be no reason whatever that we should not have simultaneously equally suffered.

The soil on which these experiments were tried is a sandy loam upon a mountain limestone. I have only, however, had it in occupation three years, and when I took it it had been much over-cropped, and was dreadfully impoverished.

Believe me ever, yours sincerely,

King's Weston, Dec. 5, 1840. W. Miles.

To be certain of the difference of the weight of the foliage of the turnips manured with glue-dross, and those manured with bones and dung, I weighed the tops of turnips growing on 44 yards respectively; on bones and dung the tops weighed 11 lbs., on glue-dross 26 lbs. I should likewise mention that owing to my farmer's mistake respecting the length of the rows, I weighed, according to our first intention, 600 yards of each, and have made the respective calculations upon that quantity. I think my weight per acre would have been greater if I had left a foot instead of 9 inches between the plants.

I regret much not having used Poittevin's manure; for at 13 bushels per acre, as tried by me last year, it has not carried through the crop of barley. At harvest I set apart two plots of precisely the same dimensions in my barley-field, carried and thrashed the produce of each carefully, and whilst the land manured with dung last year yielded 14½ bushels, that dressed with Poittevin gave but 10½ bushels, and about one-third less straw. Double quantities, however, of this manure may produce a very different result.

PURPLE-TOP SWEDES.—1840.

Acreable Produce from the 18 *and* 27 *Inch Distance.*

	Tons.	cwt.	lbs.
Common Manure.			
18 inches . . .	21	15	0
27 inches . . .	15	19	64
In favour of 18-inch distance . .	5	15	48
Glue-dross.			
18 inches . . .	22	9	6
27 inches . . .	16	1	47
In favour of 18-inch distance . .	6	7	71
Bones.			
27 inches . . .	20	5	89
18 inches . . .	16	4	44
In favour of 27-inch distance . .	4	1	45

Since writing to you, I have had the pleasure of reading Professor Liebig's work on 'Organic Chemistry,' and perceive that in treating of the different kinds of manure, he thus mentions the glue-dross: "In the manufactories of glue many hundred tons of a solution of phosphate in muriatic acid are yearly thrown away as being useless. It would be important to examine whether this solution might not be substituted for bones—the free acid would combine with the alkalies in the soil, especially with the lime, and a soluble salt would thus be produced, which is known to possess a favourable action upon the growth of plants. This salt, muriate of lime (or chloride of calcium), is one of

those compounds which attract water from the atmosphere with great avidity, and might supply the place of gypsum in decomposing carbonate of ammonia, with the formation of sal-ammoniac and carbonate of lime. A solution of bones in muriatic acid placed on land in autumn or winter would therefore not only restore a necessary constituent of the soil, and attract moisture to it, but would also give it the power to retain all the ammonia which falls upon it dissolved in the rain during the period of six months."

Acting upon this hint, I propose to lay on this manure, next fall, or early in the winter, upon a piece of oat-stubble, without mixing it with road-scrapings and ashes, at the rate of about 10 tons per acre; the field measures about 10 acres, which I shall divide equally,—half I shall manure in this manner, half with dung at the rate of 20 tons per acre, and a fair result of the four crops shall be forwarded to you. I feel confident, however, in the success of the application of the glue-dross, as I have tried it for three years, always dressing highly with other manures, and I can safely affirm that in the wheat-crop, barley, and clover a visible and superior effect was always produced by the use of this manure. I only trust that other persons resident near glue-factories may be induced to try the experiment applied in the manner recommended by the Professor, as I feel confident they will be satisfied with the resulting production.

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2. *On the Comparative Efficacy of Bones and of Poittevin's Manure, as applied to Turnips.* By R. A. Christopher, M.P.

To the Secretary.

Sir,—I beg to enclose, for the information of the Society, the result of three experiments which have been made on my property under the superintendence of my agent, on the comparative merits of bone-dust and of Poittevin's disinfected manure. The trial on the whole has been favourable to the latter, inasmuch as the crop, in two instances out of three, produced from Poittevin's manure, has been more abundant than that produced by the application of bones; but I am afraid that the cost of the disinfected manure will be a serious obstacle to its sale in this part of the country. Some years since I visited a large farm at Charenton, near Paris, which produced in its rotation large crops of beetroot. The soil was of a rich loam; and Poittevin's manure was administered once in four years in a smaller proportion than it has been used by my tenants at Rigsby and Salmonby, and, as I was assured by the occupier, with complete success. The cost in Paris is, however, very much lower than what it is in London. Of the three experiments made on my property the last mentioned in the enclosed report is the one most favourable to the disinfected manure, inasmuch as the crop was greater

and the cost less than that produced by means of bones. I saw the fields both at Rigsby and Bloxholm soon after the seed was sown, and the luxuriant appearance of the plant at the commencement of its growth, where Poittevin's manure was used, was very manifest; this I consider of great consequence, as it insures the tender plant against the fly, which is frequently so injurious to the turnip-crop. Under these circumstances I think that the Society may encourage the use of the disinfected manure, and I have no doubt that the Messrs. Poittevin might command a more extensive sale were they satisfied with a lower price, and were they to establish depôts of their manure in agricultural districts.

Sir, I have the honour to be
Your obedient humble servant,
R. A. Christopher.

Bloxham Hall, Sleaford,
April 2, 1841.

To R. A. Christopher, Esq., M.P.

Sir,—I have ascertained from your tenants the result of the different experiments in the use of Poittevin's disinfected manure, in comparison with bone-manure of equal value, upon the same soil and under the same care and treatment.

Mr. James Mason, of Rigsby, near Alford, selected two acres of land in the middle of a field prepared for turnips, consisting of a strong soil with a substratum of chalk. Upon one acre he drilled turnip-seed, with 24 bushels of Poittevin's manure, and upon the other acre adjoining he applied 16 bushels of bones, reduced to the size of nuts; the cost per acre, including carriage of the bones, was 2*l.*, and of the Poittevin's manure, 2*l.* 7*s.* 6*d.*, including freight from London to Louth.

In the early growth of the turnip-plants there appeared a decided advantage in favour of Poittevin's manure; the plants grew faster, and had a more thriving appearance, than with the bone-manure, and continued so up to their maturity; but on weighing one-tenth part of an acre of each as fairly selected as could be, the following result appeared:—

	Tons.	Cwt.	
Of turnips topped and trimmed from bone-manure	10	1	per acre.
Of ditto ditto from Poittevin's manure	9	2	„

Hence it appears that bones suited best this description of soil.

Mr. Emperingham, of Salmonby, near Horncastle, tried the experiment in precisely the same manner and proportions as Mr. Mason, selecting two acres of land in the middle of a field of sandy soil, with substratum of sandy rock: the result in this case differed from the last, as the acre of land drilled with Poittevin's manure assumed the same luxuriant appearance in the early growth of the turnips, and retained the advantage over the bones until the end; the produce being as follows:—

	Tons.	Cwt.	
Of turnips topped and trimmed from 16 bushels of bones	13	14	per acre.
Of ditto ditto from 24 bushels of Poittevin's manure	15	10	„

The strictest impartiality was observed throughout in hoeing and managing the crop.

The third experiment was tried upon Mr. Robert Graves's farm at Bloxholm, near Sleaford, upon a field of sandy soil on a thin shelly rock, which had been prepared for swede turnips; he applied 12 bushels only of Poittevin's manure upon one acre of land, and 12 bushels of bones upon an acre close adjoining. As in the two former cases, the Poittevin-manure plants took the lead considerably in growth, and upon weighing the produce in the spring there appeared—

	Tons.	Cwt.	
Of swede turnips from 12 bushels of Poittevin's manure	11	0	per acre.
Of ditto from 12 bushels of bones	10	5	,,

The result of these experiments proves that, upon light soils, Poittevin's manure is eminently successful; and I attribute its failure upon Mr. Mason's farm chiefly to the strong clayey nature of the soil.

The tenants desire me to thank you for the encouragement you have given them in these experiments, which have been both interesting and useful to them.

I remain, Sir,
Your faithful servant,
JOHN HIGGINS.

Alford, 30*th March*, 1841.

NOTE.—These experiments, however satisfactory, do not, in my opinion, prove the superiority of Poittevin's manure over that of bones; for I am inclined to think that the bones will have a future effect upon the land of a more beneficial nature than that of the disinfected manure, and this cannot be fairly ascertained until the returns be given of the next three years. The present spring crops will no doubt be barley, followed by clover; and I would submit to the Council the propriety of requesting Mr. Christopher, not only to obtain from his tenants exact statements of their several product, but to get them to sow the clover ley with wheat of the same kind and quantity, and to till the land in a similar manner.—J. FRENCH BURKE.

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3. *Experiment on the Growth of Swedes.* By HENRY C. COMPTON, M.P.

Purple-top Swede, sown June 15, 1840. *Produce weighed March* 20, 1841. *Soil heavy, on a clay subsoil, land not drained.*

THE field was ploughed in balk; one set of balks at 27 inches apart, and the other set at 36 inches apart, from the centre of one balk to the centre of the other. On the balk at 27 inches apart there was but one row of turnips sown, and on those at 36 inches two rows, each row being 12 inches apart, so as to allow of their being horse-hoed. A double-breasted plough was afterwards run down between all the balks to clear out the furrows and to earth up the turnips.

No.							cwt.	lbs.
1.—5 cart-loads of cow manures to $\frac{1}{4}$ of an acre,					rows 27 inches,	weight	79	0
2.—5	„	horse	„	„	27	„	80	0
3.—5	„	cow	„	„	18	„	87	73
4.—5	„	horse	„	„	18	„	101	0
5.—5 bushels of half-inch bones				„	27	„	73	82
6.—5	„	„	„	„	18	„	89	12
7.—$6\frac{1}{2}$	„	Poittevin's manure		„	27	„	74	26
8.—$6\frac{1}{2}$	„	„		„	18	„	82	0
9.—5	„	with soot and ashes			18	„	90	0
10.—Bone refuse, with soot and ashes, cost 16*s*.					18	„	80	0
11.—Grass and weeds, 5 cart-loads put in green					18	„	64	0

Manor House, April 26, 1841.

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4. *Experiment on Swedes.* By Isaac Everitt.

Width Drilled on Ridges.	Width Drilled on flat surface.	No. of Turnips per rod.	Weight per rod, topped and tailed.		Weight of tops and tails, per rod.		Description of Manure used.
			st.	lbs.	st.	lbs.	
27 inches	. .	106	13	10	2	8	9 loads of muck and 9 bushels of bones per acre.
. .	18 inches	132	13	10	3	8	9 loads of muck and 9 bushels of bones per acre.
27 inches	. .	101	14	12	3	2	9 loads of muck and 9 bushels of rape-cake per acre.
. .	18 inches	150	15	6	3	8	9 loads of muck and 9 bushels of rape-cake per acre.
27 inches	. .	116	13	12	. .		20 bushels of bones per acre, deposited between the ridges with a drill.
. .	18 inches	158	14	4	. .		16 bushels of bones per acre, deposited with drill at the same time with the seed.
27 inches	. .	116	14	6	. .		20 bushels of rape-cake per acre, as the last.
. .	18 inches	135	13	8	. .		16 bushels of rape-cake per acre, as the last.
27 inches	. .	116	14	4	. .		8 loads of muck and 9 bushels of mixed bones and rape-cake, per acre.

P.S.—I need not say that the number of stones in weight upon 1 rod gives the same number of tons per acre.

The quantity of bones and rape-cake used in the four first trials cost the same price per acre.

It will be seen by this the rape-cake produced more weight per acre than the bones, and the narrow drills more than the wide ones. The land on which these 4 rods were grown is a light loam with a chalk subsoil. The swedes were sown in the first week of June, and weighed on December the 15th.

The swedes in the last four trials were weighed after the very severe

winter, consequently the tops were so trifling that I did not weigh them.

In this instance the rape-cake on the ridges produced the greatest weight; but on the flat surface it will be seen the bones had the advantage; this arose more from the hoeing, as there were 23 turnips more on one than on the other. This will often be the case in every trial, from the difference in men's hoeing. These four were grown on a better description of loam than the four above with a clay subsoil.

South Creake, near Fakenham, Norfolk,
April 24th, 1841.

VIII.—*Notice of Contributions of Specimens of Wheat to the Museum of the Society; with Instructions to future Contributors.* By Rev. J. S. Henslow, M.A., Professor of Botany in the University of Cambridge, and Rector of Hitcham, Suffolk.

Having undertaken to arrange the specimens of corn presented to the museum by various contributors, I take the liberty of directing attention to the kind of specimens which should be procured, and also of suggesting the mode of preparing and forwarding them. There should be about six entire specimens of each variety, with the root and leaves attached. Each variety should be formed into a separate bundle, by being tied to a stick or flat board; and the ears should be wrapped in paper to prevent friction: each bundle should be labelled. A few additional ears (about a dozen) of different sizes should be put up, wrapped in paper, and this packet should also be labelled. There should be about half a pint of seed of each variety; or, where so much cannot be spared, about twenty seeds may be sent in a vial; and this also labelled. One of these labels should contain, besides the name of the variety, as many of the following particulars as can be ascertained, viz.:—1, the name of the grower; 2, the parish and county where grown; 3, the nature of the soil; 4, any general observations respecting the amount of produce, peculiarity of culture, or precise conditions under which the culture took place. Where several bundles are placed in the same box, the whole should be carefully and closely packed, to prevent injury from mutual friction during their carriage. I regret to say that very few of the specimens hitherto sent were accompanied by separate samples of the seed, or have arrived in a state sufficiently perfect to be placed in the glass-cases which are to receive the collections intended for exhibition. Many of them will answer very well for a second, separate or consulting collection, in which the specimens are to be attached to paper. For this second collection it is very desirable that specimens of all varieties should be sent from all parts of the country, as it will be an interesting and important object to trace the precise influence which a difference of climate, soil, and culture produces upon them. The following is the list of the specimens which have hitherto been sent:—

CONTRIBUTORS.	SPECIMENS.
Baines, J. F. . . .	1. improved Essex red; 2. improved prolific white.
Daniel	1. Mumford's gigantic Richmond white.
Fernie	1. blood-red; 2. red-straw Lammas; 3. red cluster; 4. golden drop.
Gough, F. . . .	1. imperial white.
Guppy, S. . . .	1. Brown's ten-rowed chevallier.
Harris	1. Burwell wheat.
Hayward, W. . .	1. farmer's glory; 2. gigantic.
Kinder, John . . .	1. white wheat.
Leidiard	1. blue cone; 2. Rivett's.
Molesworth, Miss .	An ear, and selected sample of grain of 85 varieties; also ears and samples to illustrate experiments undertaken by herself.
Morton, J. . . .	1. Talavera; 2. eclipse; 3. Hunter's; 4. red-straw white.
Norris	1. Hunter's white; 2. prolific red; 3. golden drop; 4. Whittington's white; 5. Leeds prize; 6. Britannia red; 7. Rivet; 8. Chedham; 9. Chevallier, or ten-rowed prolific; 11. Suffolk eclipse.
Pusey, Ph. . . .	1. old red Lammas; 2. golden drop; 3. ten-rowed prolific; 4. Hunter's; 5. thick-set Suffolk; 6. Hicklin's prolific; 7. white Taunton; 8. silver drop; 9. Scotch white; 10. Talavera; 11. a red wheat; 12. Egyptian; 13. red straw Lammas; 14. blue cone; 15. red cone.
Smith, R.	1. no name; 2. no name.
Taylor	Ears only. 1. blood-red; 2. small round; 3. Dantzic; 4. Downy; 5. Hunter's E. Lothian; 6. Colisenum; 7. Talavera; 8. single-eared red; 9. Burwell; 10. cornard white.
Twynam	1. Brown's red Britannia; 2. golden drop; 3. Brown's white chevallier.
Whitfield, Ex. Farm	1. Shirreff's white; 2. short-straw red.
Anonymous Contributors . . .	1. Chidham; 2. Oxford prize; 3. giant; 4. Taunton Dean; 5. Finch's white; 6. cone; 7. chevallier prolific; 8. golden swan; 9. eclipse; 10. silver drop; 11. white Suffolk; 12. red-straw Lammas.

XXV.—*On the Drainage of Land.* By J. French Burke.

Of all those improvements which the increase of wealth and population has occasioned to the agriculture of the country, none was, until within these few years, in so backward a state as that of drainage. Notwithstanding the improved fertility of those soils on which, in some few instances, it had been carefully tried, the owners and occupiers of the land seemed generally insensible to its value; and there was among them an unaccountable degree of apathy to its adoption, caused probably both by want of due information regarding the best modes of carrying it into effect, as well as by disinclination to incur the expense.

Our farming ancestors, although constituting an estimable race of sturdy yeomanry, were, indeed, mostly ignorant men, working upon small holdings, and with such slender capital as seldom to inspire any thought of obtaining from them more than a decent subsistence. Rents were paid chiefly in kind from the produce of the ground and personal service; the population was scanty; the product of the soil comparatively trifling; and large portions of the kingdom were either under forest or in a state of unproductive waste. It may, therefore, be naturally supposed that little value was set upon land apparently so worthless; and it was not until long after the abolition of the feudal system that any attention was paid to its improvement. Even then, although farmers might endeavour to carry off the waste water from the surface of their land, by cutting a few furrows across a field to communicate with the ditch by which it was bounded, yet such an operation as that of the present manner of under-drainage, for the purpose of laying the land permanently dry, was hardly known to them; for although remains have been found of some very ancient land-drains, they were only made either on the demesne of some wealthy baron, or, not improbably, on estates belonging to the monks, who were then the only enlightened husbandmen in the kingdom. The drainage of the fens in Lincolnshire and Cambridge, although a public measure of national importance proposed in the reign of James I., was not actually commenced until the time of the Protectorate, when it was undertaken by foreigners; and the present state of the Bedford Level is mainly due to the exertions of Colonel Vermuyden, a Dutchman in the service of Oliver Cromwell, who was himself a farmer, and a warm friend to agriculture.* His countenance, added to the political circumstances of the times, then induced many persons

* There is existing, however, the record of an ineffectual attempt made by a company of Flemings so long ago as in the reign of Henry VII., referring, as it is supposed, to the same object.

of means and education, who had been engaged in the civil war, to turn their attention to farming on the cessation of hostilities; and a still further impulse was added to it by the subsequent introduction of the turnip husbandry, which, in a great degree, altered the previous system of culture, by the progressive advancement of alternate corn and green crops, to which is chiefly owing our present eminent station as agriculturists.

The turnip husbandry, however, demands a comparatively dry soil; for one of the greatest advantages attendant upon the growth of the root arises from the power of having it eaten off by sheep upon the ground, and thus effectually manuring it without expense. The propriety of adopting this practice became apparent from the evident increase which it occasioned in the crops of grain, as well as by the consequent increase of rent justly demanded by landlords for soils of a description adapted, either by nature or by art, to its operation; and this, together with the certainty that land chilled by stagnant water can never make a profitable return for the labour of tillage, induced a greater attention to drainage. Still, the difficulty at that time of conducting it scientifically, and the failure in several instances of the principles put forward on the subject by Elkington, added to the sums of money thrown away in unskilful management, caused a temporary check to its general use. Farmers, however, having learned from experience that manures, whether caustic or putrescent, do not impart their intended benefit to wet soils, while those laid upon gravels, loams, or land of a light porous nature (if not resting upon an impervious subsoil), act to the full extent of their powers upon vegetation, are at length convinced that the only means to be relied on for the correction of this serious evil is—*to render the ground dry by drainage.*

It is, indeed, so essential to the due effect of all kinds of manure, that in the application of lime it is indispensably requisite not only that the ground should be in a dry condition, but also that the lime be laid on it in the driest season: bone-dust is now well known to be ineffectual on wet soils; and even stable-dung has comparatively less power on land in a humid state than on that which has been drained.*

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* "Although *lime* readily decomposes vegetable matter, it yet only decomposes it advantageously in dry soil, or soil rendered dry by draining, the moisture in wet land rendering it effete before it has time to act chemically on the vegetable matter in the soil. Before the application of lime in any circumstances land should therefore be thoroughly drained."—P. 175.—Quart. Journal of Agriculture, N.S., No. 38.

"Whatever may be the chemical action of *bone-dust* on soils, we can assert with confidence that bone-dust will impart no richness to any kind of soil unless the land is either naturally dry or has been drained, and the

Soils of various kinds are in many cases infested with surface springs, which may frequently be got rid of with comparative ease by *open drains*, which lay the land tolerably dry wherever there is sufficient declivity to carry off the water; although, if these be cut on pasture-land, they are subject to this objection, that, if sheep be fed upon it, they sometimes render the fat stock liable to the accident of being cast. If, however, those springs be lower down, and found at different distances in alternate strata of sand and clay, or gravel, their depth should be ascertained by boring; as the land can never be laid dry until perforated to the bed of impervious subsoil upon which those strata rest, and upon which *covered drains* must be sunk for the complete escape of the superabundant moisture. It should also be borne in mind, that, although open and covered drains may have partly similar effects, they are yet essentially different in execution, and should never be used together in the same operation; for if the surface water be allowed an open passage into the covered drains, the sand and earth which it will carry into their channels will be apt to choke them up.

Heavy clays also, like those, for instance, in the wealds of Kent and Sussex, or any land retentive of water, and lying upon a dead level, can never be rendered efficiently productive without the most thorough *under-ground drainage;* for, the water being upheld upon the surface during the winter, the ground must be ridged up at a great expense of toil and wages for the purpose of exposing it to the sun and air; yet still vegetation flags until an advanced period of summer sunshine evaporates the injurious humidity occasioned by the falls of snow and rain. In this state, indeed, may be found some of the richest land in the kingdom, consisting of alluvial layers of absorbent earth over a substratum of adhesive clay, with a surface of little or no declination, which, thus retaining the superfluous moisture, retards the progress of vegetation; added to which, if the land be in grass, it will be materially injured by the poaching of cattle pastured upon it in wet weather; and, if sheep be put upon it in autumn, it will go far to rot them.

Hence the plants become sickly, the harvests are generally late as well as precarious, and the crops not unfrequently deficient in

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more thoroughly it is drained the greater effect will bone-dust have upon it as a manure."—P. 176.

"The perceptible dampness in undrained soils dissolves the soluble portion of *farm-yard manure*, which, by its gravity, descends beyond the rootlets of young plants, whilst the strawy portion remains undecomposed for a length of time, which may account for the invariable languid vegetation of plants, while young, in undrained land."—P. 173.

both quantity and sample: yet numerous instances might be adduced of not only such lands, but of soils of every description, which were reduced almost to the state of worthless swamps by the retention of stagnant water, having been converted into sound turnip land, worth more than double the rent at which they were originally held; and that simply by the simultaneous operation of subsoil-ploughing and under-draining, at an expense which, in many cases, has been repaid by the increased value of a couple of crops. Indeed, it appears, by a communication recently received from Mr. Robson, the land-agent of Earl Grey, in Northumberland, that the entire charge of drainage has been covered by a single crop of swedes; and many communications from other quarters have been made to the same effect.

In order to remove any doubt which might be entertained of the success of the operation, the following accounts, taken from a variety of cases, may be not inappropriately quoted.

One of these, lately published, contains the particulars of a purchase made by Mr. Denison, of Kilnwick Percy, of about 400 acres of rabbit-warren, of an apparently sterile sand, with a heavy ferruginous subsoil, the hills covered with heather, and the hollows a bed of marshy aquatic plants. The cultivation had been abandoned, as it was found, though pared and burnt, not to produce more than 3 quarters an acre of oats, and the land was let at 2*s*. 6*d*. the acre. Mr. Denison then subsoil-ploughed a portion of it, and tile-drained it with soles at every 12 yards apart, at the cost of 5*l*. 4*s*. 8*d*. the acre, exclusive of the carriage of the tiles from the manufactory. The land, being afterwards manured in the common way, has produced 10½ quarters per acre of Tartarian oats, which fetched 26*s*. per quarter; and now bears wheat and oats on a property which was previously considered useless.*

In the same publication it is also stated, that some land belonging to the Rev. Mr. Croft, of Hutten Bushel, which was not thought worth 5*s*. an acre, is now let at a guinea: "evidently from the effect of the drainage by the breaking up of the Moor-Pan."†

Sir James Graham likewise mentions his having recently let a farm at 20*s*. an acre, after its having been subsoil-ploughed and drained, which had been valued before the operation took place at 4*s*. 6*d*. per acre.‡ The cost of this improvement was 6*l*. 18*s*. 4*d*., as follows:—

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* See Transactions of the Yorkshire Agric. Soc.; and Journal of the Royal Eng. Agric. Soc., vol. ii. art. 2.

† Journal of the Royal Eng. Agric. Soc., vol. ii. p. 35.

‡ Id., vol. i. p. 32.

	£.	*s.*	*d.*
70 roods of draining, cutting, laying the tiles, and upfilling, at 4*d.* per rood	1	3	4
1500 tiles per acre, at 30*s.* per thousand . .	2	5	0
Carriage of do., 6*s.* per do.	0	9	0
Do. of turf for covering the tiles, and cutting do., 70 roods, at 6*d.* per rood	1	15	0
Ploughing with the Deanston plough, and four horses	1	6	0

Thus yielding an annual interest of rather more than 11 per cent. on the outlay.

I have moreover the authority of the Marquess of Tweeddale for stating, that the increased product of his home farm, at Yester, in Scotland, has been nearly two-thirds on most of the crops, and in some cases much more, upon all the land which has been subsoil-ploughed and drained. One field, indeed, which his Lordship declares to have formerly carried only 17 bushels of oats per acre, has given 67 bushels of barley, after having been trench-ploughed and drained.

These improvements by means of drainage, although clearly evincing its importance, both to the landlord in the increased value of his property, and to the farmer in the production of his crops, are yet less decisive than that which I shall here briefly attempt to describe.

The extra-parochial place of Teddesley Hay, in Staffordshire, is the residence of Lord Hatherton, and contains 2586 acres. It was originally part of the forest of Cannock, and, with the exception of two anciently enclosed parks—one of them containing 589, the other 198 acres—continued unenclosed till the year 1820, when the whole became, either by allotment or purchase, the property of his Lordship.

Since then Lord Hatherton has been engaged in laying out this tract and the adjoining land in a manner suitable to the neighbourhood of his residence, by making large plantations and an extensive farm; the old park fences having been thrown down, and the whole of the lands subjected to a new arrangement.

The extent of the farm-lands is 1832 acres, comprising a range of high and dry hills to the east, adjoining Cank Chace, which hills were formerly an extensive rabbit-warren, covered with heath, or fern. From the hills the lands slope gradually, with slight undulations to the west, down to the River Penk—a distance of somewhat about 3 miles.

Having heard this tract of land below the hills mentioned as exhibiting in a striking manner the results both of judicious draining and employment of the water so obtained, I took an opportunity of visiting the place in the latter end of May, 1841,

I was conducted over it by Mr. Bright (the respected land-steward in the management of the property), who gave me the details contained in this paper; and, on riding through the farm, —which then presented an appearance of the most luxuriant vegetation,—described to me the condition of the lands in 1820. The larger park, which had been long divided into fields, was ill cultivated, and the lesser park might be fairly viewed as one bed of rushes. The circumjacent common-lands were also covered with heath or rushes, and, in the lower parts, with alder. The extent of surface which did not require draining was comparatively small; and the whole consisted generally of a light soil, rather inclined to peat; the subsoil being chiefly a stiff clay.

While the enclosure was in progress, some very deep drains were made in the marshy lands of the larger park, which were effectually drained, and from which large volumes of water now issue. As soon as the enclosure was completed, other deep drains were made on several parts of the allotted waste, and for the most part with excellent effect.

Things were in this state when Mr. Bright became agent to Lord Hatherton, about eleven years ago. He immediately conceived the notion of putting a portion of the waste allotments, and the whole of the lesser park, containing a surface of nearly 600 acres, through a regular course of thorough drainage, and afterwards collecting the whole of the drain-water into two main channels; with the double intention of conducting one of them through the farm-yard, for the purpose of obtaining by it a water-power for various objects connected with the estate, and then employing it, in conjunction with the other stream, in making an extensive tract of upland water-meadows.

The plan occurred to him in consequence of there being no natural stream on any part of this land. It must, however, be acknowledged to have been a bold attempt, which could only have been conceived by a comprehensive mind and a man of great practical knowledge; but it was liberally seconded by his noble employer, and has been accomplished with admirable success: as the following statements will sufficiently explain.

First, as to Draining:—

The following is a statement of the improvement by drainage, and the expenditure, during the ten years preceding 1841, upon such parts of the estate as have been drained:—

Quantities.			Value of the Lands in their original state.				Amount of Expenditure in Under-draining.			Value of the Lands in their present state.			
			Per Acre.	Annual Value.						Per Acre.	Annual Value.		
a.	*r.*	*p.*	*s.*	£.	*s.*	*d.*	£.	*s.*	*d.*	*s.*	£.	*s.*	*d.*
78	1	36	10	39	4	9	262	15	0	27	105	18	9
19	1	32	10	9	14	6	74	9	8	35	34	0	9
38	0	3	16	30	8	3	52	14	2	40	76	0	9
82	2	2	15	61	17	8	346	16	4	30	123	15	4
30	3	24	10	15	9	0	121	5	8	35	54	1	6
81	1	34	8	32	11	8	153	16	4	22	89	12	2
36	3	16	10	18	8	6	142	8	0	30	55	5	6
33	0	0	8	13	4	0	80	5	2	26	42	18	0
10	2	33			..		90	8	0	50	26	15	3
10	0	8			..					21	10	11	0
9	0	0	12	5	8	0	76	9	8	30	13	10	0
15	0	11	16	12	1	0	41	9	4	33	24	17	3
21	2	10	15	16	3	5	66	0	0	30	32	6	10
467	0	9	..	254	10	9	1508	17	4	..	689	13	1

The main drains have been laid about 3 feet deep, with tiles about 5 inches wide by 12 inches long. The branch drains are about 2 feet 6 inches deep, and are laid with tiles about 4 inches wide by 12 inches long. The cost of the former was about 45*s.* and the latter about 35*s.* per thousand, when purchased at the kiln. The cost of cutting and laying the main drains was about 1*s.* per rood of 8 yards, and the small drains about 9*d.* per rood; but it should be observed that in this part of Staffordshire the labourers' wages are from 2*s.* to 3*s.* per week higher than they are in many other counties, on account of its being near the important iron and coal mines, as well as the Staffordshire potteries. In some of the valleys the substratum is of a loose mixture of sand and gravel, and in those places it was found necessary to adopt drains varying from 5 to 8 feet deep, which pour forth large bodies of water both in summer and winter.

These lands having been effectually drained, Mr. Bright's next object was to collect so much of the drain-water as the levels permitted into two main carriers, for the purpose of employing them as a power to turn a mill-wheel, and afterwards to be applied in irrigation. For the former object, a small reservoir has

been constructed, at a favourable level, about half a mile distant from the farm, the buildings of which are in a central situation. Here at the farm-yard a mill has been built; and it is a work which, both in its conception and execution, does infinite credit to Mr. Bright, for not only is there much merit in various contrivances by which the water is conducted to it, almost everywhere in covered drains and carriers, but it was necessary to seek a level to carry off the water at a considerable depth, by driving a head-way through a bed of hard sandstone from a distance of about 500 yards. The stream of water was of course not sufficiently powerful to turn an under-shot wheel; and, to enable it to act with force, it was necessary to bring it out to the upper part of a wheel of 30 feet diameter. This wheel has been placed in the rock 35 feet deep, and the head-way has been carried from the bottom through the rock, which comes out in a valley below, at the distance, above mentioned, of 500 yards.

The mill and this channel for the water cost very little more than 1000*l.*: it works a thrashing machine; cuts hay and straw, and kibbles oats and barley for a stock consisting of about 250 horses and cattle; grinds malt; and also turns a circular saw, which does great part of the sawing for a large estate. The annual saving by this machinery has been carefully estimated at about 400*l.*, and it is still intended to apply the power to other purposes.

From this wheel, and from another small carrier, which is made to pass immediately under the farm-yard (where all the urine and moisture that runs from the manure is carefully collected in a reservoir, which overflows into the carrier), the water has been conducted over lands,—principally uplands,—containing altogether 89 acres, at an expenditure of only 224*l.* 4*s.* 10*d.*: by which an improvement of 2*l.* per acre has been effected, or 178*l.* per annum. This is Mr. Bright's calculation; but it is difficult to estimate the importance of such an acquisition as 89 acres of productive water-meadow to a large farm like this, on which there is (especially on the upper part of it) a great quantity of very dry and thin soil. I know no other place in which drain-water has been turned to such good account; luckily, the water is all soft, and good for irrigation.

Summary.

Total Expenditure.

	£.	*s.*	*d.*
Underdraining, as per statement	1508	17	4
For erecting water-wheel and machinery . . .	1000	0	0
Irrigation	224	4	10
	£ 2733	2	2

Total Increase in Value collected.

	£.	s.	d.			
Lands underdrained, present value . .	689	13	1			
„ original value . .	254	10	9			
				435	2	4
Estimated saving by the mill				400	0	0
Increase in value of water-meadows				178	0	0
Being an increased annual value of . . .				£1013	2	4

resulting only from draining 467 acres, and employment of the drain-water over 89 acres of land: *affording a clear annual interest on the outlay of full 37 per cent.!*

The *subsoil-draining,* or *mole-plough,* is a valuable implement in the operation of drainage; and although the inventors of the various denominations now in use each claim different degrees of merit, yet they all tend to the same object—that of loosening the tenacious substratum, and thus allowing both the water to filter through it, and the roots of plants to spread themselves in search of nourishment. There is, however, much difference of opinion amongst those who have employed it: "Some eminent farmers maintaining that it is lost labour, while others, equally eminent, think that no system of management is complete without it."* There have been, indeed, some extraordinary instances mentioned in the 'Transactions of the Yorkshire Agricultural Society' of conflicting testimony on the subject, made by men of equal credibility, whose experiments have shown totally opposite results; but it would seem that this must have arisen from the fact that, although the land upon which their trials were made appeared to be equally stiff, yet the soils were not of the same quality: the one being so much more clayey than the other, that it would run together in a wet season without exhibiting any symptom of having been underploughed. The soil should, therefore, be analysed, to ascertain the quantity of *alumen* which it contains; for if so large a portion as 40 per cent. of that cohesive substance be found united with the other earths of which it is composed, the operation of subsoiling, without draining, will not, it may be feared, be permanently successful.

If, however, the intention be merely to break through that indurated mass of matter termed "moor-band," or "pan," which is so frequently found imbedded between the upper and the lower layers of the soil, the plough alone may have a decidedly good effect; but if the lower layer should contain so much tenacious clay as to be retentive of water, no benefit can be derived from it, unless it be connected with drainage. Of this, indeed, a remark-

* Brit. Farm. Mag. for April, 1841, p. 109; and this Journal, vol. ii. art. 2.

able instance has lately been related of an experiment made by that very highly-informed agriculturist the Rev. Mr. Rham; of which the following is an extract:—

"The field which was the subject of the experiment was once a portion of the open common in Windsor Forest, and brought into cultivation in 1813. The soil consisted of a very moderate loam, inclined to yellow clay, only a few inches in depth; the subsoil chiefly a stiff clay, but with occasional portions of a very gravelly loam, nearly impervious to water. The land, being slightly undulated, and sufficiently inclined to let off the surface water by means of open drains, was usually dry enough to let the turnips be fed off upon it by sheep; and being pared and burnt, chalked and manured, it bore a fair average of crops. Six acres of this land were subsoil-ploughed in 1838 to the depth of 14 or 15 inches, by the Rackheath plough, which stirred the subsoil 9 or 10 inches deep, after a common swing-plough had made a furrow of about 6 inches. The land was sown with turnips, but, the winter being wet, it was soon necessary to remove the sheep; and the ground—which had been so loosened by the subsoil-ploughing as to hold water like a sponge—was found too hollow either to bear the cart-wheels or the tread of horses for carrying off the roots. The operation was, therefore, ruinous to the land, and the only effectual remedy was to underdrain it. This being immediately done, with footed tiles, a copious mass of water ran out, and, soon after the drains were covered over, the sheep were returned to the fold; the cart took the daily supply of turnips to the cows; the following crop of oats was 9 quarters per acre; the field has been during the succeeding winters as dry and sound as any pasture on the farm; and, according to a recent personal communication, 'there is now standing on it a splendid crop of wheat.'

"The conclusion to be drawn from this experiment is," as Mr. R. says, "important; as it shows that, wherever the subsoil is retentive of moisture, complete underdraining is essential, and the subsoil-plough should never be used until the water can run off below. It also shows what an improvement can be made on moderate land by the union of draining and subsoil-ploughing. The cost (which was 5*l.* per acre) is nothing when compared with the result; and," he adds, "I consider the sum laid out on this field as the most profitable investment I ever made." He concludes by saying, "that the subsoil-plough does wonders in lands which have a porous subsoil, even when employed by itself; but, *unless its application on stiff wet lands be accompanied with draining, it makes them worse;* keeping in the water which would otherwise run off the surface."*

All farmers are not aware that land, *if meant to be irrigated,* should be, in most cases, even more deeply drained than common meadow. Although draining and irrigation are apparently of opposite means, they are yet equally beneficial in their effect on the herbage; for *flowing water,* if at complete command, so that

* See "Experiments on the Improvement of Poor Lands," by the Rev. W. L. Rham, vicar of Winkfield.—This Journal, vol. i. art. 30.

it may be laid on and taken off at pleasure, and discreetly used by a skilful husbandman, invigorates and sweetens it, while *stagnant water* fills the sward with grasses of the coarsest character. It is indeed thought by many intelligent graziers to engender an insect which spreads itself over marshy ground, and, being there eaten by sheep along with the grass, is supposed to occasion the rot. Whether this be the fact, or not, it might be difficult to determine; but it is well known that, if land which is irrigated be not also thoroughly drained, it will, when pastured, occasion that fatal malady. Although no irrigated meadows can be said to be quite safe for sheep in the autumn, they are yet generally considered to be free from danger in the spring: but when the drainage has not been duly performed, they have been known to cause the rot in all seasons; and it has in many cases been found necessary to deepen the drains, for the purpose of completely removing the water.

Some startling facts on this subject are stated in a very interesting publication regarding the extraordinary success of irrigation on the estate of the Duke of Portland, in Nottinghamshire. One of which mentions that ewes and lambs fed upon a piece of land which had been drained in 1826, and regularly irrigated, invariably gave them the rot in spring; until, in 1837, it was more effectually drained, and the out-fall rendered complete: since which all appearance of the disease has ceased.

It is there laid down as an axiom demonstrated by a long course of experiments, "that a complete and perfect drainage of the bottom-water is absolutely necessary; its noxious effects showing themselves at a depth and under circumstances which could hardly be credited by any but those who have actually witnessed them." It then says, "it is not uncommonly held by persons conversant with draining, that, if the land is filled with shallow drains, so that no *top-water* can lodge, and that all *bottom-water* which should rise to the level of those drains should be carried off, then all that is necessary has been done. But if, instead of shallow drains at 20 inches, the case should be put of land well filled with drains at 5 feet deep, it would be doubted by few that such land would certainly be secured from all the bad effects of bottom-water." The account, however, mentions instances to the contrary, which it is unnecessary to copy; but it concludes by stating, "that to effect a perfect drainage, spring-water pressing upon the land should in all cases be cut off; and, in land to be watered, a more thorough drainage is requisite than for any other purpose;"* the truth of which no one who really understands the

* John Evelyn Denison, Esq., on the "Duke of Portland's Water-Meadows at Clipstone Park."—This Journal, vol. i. art. 39.

See also the "Quart. Journal of Agric.," vol. v. p. 503, in which an in-

business professionally, will seriously question; for irrigation adds so much to the springs that, in many cases, the drainage has to be done twice over.

It cannot be doubted that, if all superfluous moisture be removed from the ground, it will promote healthy vegetation, and in a great degree prevent the recurrence of that frequent injury to which the flocks of farmers are exposed by the rot. The herbage will also be found so much richer, that the same quantity of hay will yield a greater amount of nourishment to live stock; and, if sheep be fed upon the pasture, it will strengthen the staple of the wool. Nor is this all: it also checks those baneful exhalations which cause the climate to be so dangerous in the fenny districts, and thus renders it, in every point of wealth, health, and comfort, a truly national object; which, although it may be viewed as a secondary consideration by those who look solely to self-interest, yet cannot be treated with total disregard.*

These observations may perhaps be thought needless; for the advantages arising to the soil from its amelioration, by *thorough under-ground drainage*, are now so justly appreciated by its occupiers, that they universally consider it as the standard basis of all essential improvements in the land, and the main-spring of what may be distinctively termed "GOOD HUSBANDRY." But so much depends upon the nature of the soil and subsoil, and the inclination of the strata, as well as the various localities of the lands intended to be drained, that it is difficult to lay down rules for the process. It is, therefore, not to be wondered at that they do not agree as to the best modes of effecting it: some using stone, or rubble, brushwood, peat, turf, or any substance which may be at hand and obtained at trifling cost, and filling those "rumbling drains," as they are called, with rubbish; without calling in the aid of a practised land-surveyor to lay them down at the proper distances, depths, and levels, to render them efficient;—imagining that in saving a little expense they are gainers; though, in

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stance is mentioned of a large tract of land, which was constantly fed during fifteen years by ewes and lambs, without any symptom of rot; but after being irrigated and partially drained, although a great improvement was made in the quantity and quality of the herbage, yet, so far as the rot is concerned, it has been equally fatal to every sheep fed upon it.

* "The hurtful effect of rime, or hoar-frost, on vegetation, is a circumstance familiar to all who have had experience of cold elevated districts, or of lower lands subject to exhalations, and is found, even in the warmest seasons, to be productive of serious inconvenience to the growing crops, and that chiefly at the period when the grain is approaching to its maturer state. This evil, it may be said, has been removed by drainage, and is now so little felt, that the grain produced in the very hollows has for many years escaped the smallest perceptible injury from this cause." See Black's "Account of the Drainage of an Estate in Berwickshire."—Prize Essays of the Highland Soc., N.S., vol. i. p. 234.

fact, they frequently thus expend their time and money to little good purpose, and verify the homely adage of being "penny-wise and pound-foolish."

Every farmer who is familiar with the use of the spirit-level conceives himself competent to the drainage of his land without the assistance of a surveyor; and, in cases applying solely to clays and surface-drains, the object is generally well effected. But, in springy soils, the springs must be sought for wherever they can be discovered, and the water carried from them in efficient conduits at whatever depth they may be found; for if the water be forced to find its way through the earth without artificial assistance, the greater portion will remain there in a stagnant state: thus turning good land into bad, and causing the injury to which allusion has already been made. This, however, demands more scientific knowledge than most farmers possess; and if they have land of that nature to drain, they would do much better to employ a professional man to commence and superintend the work, than to rely upon their own judgment, and thus, perhaps, injure their land by unskilful management. In being thus guided by a person who is in the constant habit of laying out drains, and who has the opportunity of observing their operation and effect in every variety of situation and soil, they will assuredly find that many errors inseparable from first trials will be avoided, and much expense saved in the prosecution of the practical details; while his charges will be but trifling in comparison with the advantages which will probably be derived from his directions.*

Of this any one who is aware of the great difference in the nature of soils must be sensible, if he reflects for a moment upon the steps which should be taken previous to the drainage of an estate. First, the surveyor has to make himself accurately acquainted with both the nature of the adjoining land, and its inclination, if it be higher than that to be drained. He should then measure the extent, and carefully examine the different strata, of every field of which the latter may be composed; taking, at the same time, the levels of each, and using the auger freely for the search of under-ground springs. He will thus be enabled to ascertain the proper distance and the requisite depth of the main-drains, together with the number of cross-drains as feeders; each of which should be distinctly marked out upon a plan of the ground. The price of labour and materials being known, a correct calculation may then be made of the probable efficiency and cost of the operation; from which the farmer may make up

* See Black's "Account of the Drainage of the Estate of Spottiswoode," Prize Essays of the Highland Soc., N.S., vol. i., and "Thoughts on Fertilizing the Soil."—Quart. Journal of Agric. N.S., vol. vi.

his mind as to the expediency of undertaking it, without being heedlessly drawn into those losses which have been so often occasioned by inexperienced drainers. If determined upon, the object is not unfrequently carried into effect by labourers who undertake the work "by the job." It is, however, so much their interest to slur it over with as little trouble as possible, that they must be more than commonly honest if they do not endeavour to cheat their employer by doing it imperfectly. It is, therefore, perhaps better to employ day-labourers; but, in either case, the operation should be committed to the inspection of some steady fellow, who must take care not to allow a foot of drain to be filled up without closely examining the manner in which it has been done.*

A great degree of local observation regarding the nature of the ground, combined with practical knowledge and skill in the execution of the work, is requisite in cutting off the water of the springs at their source. If not done effectually at first, the drains must afterwards be deepened at considerable additional cost; whereas one deep drain, if judiciously placed, will generally preclude the necessity of any other; and should any doubt be entertained respecting the proper depth, the safest way is to make it rather too deep than too shallow. This, however, applies solely to those *main-springs* which lie far below the surface of the ground; for the injurious effects of *land-springs* are, as already observed, very commonly remedied by open drains. As these are apt to be dried up in summer, the farmer is, notwithstanding, often reconciled to bear with their pernicious consequences; and we thus see vast tracts of meadow left by this practice in a state of marsh, though it is a very ill-judged economy, as the expense of drainage would soon be repaid by improvement in the sward.† Whether these springs be perpetual or only temporary, they

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* "The doing the work insufficiently is often nearly as bad as the leaving it undone. The defects of half-draining frequently cannot be discovered until a great loss has been sustained, and to remedy such defects it is for the most part necessary to make new drains entirely, which generally cost as much, and in many cases more, than the first outlay." "As an instance in point—the expense of lifting drains which had been imperfectly formed in a field of the estate of Lord Strathallan, in Perthshire, and which had thus stopped or become *blown*, and the water forced to the surface, was 16*l.* 10*s.*, and the cost of new drains was only 13*l.* 14*s.*"—Stephens on "Furrow-Draining," Quart. Journal of Agric., N.S., vol. iii. pp. 291, 292.

† "There is a field on the estate of the Earl of Leicester, at Longford, in this county, which some years ago was occupied by Mr. John Sherratt, and brought forth rushes in such abundance that he gave leave to anybody who would be at the trouble of mowing to carry them away. Three years ago the field was drained; and this year we are told the present occupier, Mr. T. Robinson, has cut three tons an acre of as nice herbage as ever grew."—Derbyshire Chronicle, 25th July, 1841.

should therefore be diverted from the surface either by open or under-ground drainage; and the latter, as being the most effectual, will in the long run be unquestionably found the cheapest.

So various are the soils and situations of farms, and so many are the gradations between the extremes of light absorbent sands or gravels and cohesive clays, that no uniform system of drainage can be applicable to them all. Our object is indeed rather to excite attention to the subject than to offer instructions on the proper mode for each, which would not only swell this brief notice into a tedious essay, but would doubtless be also thought by those who are professionally conversant with the subject to savour somewhat of presumption.

It may, however, be observed that those light loams, or sands and gravels intermixed with a portion of pure clay, resting upon beds of gravel, and which compose the true "turnip soils," rarely require draining; but in those which consist of sandy and gravelly strata, resting upon various kinds of clay (and comprising, perhaps, the greatest portion of the arable land throughout the kingdom), the water filters through them until it meets with the impenetrable layer by which its further progress is stopped. On this layer the drains should be placed, and sunk into it just so far as to allow a free passage for the water; unless it should be very near the top soil, in which case the drains must be sunk still further down; but if the soil be wholly clay, it will be useless to sink them lower than sufficient to guard the materials with which they are covered from being injured by the tread of heavy cattle; or in arable land, from being disturbed by the action of the plough.

It is obvious that the depth of drains, and their distance from each other, must be governed by the nature of the soil. It is also evident that "the flatter the surface, and the stiffer the soil, the greater will be the number required;"* and the intermixture of several different layers renders the drainage more complex and difficult to manage than if the land consists simply of an upper and an under stratum. Generally speaking, however, it is thought that the object will in most cases be completely attained if the main drains be carried to the depth of 30 inches to 3 feet, or at the most to 3½ feet, the depth of the smaller drains, or tributary feeders, being about 6 inches less. The main drains should be cut deeper than the side ones, in order to prevent the water in them from standing back when the main is full. It will also, in most instances, be found more prudent to carry the main-drains diagonally across the slope of any rising ground than to dig them straight down the declivity, whereby a rapid fall is occasioned, which is apt in heavy rains to sludge them up with earthy impu-

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* Penny Cyclopædia.

rities, besides draining the water chiefly from one point; whereas if placed in a slanting position, they will intercept it in its descent from every part of the land, and thus gradually collect a much larger quantity, without carrying along with it anything to choke their channel. Nor should the cross-drains be cut at right angles to the main receivers, but made to join them in an oblique direction, tending downwards, so as to secure the course of the water in its passage to the outlet. Their distance must of course be regulated by the state of the land; for if it be of a decidedly retentive character, the drains will not act effectually if more than 20 feet apart; and it has sometimes been found necessary to place them at only 12 feet apart. If, however, it be of a porous species, they will act at from 40 to 50 feet asunder; but from 18 to 30 feet may be considered a usual average.*

Notwithstanding what has been here said, it must be understood that if the ground be nearly level, every advantage should be taken of any declivity which it may offer; and if entirely flat, the drains should be constructed with a gradual fall to the outlet into which the water is to be discharged, which, whether ditch or rivulet, should always have a deeper bottom than the drain itself. To secure this regular descent, so that the water may run from one end to the other of the drain without its being in any way impeded or suffered to stand dead, is a matter of serious importance. Although every one knows that water will flow at a very slight inclination from its level, and it may be true that "there is more danger attending the greater than the lesser fall," yet the exact rate at which the proportion of that inclination should be measured in making drains on level ground—or the fall which they should have in order to the attainment of their object—has given rise to considerable variance of opinion among professional men. Thus, in the "Penny Cyclopædia," one foot is stated as sufficient fall for a drain of 300 feet in length, provided the drains be not more than 20 feet apart. One writer assumes that "a fall of one inch in 20 feet is sufficient;† while another insists that "no drain should have a fall of less than one foot in 75;"‡ others,

* It has been held as a rule to apportion the area of all drains to their length, declivity, and distance from each other. Thus, supposing the length to be 200 yards, and the distance from drain to drain 18 feet, the square feet of surface receiving rain-water in twenty-four hours will give 1800 cubic feet of rain-water; and taking the sectional area of the smallest, or $2\frac{1}{2}$ to 3 inch tiles, at 7·5, and the water moving in this aperture at the rate of one mile per hour, the number of cubic feet discharged by the drain in twenty-four hours will be 6600, or nearly four times as much as is necessary to carry off a surface fall of two inches of rain. See Prize Essays of the Highland Soc., N.S., vol. vi. p. 94.

† Carmichael, of Raploch Farm, on Tile-Draining.—Prize Essay of the Highland Soc., N.S., vol. vi. p. 85.

‡ Thoughts on Draining.—Quart. Journ. of Agric., N.S., vol. iii. p. 88.

again, one foot in 100, up to 150; and one gentleman, in treating of tile-draining, says that "tile-drains will act with very little fall; one foot of fall in every 1000 feet in length will be perfectly safe, though it is best to have one foot of fall to every 300 feet of drain."*

Although admitting the superiority of tiled drains in allowing a free passage to the water, yet the soundness of his view of the subject may be doubted; and on discussing it with an eminent land-surveyor (Mr. Deane of Tottenham), who has been extensively engaged in drainage, he stated "that in the course of his practice he always found those hollow drains to continue longest serviceable which had a good fall; and that he would recommend not to be too sparing in giving them such a fall whenever the circumstances of the case would admit." Perhaps, therefore, a declivity of one foot in 120 may be sufficient to secure a proper current in the main; paying attention at the same time to the fact, that if the water does not run at increased speed towards the bottom of the drain it will probably occasion deposits of sediment.

It should also be observed that if the field be of large size receiving drains or ditches must be opened at different distances, say not farther apart than 200 to 300 feet; for otherwise the necessary artificial fall of the drain at the rate of one foot in 120 would bring its excavation to an inconvenient depth, even if the outlet be deep enough to receive it; besides occasioning such a collection of water as during continued rains might endanger its safety, by causing it to burst.

A great portion of the heavy arable ground throughout the kingdom is rounded up into permanent "lands," of various breadth and height, according either to its wetness or to the custom of the country, with the intention of causing the rain-water to run from the surface into the furrows, which act as so many open drains in carrying it off. It is thus not unusual to see good crops of corn growing on the crown of these ridges, while their sides, being bared of the best soil by its collection on the top, are rendered comparatively worthless, and the crop inferior in both bulk and quality; whereas if the lands were well under-drained, the height of the ridges could be reduced, and, the soil which is taken from their sides being then replaced, the crops would be found equal in every part. This, it is true, is sometimes done, and always with good effect; but those covered drains are most commonly sunk in the furrows, with a view of saving labour, although they could often be more judiciously placed in a different direction, and in no case should their distance be influenced by the size of

* Wilson on Tile-Draining.—Prize Essays of the Highland Soc., N.S., vol. vi. p. 114.

the lands, as these are in many instances no less than 30 feet wide, and drains may be necessary at half that width.* This, however, must not be construed into a recommendation of altering the form of the lands, which is always a difficult and frequently an unprofitable operation; but even when their size, and the inclination or bend of their declivity are in every respect unobjectionable, and the course of the furrows such as a surveyor would approve, it might perhaps be better to sink the drain in the very centre of the ridge. Some intelligent farmers, indeed, place them within three or four feet of the furrows, and find that plan very advantageous. Should the drains be, nevertheless, made in the furrows, then care should be taken to sink them a few inches deeper than if made in level ground, in order to prevent the injury which might otherwise be occasioned by the tread of horses at plough, when stepping in the trench. Nor should the covering materials which are placed over the water-channel be formed merely of the soil which has been dug out of the drains; for if that be loose earth, it may find its way into the channel, and choke it up; or if it be clay of an impervious nature, and trodden down by the working of the cattle, it will materially impede the good effect of the drainage.

Among the many expedients which have been resorted to for the purposes of under-drainage, none has been longer or more universally employed than stones; and in situations where they can be found in sufficient abundance upon the land, of a smooth, rounded form, not larger than the size of a man's fist, they will no doubt continue to be used, as good and durable drains can in that case be made with them at moderate cost. But if they are to be quarried, or to be carried from any long distance, they become so expensive that many persons have given them up, not only in consequence of that objection, but of others which will be hereafter stated. Schemes have also been adopted, such as the filling up of the conduits with peat, or with bands of twisted straw; and there is one called "wedge" or "plug-draining," which has been within these few years rather extensively used in some of the strong clays, to which alone it is applicable, and better adapted to pasture than to arable land.

The operation is commenced by cutting a turf of 12 inches wide and 6 inches deep, followed by other cuts at such an angle down the side of the intended drain as will leave the bottom (at 2 feet deep) only 1¾ inches wide, into which the plug is inserted. This is

* In the case here supposed, I have seen a very intelligent farmer place the drains on each side of the furrow, midway between that and the crown of the ridge. This ingenious arrangement seems to meet all future difficulties that might otherwise arise in gradually ploughing down the lands to a level.—Ph. Pusey.

exactly fitted to the channel of the drain, and formed of several pieces of wood, each being 6 inches long by $3\frac{1}{2}$ wide at the top, and $1\frac{3}{4}$ at bottom, connected by iron links, and drawn by a chain. Upon this the clay which has been thrown out is replaced and rammed down upon the plug into as solid a state as possible, after which the plug is withdrawn and the operation repeated. The process is comparatively cheap, but more difficult of perfect execution than may perhaps be imagined, and cannot be recommended as either effectual or permanent; for it must evidently be very subject to break in; and should any such accident occur, it will not only stop the drain, but that cannot be repaired without its being entirely re-made, as the plug must be drawn out to its very end, and cannot be lifted from the ground. Where it has been successful it has, however, had such good effects, that land which in wet seasons invariably rotted every sheep put upon it is now stocked without any occurrence of such casualties; and mowing has commenced a fortnight or three weeks earlier than before it was drained.*

In order to correct as far as possible the imperfections in these various modes, as well as in the rumbling drains to which allusion has already been made, the system of *tile-drainage* was introduced some thirty years ago, and has since been found so much more effectual that it has almost universally superseded every plan except that of stone-draining, and is now generally employed throughout those wide districts which are still in want of improvement. On the commencement of tile-draining great objections were made to it, from the suspicion that the tiles would decay; and the outlay of money for their purchase startled both the landlord and his tenant. In process of time, however, it has been found that drains thus constructed many years ago are now as perfect in their operation as when first formed. It has, indeed, been ascertained that good tiles do not perish in the drains; and it has been seen in the account of improvements on Lord Hatherton's property, as well as in the published statement of the drainage of the Netherby estate (on which some thousands of acres of otherwise unproductive land have been rendered perfectly dry, and fit for every operation of husbandry, by the process of tile-draining), that when there is occasion to lift any of the drains the tiles are found in the same perfect state as when they came out of the kiln.†

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* See Farmers' Mag., N.S., vol. ii. p. 98, and vol. xv. p. 67, of the "Papers of the Bath and West of England Society," in which it is stated that on a farm where green crops formerly rotted on the ground 800 sheep are now fed on turnips throughout the winter.

† See "An Account of Draining by means of Tiles, as practised on the estate of Netherby, in Cumberland, the property of Sir James Graham,

It must, however, be observed, that really "good tiles" are essentially requisite; for if only one of them becomes decayed or broken it stops the current of the water on the spot where it stood, and the injury cannot be discovered until damage, of sometimes a very serious nature, has been occasioned. The operation of draining, although amply returning the outlay, yet being very expensive, it is extremely important to ascertain not only the cost but the intrinsic value of the tiles when made. Purchasers should therefore be cautious; for, if induced by comparative smallness of cost to use those of an inferior quality, they may have cause to find, in the course of time, that they have been actuated by false economy.

The more compact the tile is made, the stronger it will be, and the more pressure it will bear the better. It should not appear porous; and, if struck upon by the knuckle, it should, if well made, emit a metallic sound. Being, however, usually made by hand, and very generally by persons who neither understand the kind of clay which should be used in the formation of a tile which will last without decay, nor possessed of sufficient capital to work the clay during the time required for producing it of proper quality, thousands are daily made which are not trustworthy; being not only imperfectly moulded, but, "being either too much or too little burned, a night's frost has been known to break the whole tiles laid down in a drain."* The making of tiles demands, indeed, more time, and consequently more capital, than may be generally imagined. When the proper sort of clay has been discovered, it is usually dug up during the course of the year for the entire supply of the ensuing season; being turned carefully over, about the preceding Martinmas, to receive the benefit of the atmosphere throughout the winter. In spring the process of tempering commences, and the tiles are not manufactured until the following summer, as large quantities can only be conveniently dried in fine weather.

Land-draining being not only a tedious and a laborious, but also in most cases an expensive, operation, should never be undertaken but with a determination to do it effectually, by employing the best modes of workmanship and material; so as to ensure, as far as possible, the permanent improvement of the soil. *Stone-drainage* has that effect; but accompanied with these ob-

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Bart., M.P.," communicated by John Yule, Esq., of Glingerbank.—Prize Essays of the Highland Soc., N.S., vol. i.

* Thoughts on the Extension of Draining.—Quart. Journ. of Agric., vol. vi., N.S., p. 330. The effect of *over-burning* is, however, merely that of rendering the tile brittle; but if *under-burned*, it then imbibes moisture, which, when frozen, and afterwards thawed, occasions it to rot and fall to pieces.

jections:—that the drains require to be sunk deeper than those of tiles; and that, in case of dead-levels,* the fall must be made greater than when performed with tiles; also that vermin are apt to burrow in them; and, if the drains be set near to trees, the roots are attracted by the moisture, and the fibres, inserting themselves between the stones, sometimes fill up the conduit. There is also this great disadvantage attendant upon it;—that, as the operation is usually deferred until winter, when the ground is in a wet state, the land becomes so poached by the cartage of the heavy loads of stones which must be carried upon it, as frequently to injure meadow, and to occasion in arable land a serious increase of difficulty in the working.

The main objection, however, is the expense of carriage, which is frequently so burdensome as to occasion a preference to the employment of tiles. It has, indeed, been stated by a very experienced drainer, that, "taking the cost of carriage at 5*s.* per day for each man and horse, and supposing the materials to be equidistantly situated from the respective drains, so that one cart conveys five loads of tiles, and the other five loads of stones, in the day, one cart, proportionally filled with 14-inch tiles and soles, will lay upwards of 100 yards of drain; while one cart, or cubic yard, of stones will only lay 18 yards of a similar sized drain, viz., 6 inches by 12: *being a saving of labour of six to one in favour of tiles.*" †

It may, indeed, be difficult to decide upon the comparative merits of tile and stone drainage, and the expediency of either must in most cases be governed by circumstances dependent upon the facility of procuring either the one or the other. A preference to the former is however not only given by the gentleman who has been just quoted, but also by several other eminent professional writers on the subject, who thus express themselves:—"I conceive, were burnt tiles laid on thick soles, and covered with turf, they would be preferable to stones, unless a sufficient quantity be used, and found within a mile of the operations." ‡ "A tile and sole, with a few inches of stones, is the *ne plus ultra* of draining. I would recommend tiles to landlords who give any assistance to their tenants in draining, because they scarcely can make

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* In the case of dead-levels, tiles seem to be almost indispensable. I have seen a tile-drain act well at a dead-level of 300 yards; while a broken stone-drain was choked in very wet land, by the abundance of water, in 20 yards, before it was completed. The stones were consequently taken up, and replaced with tiles.—Ph. Pusey.

† Carmichael, of Raploch Farm, on Tile-Draining.—Prize Essays of the Highland Society, N.S., No. xxxviii. p. 97.

‡ Stephens on Furrow-Draining.—Quart. Journal of Agric., N.S., vol. iii. p. 293.

a bad drain with them, and seldom make a good one with stones; the carting of stones obliging them to neglect their other work." *

In enumerating the comparative advantages and disadvantages of using tiles or stones in the execution of drains, another also states, that, "if tile-drains are carefully executed, they will be found in every respect equal, if not superior, to the best stone-drains." †

In the account which has been already mentioned of the Netherby estate, it is there also stated that, "from estimates, which are strictly correct in practice, it would appear that, even supposing tiles are to be carried to the field to be drained a distance of three miles, or even more, and that a stone-quarry existed in the field itself, the drainage by means of tiles is by far the cheapest."

Tiles are indeed very generally thought to be, "when properly made and well burned, not only the handiest but the best material for setting in the bottoms of drains; for they ensure such a clear water-course, that a drain of 2 feet deep, set open at the bottom, is more effective than one 4 feet deep filled with rubble, and is not half so expensive." ‡ They should, however, be invariably laid upon soles of about ½ an inch wider than the tiles, to guard them from slipping off; that mode being found far superior to that of laying them upon a naked bottom, both as securing them from sinking into the soil and preventing the intrusion of moles, which will otherwise burrow under the tiles in search of earth-worms, upon which they feed, and sometimes occasion incalculable mischief. To prevent their sinking, tiles are often formed with flanges, or broad shoulders to rest upon; but the most obvious remedy to obviate the inconvenience is to lay them firmly upon soles, in the manner of a pavement; and, in sandy soils particularly, it is a necessary precaution.

In laying tiles and soles the most usual mode is to place them along the edge of the drain, the tile-layer then fixing them alternately in close and regular order, uniting them at the same time so accurately as to guard against any obstruction to the stream of water; he having his face to the work, and moving backwards until it is finished. The farmer should, however, carefully inspect every foot of the drain before he allows it to be covered.

The manner of *connecting the main and minor drains together,* though but little attended to, ought to be correctly done. A very common mode is to break off the corner from a main tile for the

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* Stirling, of Glenbervie, on Tile-Draining.—Prize Essays of the Highland Society, N.S., No. xxxviii. p. 108.

† Wilson on Tile-Draining.—Prize Essays of the Highland Soc., N.S., No. xxxviii. p. 121.

‡ On Underground-Draining.— Quart. Journal of Agric., N.S., vol. v. p. 234.

purpose of inserting into it the end of one of the lesser sort, and allowing the water to enter; in doing which the tile frequently breaks to pieces, thus occasioning both waste and trouble; or else a small space is left between two tiles in the main where the minor drain enters, and the aperture is covered with broken pieces. A better mode is, to leave an opening in the side of as many as may be required, for the insertion of the smaller ones, of the exact size of the mouth of the latter; but, in either case, care should be taken to slope the bottom of the cross-drain gently down to the main receiver, so that their junction may be accurately effected.

In regard to the *covering of drains*, even experienced practical men are not agreed. The greater part, indeed, recommend some such porous material as peat, brushwood, tough haulm, or gorse, to be laid over them, to the depth of 10 or 12 inches, before the return of the top-soil; as that, if it be a tough clay, will, they say, prevent the filtration of the water, and partly impede the operation of the drain: while some assert that, "however strong the clay may be, it will not prevent the percolation," for, according to an old adage, "if one drop of water finds its way down, two will be sure to follow:" and a few, as we have seen in the account of wedge-draining, prefer the ramming down of the top-soil, even of the strongest nature, immediately over the drains. It must be admitted, on the part of the latter, that the effect of drainage will, in no great length of time, render the entire of the land so permeable that the action of the drain will not then be seriously obstructed. The system advocated by the former is, nevertheless, the most prudent; and we learn, from some very experienced drainers, that when the clay has been laid upon the tiles it not only retains the water, but has been found to produce more rushes immediately over the drains than on any other part of the field. Perhaps small round stones or clean gravel, if they can be easily had, are the best covering for the drain if the soil be clay; or, if permeable, it may be safely thrown back; but, whatever material may be used, a green turf, cut thick, turned the grass side downwards, and put next the tile, between it and the covering, will be found a good precaution to secure it from damage.

It has been remarked by a late writer on agriculture, that, "were draining universally effected, the whole of the now comparatively unproductive soil of the country would, to a vast extent, be rendered capable of receiving the benefit of numerous modes of fertilizing it. Its returns are immediate, as well as compensative; and to hesitate to drain the land is to hesitate to confer a benefit upon oneself."

One would suppose that, viewing all its advantages, not an acre

of wet land would be left undrained of the ten millions which are supposed to stand in need of that improvement in this country. But, although alive to the increased value which it would impart to the soil, yet the undertaking is sometimes impeded by disagreements between landlord and tenant, both regarding the cost of drainage and the terms of lease; as well as by difficulties occasioned by the settlement of many entailed estates, which render the life-tenants disinclined to incur the charge. This, however, will be partly remedied by a late enactment of the legislature, enabling the owners to defray the expense of draining by way of mortgage.

XXVI.—*On the Comparative Feeding Properties of Mangold-Wurzel and Swedish Turnips.* By the Right Hon. Earl Spencer.

To Ph. Pusey, Esq., M.P.

My dear Sir,—You expressed a wish that I should again publish the results of an experiment which I made fifteen or sixteen years ago on the comparative feeding properties of swedish turnips and mangold-wurzel. It was published in the 'Farmer's Journal' of that day, but I believe it is now very little if at all remembered; and I agree with you in thinking that it may be more interesting now, when men's minds are more turned to this sort of investigations.

The mode of ascertaining the nutritious properties of different kinds of vegetable food by chemical analysis, which was adopted by Sinclair and other scientific men, gives a reasonable probability of their relative value; but we know so little of the processes of nature in converting food into the flesh of the animal that consumes it, that this mode has never appeared to me quite satisfactory. Although, therefore, I believed that mangold-wurzel contained more saccharine matter than swedish turnips, and ought consequently to be the more nourishing root of the two, I determined to try practically whether an ox fed upon mangold-wurzel increased in weight more than one fed upon swedish turnips, in proportion to the quantity of each consumed. In order to have rendered my experiment perfectly accurate, I ought to have ascertained the weight of hay consumed by each beast during the progress of the trial, but I did not do this, although I am pretty confident that the quantity consumed by each was nearly the same. I selected two steers, tolerably and at least equally well-bred: No. 1 calved March 29, 1823, and No. 2 calved May 6 of the same year; and on the 24th of December, 1825, I

put No. 1 to swedish turnips, and No. 2 to mangold-wurzel. I ascertained their weight by measurement, and both of them measured the same, viz. 4 ft. 10 in. in length by 6 ft. 5 in. in girth, making them to weigh 668 lbs. each. On the 23rd of January, No. 1 had consumed 1624 lbs. of swedish turnips, and measured 4 ft. 10 in. in length by 6 ft. 7 in. in girth, making him to weigh 703 lbs., and to have increased in weight 35 lbs., or at the rate of 48¼ lbs. for every ton of swedish turnips consumed. No. 2 had consumed 1848 lbs. of mangold-wurzel, and measured 4 ft. 10 in. in length by 6 ft. 8 in. in girth, making him to weigh 721 lbs., and to have increased in weight 53 lbs., or at the rate of 65½ lbs. for every ton of mangold-wurzel consumed.

This difference, however, might have arisen from No. 2 having a greater propensity to feed than No. 1; I therefore now put No. 1 to mangold-wurzel, and No. 2 to swedish turnips. On the 20th of February, No. 1 had consumed 1884 lbs. of mangold-wurzel, and measured 4 ft. 11 in. in length by 6 ft. 8 in. in girth, making him to weigh 734 lbs., and to have increased in weight this month 31 lbs., or at the rate of 36¾ lbs. for every ton of mangold-wurzel consumed. No. 2 had consumed 1880 lbs. of swedish turnips, and measured 4 ft. 11 in. in length by 6 ft. 8 in. in girth, making him to weigh also 734 lbs., and to have increased in weight during this month 13 lbs., or at the rate of 15½ lbs. for every ton of swedish turnips consumed. I then put both to mangold-wurzel, and divided the food equally between them. On the 19th of March, they had each consumed 1792 lbs. of mangold-wurzel; No. 1 measured 5 ft. in length by 6 ft. 10 in. in girth, making him to weigh 784 lbs., and to have increased in weight 50 lbs.; No. 2 measured 5 ft. in length by 6 ft. 9 in. in girth, making him to weigh 765 lbs., and to have increased in weight 31 lbs.

It would appear, therefore, as if the propensity to feed of No. 1 was greater than that of 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-wurzel, No. 2 beat No. 1 in the proportion above stated of 65½ to 48¼. It appears 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 country for 24*l.* 3*s.*, and No. 2 at Smithfield for 24*l.*

It will be for practical men to decide upon the value of this trial; what appears to me to be the most conclusive part of it is, that No. 2, who had during the first month, when he was feeding upon mangold-wurzel, increased in girth 3 in., in the next month, when his food was changed to swedish turnips, did not increase in girth at all, and when in the third month he was feeding again

upon mangold-wurzel he again began to increase in girth, because it is very well known that, if an animal is changed from more to less nutritious food, the probable consequence will be that his growth will be stopped. The result appeared to me so decisive, that I have not tried the experiment with the same accuracy since; but I did try the following year the feeding a cow alternately on swedish turnips and mangold-wurzel, and though I have not by me the details of the trial, I remember that the result confirmed the experiment of the previous year.

Believe me, my dear Sir,
Yours most truly,
SPENCER.

Philip Pusey, Esq.

XXVII.—*On the Cultivation of Mangold-Wurzel.* By WILLIAM MILES, M.P.

To Ph. Pusey, Esq., M.P.

DEAR PUSEY,—Notwithstanding the favourable result of Lord Spencer's experiment with mangold-wurzel, the consideration will naturally suggest itself to the mind of the farmer previously to his adopting the cultivation of this root, whether, although the mangold-wurzel may bring on his cattle faster and better than the swede turnip, it is not more difficult of culture, more tender in its habits, and less productive in bulk per acre than the swedish turnip; and I think, therefore, it may not be unprofitable to lay before the readers of the Journal first, the chemical analysis of the highest and lowest order of turnip and of mangold-wurzel as given by Sir H. Davy, and of the sugar-beet and orange globe mangold-wurzel as lately obtained on the same plan by the celebrated Bristol chemist, Mr. Herapath; and then to point out the system adopted by myself in the West of England in the cultivation of mangold-wurzel, which has been attended with complete success.

Roots.	Quantity of Nutritive Matter in 1000 parts.				
Species.	Mucilage or Starch.	Saccharine Matter or Sugar.	Gluten or Albumen.	Extract.	Total Soluble or Nutritive Matter.
Swedish turnip . .	9	51	2	2	64
White turnip . .	7	34	1	—	42
Mangold-wurzel .	13	119	4	—	136
Orange-globe . .	$25\frac{3}{4}$	$106\frac{3}{4}$	$1\frac{1}{8}$	less than 1	$135\frac{1}{2}$
Sugar-beet . . .	$17\frac{3}{4}$	$126\frac{3}{4}$	$1\frac{1}{4}$	1	$146\frac{3}{4}$

By this table, it is apparent that equal quantities of swede turnip and orange-globe mangold-wurzel contain very different proportions of nutritive matter, the latter more than doubling the former in quantity; and should the mangold-wurzel be of equally easy culture with the swedish turnip, it seems almost unaccountable that it should not yet have come into more general cultivation. I have grown the common red sort for six, the sugar-beet for four, and the orange-globe for three years; these kinds have regularly come into course with swedes upon light land; the product has always been equal, in most cases far heavier. The swede turnip has enemies innumerable; I have never observed the mangold-wurzel attacked either by fly, slug, or wireworm. Equally a cleansing crop with the swede, it stores better, and lasts good for a longer period. In the summer of this year I was using sugar-beet with stall-fed cattle, which cut perfectly good and crisp in August. The mode of culture I adopt up to depositing the seed in the ground is the same as that adopted in Northumberland for ridging the swede; great care, however, must be taken that the seed of the mangold-wurzel is not buried too deep, or it will not vegetate. Dibbling, as you never can ensure an equal depth, does not answer; nor does the seed drill well, if properly prepared by steeping, which I should recommend, for at least twenty-four hours before planting. To ensure, therefore, a proper depth, I have been in the habit of using an iron wheel, round the outer circumference of which, 18 inches apart, iron points project, broad at the base and tapering towards the point, about 2½ inches long; this is wheeled upon the top of the ridge, the man walking in the furrow, and thus holes are formed which can never run into the excess of too great depth, and into which the seeds are deposited by women and boys following the wheel, and generally covering the seed by drawing the foot as they advance at right angles with the ridge over the holes; the roller follows, and thus the sowing terminates. One man with the wheel will keep six persons well employed in depositing the seed after him. This system was recommended me by my friend Mr. Webb Hall, and since I have adopted it my crop has never failed.

The after culture to the storing is similar to that of the swede; great care, however, should be taken in never permitting two plants to grow in the same spot, which will be the case frequently, should only one capsule even be deposited in each hole, as every capsule contains many seeds. Should the tops remain uncut, the plant will stand a considerable degree of frost; it should, however, be stored early in November; the best and cheapest method is to build it up against some high wall contiguous to your beast-sheds, not more than 7 or 8 feet deep, carried up square to a certain height, and then tapering in a roof to the top of the wall; protect

the sides with thatched hurdles, leaving an interval between the roots and the hurdles, which fill up with dry stubble, cover the roof with about a foot of the same, and then thatch it, so as to conduct all moisture well over the hurdles placed as a protection to the sides. In pulling the plants care should be taken that as little injury be inflicted upon them as possible; cleansing with a knife should on no account be permitted, and it is safer to leave some of the leaf on than by cutting it too close to impair the crown of the root. The drier the season is for storing the better, although I have never found the roots decayed in the heap by the earth, which in wet weather has been brought from the field, adhering to them. As to the productiveness of the different sorts, in one year I have grown a larger quantity of sugar-beet per acre, in another of mangold-wurzel; both these, however, I consider exhaust the land in a greater degree than the swede; but I have formed a very high opinion of the orange-globe, though not so large a producer generally as the two other sorts; it appears always to throw at least two-thirds of its weight above ground, neither is its tap-root larger nor its fibrous roots greater than those of the swede turnip. Care should be taken in giving cattle every species of this root, as if taken in excess it is apt to scour; indeed, from the avidity with which cattle eat the sugar-beet, and from its viscous properties when quite fresh from the ground, it should be stored so as to come into consumption the last of the roots.

In feeding store cattle I should commence with swede turnip, proceed with the orange-globe, then with mangold-wurzel, and finish off with the sugar-beet; thus not only frequently varying the food, but using them in the order corresponding exactly with the nutritive matter contained in each description of plant. I have found indeed equally with Lord Spencer, that it will not do to return from any sort of mangold-wurzel to swede turnips, as even beasts in the straw-yard have for two or three days refused such a change. I may add that the earlier in April your mangold-wurzel is sown the better, the deeper the tilth the greater probability of a heavy crop, but that although both the mangold-wurzel and sugar-beet require a deeper and stronger land than the swede turnip, yet that the orange-globe will flourish wherever the latter will succeed.

These are the details of the system I adopt as regards this root, and I shall be glad if I should prevail upon those who have not yet tried the culture of it to grow a small quantity, assured as I am that for certainty of crop and feeding properties the mangold-wurzel will not deceive expectation. Yours truly,

W. Miles.

Kingsweston, Nov. 1, 1841.

XXVIII.—*On Guano.* By James F. W. Johnston, F.R.S., &c., Hon. Mem. of the Royal English Agricultural Society.

§ 1. *Of the Natural Occurrence of Guano.*

Guano, according to Humboldt, is the European pronunciation of the word "huanu," which in the language of the Incas means dung or manure. The substance long known by this name occurs at various points along the coast of Peru, between the 13th and 21st degrees of south latitude, both on the main land and on the numerous islands and rocks which are sprinkled along this part of the shores of South America. It forms irregular and limited deposits, which at times attain a depth of 50 or 60 feet (Humboldt), and are excavated like mines of iron ochre. It is not known to exist in any quantity north of 13° or south of 21°; though the flocks of cormorants, flamingoes, cranes, and other sea-fowl (from the droppings of which it has been derived), appear to be equally numerous along both the more southerly coast of Atacama and the more northerly shores of Arequipa.

Mr. Winterfeldt, who appears to have more recently visited the west coast of South America, has published the following additional information in Bell's Weekly Messenger of the 11th of September, 1841:—

"There are three varieties of guano—the red, the dark-grey, and the white. The first two are met with in the isles of Chincha near Pisco, at Iquique, and on the hill of Pica. The term 'guano of Iquique' is sometimes used from its having been first procured from the island of that name. This island is situated about 400 yards from the port of Iquique. It is about half a mile long, and about 200 yards broad; and furnished large quantities of guano for 25 years, when it became exhausted. The hill of Pica is very high, and is covered with guano down to the water's edge; while that side which does not face the sea is of sand and gravel. In this hill or rock I am informed that a silver-mine was formerly worked, but that no trace of guano was found during the excavation. The adjoining hills on either side are of sand, which is carried by the winds, and covers up the guano; to remove which the sand is first taken away, and deep excavations are made; the guano extending nearly a quarter of a league in length, and 300 *yards in depth.** It is likewise found at St. Lobos, about three leagues to the south of Pica; but, as the anchorage is dangerous, little business is done here."

§ 2. *Origin of the Guano.*

The extraordinary thickness and extent of these deposits of guano seem at first sight to throw discredit on the statement that

* Mr. Winterfeldt can scarcely mean that the layer of guano is actually 900 feet in thickness: it probably climbs up the mountain side so high. Pica and Iquique are both within the latitude of 21° S., the limit assigned by Humboldt.

it is altogether derived from the dung of the countless flocks of sea-fowl which frequent the islands and rocks of the Peruvian shore: yet the evidence on this point is perfectly satisfactory. The living birds still deposit the white guano on the islands to which they resort. In the isles of Islay and Jesus 20 to 25 tons of this recent guano are occasionally collected in a single season. In the island of Torrecilla the white may be seen changing into the red variety (Winterfeldt); while, in the midst of the great accumulations of the latter kind, bones and feathers (Frezier) of birds are found, as if to remove any doubt which might still remain as to its origin. Its real origin, indeed, was well known to the government of the Incas, and its national importance fully understood. It was made a capital offence to kill the young birds on the guano islands. Each island had its overseer; and, as the whole coast from *Arica* to *Chaucay*, a distance of 200 leagues, was manured almost entirely with guano, each island was assigned to a special district of the main land, and its produce was conveyed to that district alone (Humboldt).

It was not till the arrival of the Spaniards that the original source of the guano was for a time doubted; yet, when we consider how great a lapse of time it must have required to admit of the accumulation of the extensive beds of ancient guano still known to exist, we cannot wonder that early European visitors should have received with hesitation what we now readily admit as the true account of its origin. Of late years the increase of traffic on the coasts has disturbed or driven away the birds, and thus materially diminished in many localities the annual produce of the white or recent guano. "Since the opening of the port of Islay the birds have nearly deserted the adjacent inlets" (Winterfeldt).

It may be further added on this point that the chemical constitution of guano has been found to be exactly such as is to be expected from the above account of the mode of its production.

Why, it may be asked, does this substance accumulate within the eight degrees of latitude above stated only, though the sea-fowl are said equally to abound beyond these limits? This question involves a consideration both of the chemical nature of the substance itself and of the physical condition of the country in which it accumulates: it will be more naturally discussed, therefore, in a subsequent section.

§ 3. *Effects of Guano on Vegetation.*

It is known to have been a common practice to manure with guano as far back, at least, as the twelfth century; and the possibility of raising crops on the sandy plains of Peru is said to depend altogether on the application of this substance* (Humboldt).

* We have seen how it was prized by the ancient Peruvians. About

"In a soil of remarkable sterility, composed only of white sand and clay, it is sufficient to add a small quantity of guano to be able to reap the richest harvests of maize" (Boussingault).

"It has been calculated that from 600 to 700 tons are annually sold in the port of Mollendo, for the use of the country around the city of Arequipa. In the province of Taracapa, and in the valleys of Tambo and Victor, the consumption should be something more; as wheat, all kinds of fruit-trees and plants, with the single exception of the sugar-cane, are manured with the guano: which is not the case with the district of Arequipa, where maize and the potato alone require it. In the district of Arequipa 3 cwt. of the guano is spread over an extent of 5000 square yards;* but, in Taracapa and the valleys of Tambo and Victor, 5 cwt. are required. The land thus manured in Arequipa produces 45 for 1 of potatoes, and 35 for 1 of maize; where wheat, manured with horse-dung, produces only 18" (Winterfeldt).

In 1828 the annual consumption of white and brown guano in Peru was estimated at 600 or 700 tons in all; but this is probably now much below the truth.

These facts afford sufficient evidence of the value of this substance as a manure in the soil and climate of Peru. It has recently, however, been imported in large quantities into this country, and has already been tried upon various crops and soils, and with highly satisfactory results. Several of these results have been obligingly communicated to me; and, as the subject is an interesting one to the agriculturist, I shall insert them in the words of my several correspondents.

1. *Experiment of Mr. Pusey.*—"The guano was applied, in the beginning of July, to half an acre of ridged swedes, at the rate of 3 cwt. to the acre, drilled under the seed. Bones, Poitevin's manure or night-soil, dung, urate, and peat-ashes, were applied at the same time on neighbouring pieces of ground. The first action of the guano was discouraging; for, on one half of the ground dressed with it, no plant came up. On transplanting into the blank spaces, the seed was found encrusted with the guano, without any sign of vegetation. This ill effect might be easily guarded against. Notwithstanding this check, the piece dressed with guano now (Nov. 11) appears to be superior to all the other plots excepting that which was dressed with dung."

2. *Experiment of Mr. Love, of Castle Farm.*—"I have made trial of the guano for rape and turnips, and in both instances, I am happy to inform you, it answered my most sanguine expectations. I mixed 14 lbs. of it, in the first trial, with 2 bushels of ashes; and although the weather was very dry, I could perceive a marked difference in the growth of the plants a few days after they made their appearance. Encouraged by my results, I next mixed 28 lbs. with 15 bushels of

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Villacori this people also manured with a species of small fish, taken in great abundance on the coast.

* 4840 square yards make an English acre.

ashes, and applied it for turnips, by sowing it on the furrow, broadcast, and harrowing it in lightly; and, as we had frequent showers at the time, the seed soon vegetated, and the plants grew away from those on each side, and were large enough to hoe 2 or 3 days before those on the land I had manured in my usual way with dung and mould. In each case I applied at the rate of 2 cwt. per acre. The ashes I mixed with it were dry, and such as we usually obtain by burning round the hedge-rows and borders of our fields. I have no doubt of its being a very powerful manure; and, on very poor soils, I think I should put on 1 cwt. per acre more than I did this summer, especially if I could not procure ashes in sufficient quantities to mix with it."

3. "*Mr. Westcar, of Burnwood, Surrey,* tried 7½ lbs. upon 5 rods of land, drilled in with barley and clover. Upon other 5 rods he applied the best farm-yard manure, at the rate of 18 loads to the acre, and sowed on these an equal quantity of the same seeds. The result was—

From dung, 18 loads to the acre . . 1 bushel 3 quarts.
From guano, 2 cwt. to the acre . . . 1 „ 7 „

Being a saving of expense in the manure, with an increase in the crop."

4. "*Mr. Smith, of Gunton Park,* applied 4 bushels, about 200 lbs., of guano to a statute acre; and on another equal portion of land on the same field, applied 15 bushels (6 cwt.) of bone-dust. Both were drilled into the ground with the seed-wheat. The guano gave 6 quarters 2 bushels 1½ peck; the bone-dust only 4½ quarters of wheat." *

5. *Experiment of Mr. Skirving, at the Walton Nurseries, near Liverpool.*—"Three plots of ground were manured respectively with guano, nitrate of soda, and farm-yard manure; and to a fourth portion nothing was applied. All the four were sown with Italian rye-grass, on the 19th of May; and all were cut on the 2nd of August last. The results were as follows:—

	Tons.	cwt.	lbs.
Guano, 3 cwt. per acre . . .	14	15	26
Nitrate of soda, 3 cwt. per acre .	14	13	37
Farm-yard manure, 20 tons per acre	13	2	96
Without manure	7	0	108

Mr. Skirving adds "that the experiment was made on poor light black soil, inclining to peat. The land was first dug over, and then the manures spread on it and lightly dug in. On account of the very dry weather at the time of sowing, the seed did not come up very soon on any of the plots, but when the rain came the crop appeared; and on the nitrate of soda and guano made more rapid progress, by a great deal, than on the farm-yard manure, and continued to do so until I was obliged to cut the crop, its luxuriance being such, both on the guano and soda, that it was all down and lodged, and injured the roots.

"The second crops on these manures will differ in point of weight, I

* Communicated by Mr. Macdonald, of St. Mildred's Court, Poultry; as were Nos. 2 and 3 also.

have no doubt. At present the farm-yad manure takes the lead; the guano is next; but the crop on the nitrate is by no means making the same progress.

"I have tried the guano on several other crops, in different proportions, and all prove very much in favour of its being a most valuable manure; and the produce from it, as in the case of farm-yard manure, will be in proportion to the quantity laid on—at least, as far as 8 cwt. to the acre: beyond that, I fear, it would be too powerful for any crop." *

These are all the experiments of which the results have been transmitted to me. Though they leave very much to be desired, yet they are sufficient to show—that in the climate and on the soils of England the guano is fitted to promote vegetable growth nearly as much as on the arid plains of Peru.

§ 4. *Chemical Composition of Guano.*

To what cause are we to ascribe this extraordinary effect of guano in fertilising and increasing the produce of the land? What does it contain that renders it so grateful to vegetable life? We know that pigeons' dung and the liquid manure of the farm-yard act upon vegetation almost, if not quite, as efficiently as the guano; and as this latter substance has precisely a similar origin, we can in some measure understand from analogy only, why it should be so useful as a manure. A clear comprehension, however, of the kind and extent of its action on vegetable life, and of the circumstances under which it is likely to be most beneficial, can only be obtained from the study of its chemical constitution.

The first analysis of this substance was, I believe, published by Klaproth (Beiträge, Th. iv. p. 299); the specimen having been furnished to him by Humboldt. He found it to consist of—

	Per Cent.
Urate of ammonia	16
Phosphate of lime	10
Oxalate of lime	12·75
Silica	4
Common salt	0·5
Sand	28
Water and other organic and combustible matter	28·75
	100

* These experiments would have been much more valuable had the results been given in the state of *dry hay* instead of that of *green grass*. The reason of this is, that different samples of grass from the same field yield often very different proportions of dry hay. Thus 100 stones of grass, cut from each of six different half-acres—treated with different manures—in the same field, near Aske Hall, Richmond, gave respectively of dry hay 52, 53, 36, 46, 40, and 36 stones. No accurate conclusion therefore can be drawn from the weights of the green grass yielded by the several parts of a field.

The next analysis was by Fourcroy and Vauquelin (Gehlen's Jour., vi. p. 679). Their results gave—

	Per Cent.
Urate of ammonia	9·0
Oxalate of ammonia	10·6
Oxalate of lime	7·0
Phosphate of ammonia	6·0
Phosphate of ammonia and magnesia	2·6
Sulphate of potash	5·5
Sulphate of soda	3·3
Sal ammoniac	4·2
Phosphate of lime	14·3
Clay and sand	4·7
Water and organic matters	32·3
	100

If we suppose the analyses equally correct, the specimens examined severally by Klaproth and by Vauquelin differed very much in chemical constitution. That of Klaproth was mixed also with one-third of its weight of sand and silica.

To a circular, recently issued by Mr. Macdonald, the following analysis is appended, but the authority is not given:—

	Per Cent.
Bone earth	30½
Sulphates and muriates	3
Uric acid	15
Ammonia	15
Other organic matter	36½
	100

This also differs materially from the other two; and, allowing for slight errors in analysis, shows that the substance varies widely in composition. It cannot fail, indeed, to vary to some extent, according to the state of decay in which it is subjected to examination.

Of the guano which has been imported into this country a box having been obligingly sent to me by Mr. Macdonald of the average quality of that which, as he states, is likely to be hereafter brought to England, I have submitted it to a chemical examination, in reference chiefly to its economical value. It is of a brownish-red colour, is evidently a very ancient deposit, and has undergone much decomposition. It consists of a powdery portion mixed with lumps of various sizes. The latter, when broken, exhibit an aggregation of minute crystalline plates, are much richer in ammonia than that which is in powder, and are freer from sand and stones. When broken up, however, the lumps speedily lose their crystalline appearance, give off ammo-

nia even at the ordinary temperature of the atmosphere, and assume the condition of the powdery portion with which they are mixed.

1. *The quantity of sand* contained in a portion of the powdery variety I found to amount to nearly 11 per cent.; while in one lump there were present 8 per cent., and in another less than 2 per cent. The sand consisted chiefly of mica, quartz, and felspar, the débris of the igneous rocks of the coast of Peru. Occasional fragments of rock occur, of considerable size also, among the guano.

2. The quantity of volatile or combustible matters (including the water and ammoniacal salts) which are capable of being driven or burned off by a red heat is also very variable. Thus, 4 portions, taken at random from different parts of the box, lost, respectively, 23½, 46, 60, and 53 per cent. of their whole weight; leaving an ash of a white or slightly grey colour. This difference is not owing to the presence of unlike quantities of sand, for the numbers above given are calculated on the supposition that the specimens were all free from sand. Thus the first specimen lost by heating only 21½; but, as it contained 8 per cent. of sand, it would have lost, as stated above, if free from sand, 23½ per cent.

In so far as the volatile constituents are concerned, therefore, the guano which comes to this country may vary in value from 1 to 3.

3. Yet the loss by heating, which is very easily ascertained, is not a true measure of the richness of the guano in ammonia and other valuable organic matters. When reduced to powder it rapidly absorbs moisture from the air. Thus, in 48 hours, a weighed portion of a lump broken into coarse powder gained by exposure to the air 2 per cent.; another portion gained in 10 days no less than 6 per cent., and after a longer time it became perceptibly moist between the fingers. This absorption of water from the air will tend not only to depreciate the value of a given weight of the guano when brought to our humid climate, but also to cause errors in the results of agricultural experiments made with different samples of the manure.

4. I have stated above that the lump guano when crushed gives off ammonia at the ordinary temperature of the atmosphere. In hot weather this may be rendered sensible by holding over it a feather dipped in strong vinegar or diluted muriatic acid (spirit of salt), when white fumes will be perceived; or at any time by heating the guano to 100° or 150°. By this evolution of ammonia it loses both in weight and in virtue. By drying at 150° I found a lump to lose 11 per cent. of its weight, ammonia being sensibly given off during the whole duration of the experiment; yet when it was again exposed to the air it absorbed so much

water as in four days to be 5 per cent. heavier than it had been before it was exposed to heat.*

This evolution of its volatile constituents by exposure to the air is well known on the coast of Peru. From the guano island near Arica such a stench proceeds that vessels are prevented by it from anchoring near the town (Feuillé and Humboldt); while the white guano at the present day sells in the port of Mollendo at a price more than one half higher than that which is given for the dark-grey and the red (Winterfeldt).

I do not know in what way the guano is shipped for transport to this country; but it is certain that, were it rammed hard into casks as soon as it is taken from the mine, and so kept in this country till it was about to be applied to the land, it would neither be so far deteriorated by the loss of its volatile constituents, nor increased in weight by the absorption of water.

5. The absolute quantity of ammonia contained in the guano of Klaproth and Vauquelin is not stated. In the analysis published by Mr. Macdonald as above given, it is said to amount to 15 per cent.† This greatly exceeds the quantity contained in the specimen examined by myself, which gave me only 7 per cent. of pure ammonia. The same is true of the uric acid, which in my specimen did not amount to 1 per cent.‡ In these results a certain latitude must be allowed for necessary differences, since the older the deposit, the less rich must the guano be in uric acid and ammonia.

6. An important ingredient in the guano is the phosphate of lime, and as this substance is neither volatile, so as to rise into the air, nor soluble, so as to be washed out by the rains, it is obvious that the older the deposit and the less volatile matter it contains, the richer it is likely to be in this earthy phosphate. Supposing each specimen free from sand, &c., the analysis of Klaproth gives 14·7 per cent., and that of Vauquelin 15 per cent., while the bone-earth in the third analysis is stated at 30½ per cent.

In two portions which I examined, the phosphate of lime amounted in the one to 29, and in the other to nearly 43 per cent. of the guano supposed to be free from sand. In regard to this

* If a little guano powder be mixed in a wine-glass with a little newly-slaked lime, ammonia is immediately evolved, and becomes distinctly sensible to the smell.

† Fifteen per cent. of pure ammonia are equal to 60 of bicarbonate of ammonia, 45 of sal ammoniac, or 40 of oxalate of ammonia. As much of the ammonia in guano exists in the state of bicarbonate, I doubt if any of the specimens which come to this country can ever contain so much as 15 per cent. of pure ammonia.

‡ One hundred grains of guano distilled with dilute caustic potash, and the ammonia received into dilute muriatic acid, yielded, on evaporation at 212°, 21·5 grs. of sal ammoniac, equal to about 7 grs. of ammonia. The uric acid was separated by boiling in dilute caustic potash, and precipitating by dilute sulphuric acid.

substance, therefore, the guano is no less variable in composition than in regard to its other constituents.*

7. When cold water is poured upon guano a large portion of soluble matter is taken up, consisting chiefly of common salt and of various salts of ammonia, with a very little of the urate of soda, lime, and magnesia. After careful washing with water and drying at 150°, one portion left 40 and another 35 per cent. of insoluble residue, consisting of phosphate and oxalate of lime with some urate and other animal matters. It is these soluble salts which act most immediately and most powerfully when the guano is applied to the growing crop. The earthy constituents, though of great importance to the ultimate growth and health of the plant, begin to manifest their influence at a later period.

8. I have not thought it necessary to determine with accuracy the relative proportions of the oxalic and carbonic acids, or of the several salts of ammonia, in a substance so variable in its constitution. In the only specimen in which I sought for it I detected no sensible quantity of potash. It is true that Fourcroy and Vauquelin found 5½ per cent. of sulphate of potash, but this can only be considered as accidentally present in the specimen they examined, since it is not easy to understand how potash should be more abundant than soda in the excrements of sea-fowl, living almost entirely upon the fish of the Pacific Ocean.

9. Finally, the variable constitution of the guano brought to this country, and now offered for sale in England, will appear by the following *general* results of the analysis of two small portions taken at random from a box containing about 20 pounds' weight. The first contained 8 per cent. and the second ouly 1⅕ per cent. of sand.

1.	Per Cent.	2.	Per Cent.
Water, salts of ammonia, and organic matter expelled by a red heat	23·5	Ammonia	7·0
Sulphate of soda	1·8	Uric acid	0·8
Common salt with a little phosphate of soda	30·3	Water and carbonic and oxalic acids, &c. expelled by a red heat	51·5
Phosphate of lime with a little phosphate of magnesia and carbonate of lime†	44·4	Common salt with a little sulphate and phosphate of soda	11·4
		Phosphate of lime, &c.	29·3
	100		100

* Boussingault, after describing the astonishingly fertilising action of the guano on the plains of Peru (Annales de Chim. et de Phys., lxv. p. 319), says that it consists of urate, oxalate, phosphate, and carbonate of ammonia and *some earthy salts*. This distinguished philosopher, to whom modern agriculture owes so much, inclines to the hypothesis "*that the fertility of the soil can be increased only by the addition of substances containing nitrogen*" (ibid. lxvii. p. 16), and therefore pays less regard to the earthy matters which may be added to the soil. We are indebted to Sprengel for illustrating the important influence of inorganic substances in *nourishing* and promoting the growth of all living vegetables.

† The results above given indicate the proportions of the alkaline and

§ 5. *On the Cause of the fertilising Action of Guano.*

Though so variable in composition, however, the nature of the substances it appears always to contain enables us to explain why it exerts so marked an effect on the growth of plants, as well as to answer one or two other questions—in regard, for example, to the duration of its action in fertilising the land—and to the cause of its accumulation on the coast of Peru.

1. The most important and most active ingredient contained in the decomposed guano imported into this country is the ammonia. This substance, there is reason to believe, acts in a most energetic manner upon vegetation in every climate—it is one of the most useful ingredients in our farm-yard manures, and though writers differ in opinion as to the amount of influence actually and constantly exercised by this compound on the *general vegetation of the globe,** they all agree in attributing to it a very beneficial action on growing plants in general, when applied to them in a sufficiently diluted state. In proportion, then, to the quantity of ammonia it contains will the value of the guano be increased, and hence one reason why the more recent varieties should be accounted the best, and should bring the highest price in the market.

2. Next to the ammonia, or perhaps equal to it in value, though in the specimens I examined very much less in quantity, is the uric acid. This substance, as it decomposes, gives rise among other products to the formation and evolution of ammonia in considerable quantity. Under the most favourable conditions 100 of pure uric acid *might* yield 40 of pure ammonia. In nature, however, these conditions probably never occur, so that, during its decomposition, numerous other products containing nitrogen are formed (prussic acid among the rest), which it is unnecessary here to specify. We know little that is certain in regard to the action of these products on the growth of plants, but the well-known effect of liquid manure, which in a state of

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earthy salts as they existed in the ash that was left when the guano was heated to redness in the air. The chemical reader will understand that very different numbers would have been obtained had the soluble salts been separated from the insoluble before either of them was heated to redness. This arises from the circumstance that, when the crude guano is heated, the phosphate of ammonia and oxalate of lime are simultaneously decomposed, and phosphate of lime is formed, whereas, were the phosphate of ammonia previously removed by washing, the oxalate of ammonia would, by the burning, be converted only into carbonate. With a view to a merely *economical* object it did not appear to me necessary to enter into a rigorous examination of the relative proportions of the several salts of ammonia present in such variable quantities in the guano.

* The prevailing views on this subject, and the reasons on which they are founded, are explained in my 'Lectures on Agricultural Chemistry and Geology,' part i. p. 248.

fermentation contains the most of them, leads to the belief that they are fitted to promote vegetation.

The *fresh* guano is more valuable, chiefly because it contains more of this uric acid in an undecomposed state. We have no analyses of the recent droppings of any of the birds which frequent the shores of Peru; they would probably be found to differ in some degree, not only with the species of bird, but also with the kind of fishes on which at different seasons of the year they were found to prey. We possess analyses, however, of the excretions of other birds which live chiefly upon fish, from which we are enabled to form an opinion as to what the recent guano is likely to be. Thus Dr. Wollaston found those of the gannet (Pelicanus bassanus), when dry, to contain little else but uric acid, while in those of the sea-eagle Coindet found—

Solid Excretions.	Per Cent.	*Liquid Excretions dried.*	Per Cent.
Ammonia	9·2	Uric acid	59
Uric acid	84·65	Earthy and alcaline phosphates, sulphates, and chlorides	41
Phosphate of lime	6·13		
	100		100

If we compare the first of these results of Coindet with the constitution of the guano as it is imported into England, we cannot fail to be struck with the degree of decomposition which the latter must have undergone—supposing it to have originally resembled the solid excretions of the sea-eagle. The quantity of phosphate of lime in the latter, 6·13 per cent., is unusually large for the excrement of a bird; but if we suppose the recent guano in its dry state to have contained quite as much, it would require 500 lbs. of the latter to give the quantity of phosphate (29·3 lbs.) contained in 100 lbs. of a quality such as the one portion I examined, and 700 lbs. to yield the quantity of phosphate (44·4 lbs.) contained in the other. In other words, *from* $\frac{1}{5}$ *to* $\frac{1}{7}$ *only of the original organic animal matter remains in the guano, as it is imported into England.* It probably retains even less, since it has unquestionably absorbed from the air a considerable portion of moisture not supposed to be present in the droppings when recent and carefully dried.

It is easy to see therefore why the *recent* guano should bring so much higher a price on the coast of Peru; why the ancient Peruvians should have so carefully collected it, and should so religiously have preserved the sea-fowl from destruction or disturbance; and why they should have left the ancient accumulations comparatively undisturbed;—to be searched for and excavated in these after-times when the produce of the living birds has become less abundant or is less carefully collected and preserved.*

* The comparative value of the *recent* droppings of birds is shown by

On the other hand, in the identity of the substances contained in guano with those always found in the recent excretions of living birds, we have that evidence of a common origin—which in a previous part of the present paper was stated to lend an almost unnecessary confirmation to the evidence there adduced in regard to the source from which the accumulations, on the shores of Peru, have unquestionably been derived.

One other remark I may here venture to introduce. We are astonished — even geologists, who are familiar with extended periods of time, and are accustomed to contemplate immense results produced by the prolonged action of apparently insignificant causes—even geologists are struck with the occurrence on the existing surface of the globe of such vast accumulations of excrementitious matter: yet how are our ideas still further magnified in regard both to the number of birds necessary to deposit them, and to the lapse of time during which they must have been gathering, when we learn that what now remains is not—either in bulk or in weight—more than an eighth or a tenth part of that which originally fell from the flocks of living sea-fowl!

3. A most important part of the composition of the guano is the quantity of phosphoric acid it contains in combination with ammonia, with soda, and chiefly with lime. All plants require for their healthy growth a portion of this acid in combination with lime. All vegetable productions which unmixed are capable of feeding and nourishing animals must contain it, since from their vegetable food all animals ultimately derive those earthy and other phosphates of which so great a part of their bones consist, and which are also present in smaller quantity in their fleshy parts and in their various fluids.

The presence of these substances therefore enables the guano to minister *to a greater number of the wants of living vegetables* than it could do were it entirely composed of uric acid or of ammonia. These latter compounds may abound about the roots and leaves of plants, and yet, if the phosphates be wholly absent, the plant which sprung up of a bright green, and shot forth with vigour, will never attain to a healthy maturity, or produce an adequate return of nourishing food.

One of the uses served by bones when applied to the land is to yield the phosphate of lime they contain to the successive crops which are grown during an entire rotation. Hence one reason why the effect of bones upon the land is in many cases found to be so very permanent. The animal matter in bone-dust will

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the price usually paid in Flanders for pigeons'-dung. It is there employed as a top-dressing for the flax, and the dung of 100 pigeons is worth about 20*s.* a-year for this purpose—(Sprengel). The injurious effect of recent goose-dung arises from its falling on the grass in too concentrated a state. When diluted by a shower of rain its influence is most beneficial.

decompose and disappear in great measure from the soil in one or two seasons, but the bone-earth (the phosphate of lime) remains long in the land, is—in small quantity only, and therefore slowly—withdrawn from the soil by the crops and by other natural agencies, and thus may continue to exercise a beneficial influence on the fertility of the field to which it is applied for a long period of time.

The same remarks apply to guano. On an average, 150 lbs. of guano may contain as much bone-earth as 100 lbs. of bones;* and in the same proportion will its action on the land, compared with that of bones, be permanent—in so far as this ingredient is concerned.

This fact is of great practical importance. Nitrate of soda, so much used of late and so deserving of more extensive trial, may be washed out of the soil where the earthy part of the guano would remain : it may cease to exert a marked influence after a single crop, where it is scarcely possible that the phosphates of the guano should cease to act; and it may fail to bring to maturity crops of corn or to fill the ripened ear, when the guano would supply to the grain, among other substances, the earthy phosphates also, which the seed contains as a necessary constituent.

While then the ammonia of the guano promotes the early growth, its phosphates supply to the ripening plant the materials which are indispensable to its perfect development. The nitrates also, like ammonia, aid in a remarkable degree the growth of the plant in its earlier stages; but, except the potash or soda which the nitrate may contain, it can supply to the maturing vegetable none of the inorganic substances it is known to require. Unless these are present in sufficient quantity in the soil, the healthy appearance of the young plant, whether imparted to it by the agency of ammonia or by that of nitrate of soda, cannot be safely trusted to as an index of the weight of corn we are to reap, when the time of harvest comes.

4. The presence of common salt in the guano need not surprise us. It is no doubt derived from the sea, partly through the medium of the birds themselves, and partly from the evaporation of the salt-spray continually driven upon the coasts by the winds. It is variable in quantity, as we should expect from a knowledge of its origin. The beneficial effect of common salt when applied to the land has been frequently recognised in many localities and upon many soils. It no doubt aids the other ingredients of the guano in producing its full effect upon the living vegetable.

The important influence of guano, therefore, on the vegetation

* Four cwt. of guano as much as 7 bushels of bones, supposing the guano to contain about 35 per cent. of phosphate of lime, which is less than the mean of the specimens I examined.

equally of England and of America, seems to depend upon two circumstances—1st, on its containing a well-tempered mixture of a *great number* of those substances which the plant requires for its perfect growth and development; and—2nd, on this admixture including a considerable proportion of a substance (ammonia) which in a remarkable degree hastens the growth of the *young* plant, as well as of another (phosphate of lime) which is necessary to its healthy and perfect *maturity.*

In the arid plains of Peru, where dews are rare and rain scarcely ever falls, we can easily appreciate the value of a substance which shall make the young plant as it were rush up when a favourable day of moisture comes, shall facilitate its rapid after-growth, and shall supply the materials necessary to its perfect maturity ere the burning sun and parching winds have time to scorch and wither it. Useful as it is likely to prove in our climate, therefore, the beneficial effects of guano may never be so striking in these latitudes as they have long appeared on the shores of Peru.

§ 6. *The Cause of its Accumulation on the Coast of Peru.*

Connected with this last observation is the explanation of the accumulation of the guano on the coast of Peru. I have already stated that, according to Humboldt, it is met with only between the 13th and 21st degrees of south latitude, though the sea-fowl are equally plentiful both to the north and to the south of these parallels. The explanation of this apparent anomaly is to be found in the climate of this part of South America.

Nearly the whole of the land along this coast, between the Cordilleras and the sea, is one continued desert. "I have always," says Mr. Darwin,* "applied the terms barren and sterile to the plains of Patagonia, yet the vegetation there can boast of spiny bushes and some tufts of grass, which is absolute fertility to anything that can be seen here" (the neighbourhood of Copiapó). "In Peru real deserts occur over wide tracts of country." "It has almost become a proverb that rain never falls in the lower part of Peru." "That much rain does not fall is very certain, for the houses are covered only with flat roofs made of hardened mud; and on the mole (at Callao) ship-loads of wheat were piled up, and are thus left for weeks without any shelter."† "The town of Iquique contains about 1000 inhabitants, and stands on a little plain of sand at the foot of a great wall of rock 2000 feet in height, which here forms the coast: the whole is utterly desert. A light shower of rain falls only once in very

* Researches in Geology and Natural History, p. 428.
† Ibid., p. 446.

many years; and hence the ravines are filled with detritus, and the mountain-sides covered by piles of fine white sand, even a thousand feet high." *

It is the dryness of the climate then which has permitted the guano to accumulate on these coasts. When we reach a region in which from local causes the dews are heavier and the rains more frequent, the accumulation ceases. Cold water, we have seen, dissolves at least three-fifths of the guano in the state in which it reaches us. A single day of English rain would dissolve out and carry into the sea a considerable portion of one of the largest accumulations; a single year of English weather would cause many of them entirely to disappear.

When the recent guano falls it gradually dries and undergoes a partial decomposition. When it is again moistened by an unusual dew, or by an accession of spray driven by the wind, it again suffers a further partial decomposition, till at length it has given off, as the ancient red guano appears to have done, from five-sixths to nine-tenths of all the organic matter it originally contained. Mr. Winterfeldt states that this ancient guano is found buried beneath layers of sand; and Iquique is mentioned as one of the spots where the guano occurs. At this place, according to Mr. Darwin, the drift-sand climbs up the mountain-sides in great piles to the height of even a thousand feet. This, doubtless, is the sand beneath which the old droppings of the sea-fowl have been gradually buried; and to this ancient superficial covering it may be owing, that the buried masses still retain so much of their original organic matter. Even in that dry climate the time would at length arrive when the guano, long exposed to the agency of atmospheric causes, would retain only its earthy and non-volatile saline ingredients.

§ 7. *Of the Economical or Money Value of Guano to the English Agriculturist.*

We come now to consider perhaps the most important question of all, namely, the probable economical value of guano to the English agriculturist.

It may by most persons be considered impossible to arrive at any satisfactory conclusions in regard to this point except by actual experiment—by the trial, that is, of its *precise* effects on different crops and in different soils. This is no doubt the most certain and unexceptionable method of determining its value—but this method requires time, and the concurrence of many individuals. Until these trials are actually made, therefore, we are entitled to

* Researches in Geology and Natural History, p. 442.

inquire of theory how far it can assist us in forming an idea of the absolute money value of this new manure, and we shall be justified in allowing ourselves to be in some measure guided by the answer which theory may give.

I.—Let me first introduce the partial results already arrived at by practical men.

1. Mr. Skirving writes me thus:—"With regard to the relative cost of guano and farm-yard manure, allowing guano to cost 25*s*. per cwt., which I believe is the price at present, it would cost no more to supply 8 cwt. to the acre than 20 tons of manure would; for in this neighbourhood in spring-time good horse and cow dung is never under 10*s*. or 12*s*. per ton, besides the heavy carriage and extra expense of application, which on some land would make a great difference."

2. In connexion with his experiment on turnips, above detailed, Mr. Pusey remarks that, although it is impossible to form an opinion from a single experiment, he thinks a farmer who could afford to dress with 20 bushels of bones per acre, at 3*s*. a bushel, might find the guano answer at 20*s*. per cwt.

These two opinions, formed from imperfect or incomplete experiments, are valuable so far as they go; but they can neither as yet be considered a safe guide to the farmer, as to what he may venture to pay for this manure,—nor to the merchant, as to what he may venture to ask for his commodity.

II. But for what price can it be imported? Mr. Darwin informs us that at Arica, in Peru, the nitrate of soda is sold at the ship's side at 14*s*. the 100 lbs., or 15*s*. 6*d*. a cwt.; and in this country it used to be sold at 18*s*. or 19*s*., though during the last year it has risen to 26*s*. and 28*s*. a cwt. We may suppose, therefore, that 4*s*. or 5*s*. a cwt. would pay all expenses of freight, and leave a handsome profit to the importer. Now, Mr. Winterfeldt states that the red and dark-grey varieties of the guano, those imported into this country, are worth 2*s*. 3*d*. a cwt. in Peru;* in this country, therefore, from 7*s*. to 10*s*. a cwt. ought to be a remunerating price to the merchant, if Mr. Winterfeldt be correct.

It is true that an article is worth to the seller exactly what it will bring in the market, but it is of great importance, not only to the agriculture of the country, but to the speculators themselves, that the price of this commodity should be kept at a reasonable rate. Not only will many more be willing to try it on their farms, if the price be low, but the general demand for it will increase in

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* "The red and dark-grey are worth 2*s*. 3*d*. a cwt. The white is sold in the port of Mollendo at 3*s*. 6*d*. a cwt.; and at times, as for instance during the war, it has brought as high a price as 12*s*."—Winterfeldt.

proportion as the exact experimental farmer shall become satisfied that the use of it is attended with profit to himself.

Every man has a right to a fair return for his own labour, and to an adequate compensation for pecuniary risk; and those persons deserve especial compensation who have hazarded their money in importing a substance which, like guano, may minister to the most vital wants of the country; but those who, having themselves no pecuniary interest in practical farming, are yet desirous, as good citizens, to promote the growth of food as the foundation of national prosperity, may be excused in considering the chance of *great* profits to speculators, as subordinate to the general interests of the agriculture of the country.

III. Let us then advert to theory, and see the *highest* price which, according to its indications, the farmer ought to be called upon to pay for the guano.

We have seen that this substance is a mixture of various chemical compounds. It is a natural mixture; but an artificial mixture may be made which shall more or less completely imitate it. What would such a mixture cost at the present price of the several ingredients of which it consists? The phosphate of lime it contains exists abundantly in bones: the ammonia may be applied either in the form of sulphate of ammonia or of sal ammoniac, both of which are low in price: the common salt and sulphate of soda can be obtained at little cost; and the urea, being so small in quantity, may be either neglected alogether, or may be replaced by a little dried urine or night-soil (Poiteviu's manure). A mixture of this kind, equal in virtue to 4 cwt. of guano, would cost as follows:—

315 lbs. or 7 bushels of bone-dust, at 2*s.* 9*d.* . .	£0	19	3
100 lbs. of sulphate of ammonia, containing 34 lbs. of ammonia	0	15	0*
5 lbs. of pearlash	0	0	10
100 lbs. of common salt	0	2	0
10 lbs. of dry sulphate of soda	0	0	10
530 lbs., equal to 4 cwt. of guano.	£1	17	11

To these it might be advisable to add 100 lbs. of chalk to aid in gradually converting the sulphate of ammonia into carbonate, in which state it may possibly be more immediately active upon the plant. This, however, is a matter for trial, as I am

* At the pleasure of the experimenter, a *portion* of the sulphate of ammonia may be replaced by nitrate of potash, in the proportion of about three of the nitrate to two of the sulphate.

aware of very beneficial results having been obtained during the past season from the application of sal ammoniac in admixture with other substances, without the presence of chalk.

I consider the above mixture as likely not only to be equally efficient with 4 cwt. of guano, costing at present 5*l.*, but ultimately it may be more so; and this chiefly because in specifying the ingredients no account has been taken of the animal matter present in the bones, though the quantity of gelatine they contain is itself sufficient during its slow decay to yield about 30 lbs. of ammonia to the soil. I have not taken this into account, because the special and immediate action of guano seems to depend upon its containing, like farm-yard manure, ammonia ready formed, and thus prepared to act without delay on the plant to which it is applied. That growth which the ammonia of the sal ammoniac in our mixture is fitted to hasten and provoke, the ammonia which is afterwards slowly evolved from the decaying animal matter will carry forward and help on to maturity. The few pounds of potash in the mixture have been added, not because this substance is always present in the guano, but because it is known that nearly all plants require a certain small quantity of this alkali for the perfect development of their several parts. Another advantage which will be possessed by the artificial mixture will be, that its constitution will be constant, and may always be calculated upon.

From these theoretical considerations, therefore, we should say that until its virtues are proved to be greater, beyond dispute, than those of the above or similar mixtures, the practical farmer ought not to purchase guano at a higher price than 20*s.* per cwt., a price which in the opinion of Mr. Pusey the farmer may probably afford to pay—which according to Mr. Winterfeldt would more than remunerate the importer—and below which, according to the chemist, an artificial guano of equal efficacy may be prepared in England, and *from the superabundant produce of our own manufactories.*

§ 8. *Of Comparative Experiments with Guano and other Manures.*

But the absolute value of guano itself, as well as its relative value compared with other manures, can only be placed beyond dispute by actual and comparative trials of its efficacy in different soils and upon different crops. To be really useful and satisfactory these trials must be made according to some well-digested method, and the comparison must be made with known weights of other substances, the action and money value of which are known, and which from their constitution may be supposed to act on vegetation in a similar way. As I have elsewhere endeavoured to draw the attention of practical men to the importance

of well-devised and carefully executed experiments in practical agriculture*—not only to the general economy of the art of culture, but also to the establishment of a true theory of its various processes—I shall take the liberty of introducing a few suggestions in regard to the kind of experiments which appear to me most likely to yield results at once economically and theoretically useful.

Among those substances which owe one main part of their beneficial agency on vegetable life to the ammonia they contain or evolve, may be reckoned farm-yard manure, crushed bones, and rape-dust. As the nitrates also act upon plants in a way so far similar to ammonia as to yield nitrogen to them, the nitrates of potash and soda may be included in the list of substances with which it would be desirable to compare the action of the guano. The cost of all these substances is known,—they are all to a certain extent in general use,—and while comparative experiments accurately made by weight and measure would throw light on many obscure points in regard to the action of each of these manures,—the results obtained from every separate plot of ground would serve as so many points of comparison by means of which the absolute and relative value of the guano might be determined.

In the present state of our practical knowledge respecting this substance, it will be pronounced by every one to be desirable that its effect should be tried upon every kind of crop; but the propriety of this course is increased by our knowledge of its chemical constitution. It contains the greater part of the ingredients which are necessary to the growth of almost every variety of crop. It will doubtless prove as efficacious therefore to old pasture-land as to the rye-grass in Mr. Skirving's nursery, and to crops of corn as to Mr. Pusey's turnips; but experience alone can tell us to which it may be applied with profit to the farmer, and from what crops it will afford him the greatest return on a given soil.

I would propose therefore that it should be tried during an entire rotation to replace farm-yard manure and the other substances named, as well as against the mixture above described, which I shall distinguish by the name of *artificial guano.* The mode of making the experiments may be varied at the wish of the practical farmer, but they might be made in a way similar to that represented beneath, each square being a half or quarter acre or other accurately measured plot of land.

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* See a small tract published by Blackwood, under the title of "SUGGESTIONS FOR EXPERIMENTS IN PRACTICAL AGRICULTURE."

20 tons of Farm-yard Manure.	20 bushels of Bones with Ashes.	6 cwt. of Guano mixed with Chalk or Gypsum.	6 cwt. of Artificial Guano.
10 tons do. with 10 bushels of Bone-dust.	20 cwt. of Rape with Ashes.	10 tons of Farm-yard Manure with 3 cwt. of Guano.	10 tons of Farm-yard Manure with 3 cwt. of Artificial Guano.
10 tons do. with 10 cwt. of Rape-dust.	10 cwt. of Rape with 3 cwt. of Guano.	10 tons do. with 2 cwt. of Guano.	10 tons do. with 2 cwt. of Artificial Guano.

The practical farmer need not be deterred by the formidable array of experiments above suggested. He may try any two or three of them, and his results will be valuable in proportion to the accuracy with which his land is measured and his manures and crops weighed. I have taken 20 tons of farm-yard manure as a standard, though in many highly farmed parts of the country no more than 15 tons are usually applied. Twenty bushels of bones are recommended by the Doncaster report, and I have lately found that in the Lothians 1 cwt. of rape-dust is considered to replace 1 ton of farm-yard manure. This proportion of course will vary with the quality of the latter manure; but, whatever quantity of this latter we take as the standard of comparison, it is easy to adjust the proportions of the other substances accordingly. I have not recommended any trial to be made with more than 6 cwt. of guano, because, where farm-yard manure is valued only at 6*s.* or 7*s.* per ton, 5 cwt. of the former would cost as much as 20 tons of the latter.

The above experiments are intended to be made with the green crop and continued during an entire rotation;* any pair of them, however, may be tried on single crops, whether of corn or of turnips and potatoes. In this way it ought also to be tried against nitrate of soda and against bones, upon seeds and upon old grass-lands. The mode in which such experiments may be made will readily suggest themselves to the intelligent farmer. *In all cases the results should be accurately recorded, and if possible published.*

I consider it of importance that an artificial mixture, similar to that above suggested, of which the composition is known, and which can anywhere and by any one easily be made, should be

* By this I mean that the effect of these several manures, applied *once for all* to the green crop at the commencement of the rotation, should be traced on each successive crop through the entire course of cropping.

fairly tried against the guano;* because it does not appear, as some have been led to believe, that the supply of this substance on the coast of Peru is by any means inexhaustible.

According to Mr. Winterfeldt the supply of recent guano has diminished materially even in recent times; and in an extract from his letter already given he mentions one extensive deposit of the old guano in the island of Iqurque, which was exhausted in 25 years by the local consumption only.

But the diminution is placed in a stronger light by Mariano de Rivero, in a paper published in the Spanish language, but from which an extract is given in Ferussac's Bulletin (sec. I., tom. xi., p. 84). He says—

"The Spaniards permitted the wise ordinances of the Incas, which ensured the preservation of this valuable manure, to be entirely forgotten. The Peruvians are now aware of this great error, and see with anxiety the period approaching when the guano will no longer be obtained in sufficient quantity to meet the demands of the agriculture of the country. *The discovery of new deposits of the brown guano, which is of very ancient origin, is daily becoming more rare*, while the production of the recent white guano is rapidly diminishing, since, through the freedom of commerce, so many vessels have visited the coast and scared the birds which frequented them."†

If the above account is correct, it is the interest of Peru to prohibit the exportation of the guano; but the introduction of it into this country in the mean time will prove a great national service, if it shall teach us to imitate so valuable a natural production, and, by making available those articles of home manufacture which have hitherto been neglected by the agriculturist, to supply the lack of farm-yard manure, and thereby to raise a greater amount of food than we should otherwise be able to do. Thus at the same time will the chemical arts and the art of culture be bound together by still another tie, and the mutual dependence of all classes of the community, however apparently distinct their industrial occupations, be still more distinctly illustrated.

Durham, 20*th October*, 1841.

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* I have not suggested the comparative trial of such substances as those sold under the name of urate, animalized carbon, &c., because, though I have no doubt of their efficacy when prepared after a certain manner, yet the practical farmer has no guarantee that what he purchases this year shall prove equal in virtue to that which he applied to his land in a former season.

† See Poggendorf's Annalen, vol. xxi. p. 606.

XXIX.—*Cottage Gardening.** By James Main, A.L.S.

It is universally admitted that a piece of garden-ground attached to a labourer's cottage is the greatest boon that can be afforded him, more especially if he has a young family to support. This object has always been recommended by the societies instituted for devising means for bettering the condition of the labouring poor of this kingdom; and on the recommendation of these societies the present allotment system was founded.

The produce of even a very limited spot of garden-ground, if well managed, not only adds greatly to the domestic comfort of a working man, but is actually a means of improving his moral character, by giving him employment in his hours of leisure, and in an amusing and profitable occupation, and on a spot which he can truly and with pride call his own.

But the occupation of a piece of ground is not sufficient unless accompanied with plain directions for the guidance of the labourer in his management thereof; for although a majority of our rural population are pretty good gardeners in their own homely way, many there are who need advice, and almost all are ignorant of the most economical methods of culture. It is therefore necessary, especially at this time when the allotment system appears to be extending, and when there is such a general feeling in favour of the labouring classes, that a brief and plain tract be published to afford to cottagers general instruction on the subject. This information is intended to be conveyed in the following pages, and will be so plainly detailed that the directions can hardly be misunderstood.

When a labourer is so fortunate as to have a garden attached to his cottage—or if he be equally fortunate in having an allotment in some neighbouring field—his first care should be to ascertain whether his piece requires draining; and next, to be sure that it is properly and securely fenced, if fencing be at all necessary.

Draining.—Land is liable to be too wet for the successful cultivation of kitchen vegetables, from various causes. It may be too damp from its being situated on the lowest dip of the surrounding surface, to which rain or melted snow naturally flows; or the soil may be constantly too moist from its disposition to retain water like a sponge, such as is met with in bogs. It may be in the same drenched state from having a thick bed of clay beneath the staple, or from land-springs oozing out of a bed of gravel above it. Now, from whatever cause land becomes too

* This paper will be reprinted in a cheap form for distribution among labourers, if a sufficient number of members should signify to the secretary their wish that it should be done, and the number of copies they would require.

moist for the purposes of the cultivator, its improvement can only be accomplished by thorough draining; and unless this be effectually done the crops will not only be deficient or inferior, but the manure bestowed will be quickly consumed, and washed, as it were, out of the soil.

Although a cottager should be apprised of the necessity and effects of drainage, it is but seldom that he need be at much trouble in laying his ground dry; for even in the worst cases a ditch round the outside will generally be sufficient: taking care to make at the lowest corner some kind of outlet, either into a common and lower ditch, or sinking a *swallow* through the holding soil, from which the water may soak away into some lower and more porous layer of the ground.

Fencing.—Few cottagers need advice on this particular. Simple boundary lines are often all that is necessary. In allotment pieces a footpath all round is a sufficient mark, and better than any kind of hedge, which is usually a harbour for slugs and hurtful insects. But if the cottage-garden abuts upon a waste or common-field, then a good fence is necessary. This should either be a ditch and hedge, or a deep ditch and paling—the former is the most common and most lasting. The industry and even the very character of the man is known by the trim neatness and efficiency of his outside hedge; for if he be a slovenly fellow, intruders of every kind will annoy him.

Trenching.—When a labourer enters upon the tenantry of a piece of ground, whether it be an old enclosure or a new allotment, he should resolve to trench the whole plot, unless it has been very recently done to his hand. This, however, he need not think of doing all at once, because he will find it more convenient for him to do it piecemeal; for at whatever time he may get possession, it behoves him to see what may be done on the instant in the way of getting some kind of crop on part of the ground, and for which simple digging may suffice. The trenching, however, should always be kept in mind, and executed as opportunity allows, and immediately cropped. Trenching is useful to the most shallow rooting plants; and for deep rooting kinds it is indispensable. It deepens the staple, and renders all subsequent operations easier performed; it buries weeds and a weedy surface, turning what is useless into the food of succeeding crops. Trenching not only allows a greater range for roots and permits the sinking away of heavy rain from the surface, but in dry weather allows the ascent of moisture from below to keep the loose surface more moist.

The depth to which trenching may be done depends on the natural depth of the staple, and on the nature of the subsoil, or underlayer. If the latter be pure gravel or strong clay, too much of

these must not be brought to the surface at once, unless the clay be of that kind which falls to powder by the action of the weather. If the subsoil as well as the surface be loam, there is no fear of trenching too deep, even as far as 2 feet; and in respect of a clay or a gravelly undersoil, though not brought to the surface, the bottom of each trench should be deeply broken up with the mattock, in order to move and deepen the staple.

Whatever the nature and character of the staple may be, it is certain all and every description may be improved. Manuring as frequently as possible assists and betters every kind of land. Clay is improved by any lighter kind of earth or decayed litter, or sand, ashes, and the like; because these break the tenacity or toughness of the clay, and render it easier to cultivate, and allow the roots of plants greater scope, besides admitting a freer passage to both air and rain-water.

A light sandy soil is improved by the heaviest kind of manure, or by dressings of clay or loam, because manure laid upon sand sinks into the ground, and, being quickly absorbed, of course requires more frequent application.

Loam of any kind or colour is the best for gardening purposes; it only requires to be well laboured by occasional trenching, dug at least once in the season, and hoed frequently to keep the surface loose. But as it is, like other kinds of soil, liable to be exhausted by cropping, it must be kept in heart by occasional dressings of manure.

Obtaining sufficient supplies of manure is one of the greatest difficulties which the cottager has to encounter, especially if he keep neither cow nor pig; and unless he lives by the side of a free common it is not in his power, nor is it worth his while, to trouble himself with either, except under circumstances hereafter alluded to. But an industrious man may collect as many matters of one kind or other as may be sufficient to dress one-third, or at least one-fourth of his ground once a year. For this special purpose he should have a hollow pit or place between his house and garden, into which every kind of drainage from the former and refuse from the latter should be thrown. To this may be added all sorts of litter and cattle-droppings from the lanes, roads, or commons, together with ashes, lime rubbish, marl, or chalk—all which, when thrown together and turned once or twice till sufficiently rotten, will be found excellent manure.

As the success of a cottager's garden depends solely on his ability to keep his ground in heart, every exertion must be made to secure this advantage; and if at any time he happens to have more of any kind of crop than he wants for the immediate use of himself and family, this he should exchange for some kind of dressing; or, if he sells it, the sum should be laid out in the

purchase of good manure for his garden; for by such exchange or purchase he will be sure to reap a double advantage.

Another thing which the cottager who is short of dressing should be aware of is, that manure in a liquid state is most effective. When single plants, as cabbage, or a bed of seedlings of the same, or of any other kind, require watering, manured water—that is, such as had some kind of dung steeped in it—should be used. The drainage from dunghills is most valuable for such purpose, if not too strong; but its strength is easily reduced by the addition of a portion of clear water. In some countries, where the soil is dry sand, the cultivators have cesspools sunk on purpose for making this liquid dressing, which answers the intention admirably. By the knowledge and application of such means fine crops of kitchen vegetables may be produced, while, if they are neglected, a very different result will be the consequence.

Another means of keeping ground in good heart is by following a judicious rotation of cropping. It is bad management to grow the same kind of crops repeatedly on the same spot, and therefore the crops must be made to change places every year. This will be practically explained in the sequel, and a diagram and plan of a garden given as an illustration.

The proportion of crops to the whole garden and to each other is a material affair for the consideration of the cottager. That crop which remains longest in use, and which, consequently, is most serviceable in a family, will of course command the greatest share of the ground. In all cases the potato will have, undoubtedly, the preference, not only because they are a good substitute for bread, but because a safely-secured *winter-store* of them is of the greatest importance to the labourer. Supposing, then, that the principal part of the ground is occupied with potatoes, the remainder will receive those that are the next valuable as eatables, namely, cabbage and their varieties, carrots, parsnips, onions, turnips, common beans, and above most of the latter, the useful rough-runner kidney bean, so extremely useful in a cottager's family. There are some other vegetables which may be recommended for a labourer's garden, but they will be noticed hereafter.

There is one circumstance which every manager of a garden, especially those who are confined to a limited spot of ground, should ever be well aware of—and that is the practicability of having a constantly recurring succession of crops on the same piece of ground. This is a practice which farm or rural labourers in general are but little acquainted with, though when judiciously planned and executed it is of the greatest advantage. Mixed crops are allowable in cottage gardening—for instance, a sprinkling of radish and coss-lettuce seeds may be sown with the onions,

and when the radish and lettuce are drawn being ready for use the onions suffer no injury. Broad-beans are sometimes planted at the same time and in the same drill with potatoes, and without any very visible damage to the latter crop.

But in order to keep the ground in full employment, all the crops, that is the standing crops, must be sowed or planted in drills or rows, with the intention that, before the first crop is off, another shall be put in the intermediate spaces to follow in succession. This is quite practicable with all the cabbage tribe, or with any other kind of vegetable which may be used in *any stage* of their growth. Of this description are the cabbage, savoy, onion, lettuce, &c.; and when such are planted alternately with others, which must stand to acquire full perfection, the first may be used out of the way as soon as they press injuriously upon the second.

In this way many more useful vegetables may be raised on a given portion of land than by the old-fashioned custom of sowing broadcast, only one patch of each of the common sorts occupying the ground for the whole summer. Even the onion ground may be planted with cabbages just before the former are fit to pull, which plants, whether savoys or common cabbage, become fine useful stuff before Christmas.

This constant routine of cropping and recropping may be considered as out of the power of a day-labourer to perform; but, whether he may have time or not, it is highly proper that he should be made acquainted with every practical matter which he may endeavour to turn to his advantage.

The management of a cottager's garden must commence from the moment he takes possession. As the necessary operations are intended to be set down in calendarial order in the following pages, the tenant, at whatever time he enters upon his piece or allotment, will see what seasonal business will first require his attention; but, as Michaelmas is the usual term at which cottagers shift their quarters, and moreover the most suitable period at which to begin any system of gardening, we shall therefore commence our series of instructions from this said quarter-day, and proceed onwards with the season.

The very first thing requiring attention, as already mentioned, is to see that the fence, if one be necessary, is in sufficient order; and the next, to get ready a hollow near the house to receive all the drainage, slops, ashes, and offal therefrom, together with any rank herbage or weeds which may be cleared off the surface. Then beginning at the bottom of the upper half of the garden, let a good large piece be dug on which to plant two or three hundred early York or Battersea cabbage in rows one foot apart. The plants should be examined to see if there be any knots or clubbing on the root or bottom of the stem, in which case the

knobs must be pared off with a knife before planting. Dib in the plants as deep as the lower leaves, and fix them tightly in the soil—now the labourer need not be afraid of planting too many in this order, because every alternate row must be used as soon as wanted, so that the intermediate spaces may be dug or not, and planted with long-podded beans about the end of January. The rows which are left for the principal crop of spring-cabbage will be in use during May and June, and they should be gathered by rows in succession. When the first row is used, begin the second clearing off hand-smooth, as the cabbage are wanted. The advantage of this mode of taking the crop is, that it allows the cleared ground to be dug and recropped if requisite. From the time the cabbages are planted until the beans are put in, the ground should be frequently hoed between when the surface is moderately dry, but not at all if wet.

When the cabbages are planted there is nothing more to be done in planting or sowing till the spring—but before that season the cottager must be getting the rest of his ground ready for the spring crops. As much of it as possible should be trenched ; and if he can manage to trench the whole it would be a good job out of hand. Every labourer knows how trenching is done, and therefore advice on this point is needless : it may just be observed, however, that the trenches may be made 2½ or 3 feet wide, and as deep as the staple allows—the first is wheeled to the other end to fill the last trench. The top-spit or spadeful of the second is turned to the bottom of the first, and the remainder is raised to form the new surface, this being repeated over the whole piece.

In the autumn or winter-fallowing of garden-ground the surface is either laid flat or in ridges. If the soil be light and sandy, it can hardly be laid too level, because such soil requires no amelioration by frost, nor any exposure to the sun and drying winds to exhale away its moist riches. But if the soil be naturally heavy and clayey, then the surface should certainly be laid in ridges, not only that it may be mellowed by frost, but that it may be rendered as dry as possible before seed-time. These last observations are applicable to digging as well as trenching, for strong land should always be laid in ridges during winter. There is another advantage of ridging land to a cottager who may have an opportunity of getting it into this state during the autumn; it is, that in the spring, when so much business is going on in the fields, any portion of the cottage-garden is much more readily got in order for either seeds or plants than if it had to be dug at that busy time, when every hour of the labourer's time is so valuable to his master and himself.

During the winter the cottager must also set his head to work about proportioning his ground to the quantities of vegetables

which he may wish to cultivate for himself and family. This he ought to arrange for himself, because without knowing the size of the garden a writer can hardly give advice that would be useful on this part of the subject; but that he may not be left without some kind of guide in this affair, we shall presume that he has ½ a rood or 20 poles of garden, which is not more than is really necessary for a married couple having three or four children. Calculating then upon this quantity of ground, we shall set down what we think should be the proportions of the crops respectively, and which will serve as a scale to direct every cottager who may have either more or less of the supposed quantity of 20 poles.

We may next suppose that the piece of ground is in the shape of a long square, 38 yards long and 16 yards wide or over. This area will contain about 20 poles; of this 19 yards in length must be marked off at one end for potatoes, and which should be either trenched or dug in autumn or winter, to be ready for planting in the ensuing spring. This division will therefore lie fallow till April.

Next to this, mark off 7 yards in length for cabbage, which should be dug and planted, as already directed, as soon after Michaelmas as possible. About the middle of January let us suppose that the second, fourth, sixth, and eighth rows of the young cabbage have been used, point over with the spade the spaces where they stood, and immediately thereon dib in by line 6 rows of long-pod beans at 4 inches apart, and cover in. If the ground be loose and puffy, tread it well before the beans are dibbed in, as they strike root best in firm soil.

Thus there are 19 yards left for potatoes, and 7 in length occupied by cabbage, leaving 12 yards to be cropped in March and April. This reserved portion may be divided into 4 parallel beds of nearly 3 yards each:—the first parsnips; then carrots; next onions; and last a bed which may be a seed-bed of cabbage sown with radish, lettuce, and early Dutch turnip. A narrow slip of this last or uppermost bed may be parted off for potherbs, flowers, &c.

We have now set forth how the garden may be cropped in the first year, and mentioned what we consider the most profitable kinds; but it is necessary to revert to the manner of sowing and management during their growth, and here we may repeat that all will be the better for a sprinkling of manure; but as it is not likely that this will abound, whatever can be got together must be reserved for the potatoes. The other crops about to be particularly noticed, may be assisted in their early growth by manured water as already alluded to.

Of the Parsnip.—This very nutritious root is luckily easily cultivated, and when sown in drills on deeply dug or trenched

ground, yields a bulky return, which when stored in dry earth or sand remains long useful. The drills may be 14 inches apart, the seed sown thinly on shallow furrows opened by line with the corner of a turnip-hoe and lightly covered with the same. When the seedlings have risen 2 inches high, they should be thinned to 5-inch distances, and the ground always kept well hoed between the rows to kill weeds and benefit the plants. The seed is very light and cheap, 1 ounce being as much as a cottager will require. There are two sorts; the common long one suitable for deep soils, and the short hollow-crowned sort, which is of superior quality, and best fitted for shallow soils. Parsnips may be sown either in March or April, and they will be fit to take up in October. When dry and freed from earth and remains of the leaves, they may be stored among dry earth in any corner of a shed or other place safe from air and damp.

Of the Carrot.—This well-known vegetable is in every respect, except in qualities, very much like the parsnip, requiring the same treatment as to sowing in drills, thinning, hoeing among during the summer, and taking up and storing in October or November. In thinning the seedlings, they should be left 2 inches apart, and when they have gained a useful size, every other one may be drawn for the pot, leaving the main crop at 4 or 5 inches asunder. There are several sorts of carrots, but the orange and Altringham are the best for the cottager. A clayey soil is unsuitable for carrots; but we have known ingenious labourers, whose gardens were a stiff clay, grow very fine carrots notwithstanding. Their method was this: the ground was prepared by deep digging, and at seed-time ranks of deep holes were made by line along the bed with a crutch-headed, taper-pointed dibber; the holes were filled with rich, mellow compost, and on the surface of each 2 or 3 single seeds were dropped and slightly covered with a little more of the compost. When the seedlings appear, one only (the strongest) is left, which grows rapidly, and gains a perfect natural form and good size.

The ground intended for carrots had better be sown at twice, one half in March and the other half in April, because it is found that if the worm (a pest we know not how to banish) attacks the crop, the earliest sown suffer most. Carrots may be sown at other times than in spring, but these sowings are never a profitable crop. The seed requires to be well rubbed between the hands over a cloth before it is sown, otherwise it cannot be distributed equally, the seeds being apt to cling together if not well rubbed.

Of the Onion.—This is one of the most useful of all vegetables to a cottager; it gives an agreeable relish to almost everything else, and therefore requires the especial attention of the labourer. The ground should be well prepared by manuring (if possible)

and careful digging. Sow in drills, 10 inches asunder, about the middle of March rather thickly, because, as they are useful as soon as they are of the size of a crowquill, the drills may be thinned regularly as they are wanted either to use or sell, taking care that all the strongest are left 4 inches apart to come to perfection. The bottom of the shallow furrow made to receive the seed should be firmly trodden with a foot before sowing, and slightly covered with the rake. The intervals must be kept free from weeds by the hoe, and the drills by the hand throughout the growing season; and in August, sooner or later, the onions will be ready to pull. When pulled, they should be laid together upon a bare part of the ground for a week or ten days to harden. After this the greater part of them should be roped, as the most convenient way for a cottager to keep them, or otherwise kept in a dry cockloft.

There are many different sorts of onions, but the Spanish and Deptford are two of the best for the cottager's purpose. Onions are also sown in the autumn to draw young for spring use; but this will be again mentioned at the proper time.

Radish, Lettuce, and Turnip.—On the remaining bed to be cropped in March (it being, like the three preceding pieces, about 3 yards lengthwise and the whole breadth of the garden) room may be found for a small seed-bed of cabbage and savoys mixed, another for white Silesia coss lettuce, another for short-top radish, and the remainder for early Dutch turnip. All these are sown broadcast, but regularly, over the fresh-dug surface and raked in. The turnip-seed should be sown last, as early sowings soon run to flower. If it be advantageous to the cottager to raise a crop of early radishes for sale, he may take a bed off the potato ground; sow at Christmas, or soon after, pretty thickly on the fresh-stirred bed, rake the seed well in, and smooth the surface with the back of a spade, and cover the whole bed with dry fern or short littering straw 6 inches thick. The covering is kept on till the seedlings are above ground, and then the covering is drawn off every mild day, but always kept over at night till all fear of frost is past. The labour and care of raising early radishes is of little use to a cottager unless he is sure of having a ready sale for them.

We have as yet said nothing of peas, because we do not think they are profitable to the cottager; but if he resolves to have a few, one row only of Knight's marrow will be enough. They may be sown any time in February below the cabbage across the garden, and if sown thinly, earthed up once, and sticked when 5 inches high, are very productive, but, as already said, not profitable.

When the beds of parsnips, carrots, and onions are sown, the alleys between should be immediately planted with cabbage, if plants can be had, for every foot of the ground should be cropped.

At this time (March) the narrow slip at the upper end of the garden may be furnished with a few herbs for seasoning soup or broth; namely, a plant or two of thyme, mint, sage, savory, and marjoram, with a drill of parsley sown as an edging. Above all, half a dozen or more roots of rhubarb for the leaf-stalks, which will be found most useful in the family. Seedling plants or old roots may be had of any market-gardener.

Potatoes.—Preparations must now be made to get in next month (April) the cottager's principal crop. Much of his domestic comfort during winter will depend on his having from 10 to 15 bushels of good sound potatoes pitted near or well covered up in some safe corner within his house. We have allowed one half of his ground for this crop; and if the sets be properly planted, and the crop properly cultivated during the summer, we calculate that the yield will be at the very least 15 bushels, besides those used in summer.

This is a fine store for a labourer to look forward to, saying nothing of his stores of parsnips, carrots, and onions, all most useful additions; but he may rest assured that unless they are used with economy, twice the quantities would be of little use to him. We have been much among labourers who had gardens; but with all the authority of a master, and with all the best advice of a friend, we never could prevail with many of them to make the best use of the advantages they possessed. To begin on the potatoes as soon as they were of the size of walnuts, thus devouring bushels at a meal, was a common piece of extravagance! Selling the whole crop for one-fourth of the value, to save the trouble of taking up and storing, was a frequent occurrence; and great waste in the cooking was in many cases too visible. But, on the other hand, some, who husbanded their resources, lived comfortably, and showed the manifold advantages they and their families derived from possessing a small piece of garden.

The ground reserved for potatoes will hold 10 rows at 2 feet apart, and will require about 1½ bushels cut into sets to plant the same, placing the sets about 8 inches asunder in the drill, covering full 8 inches deep. The sets should be as large as the size of the potatoes will allow, each having at least one eye, rejecting or not counting on that at the bottom, as no shoot springs from it. The best way of cutting the sets is first to split the potato down the middle; each half may be divided into two or three sets, according to the number of good eyes, taking as much of the substance of the potato with each eye as possible. Some curious growers make sets of the crowns, which they keep and plant by themselves, for the purpose of being first used, as the tubers from these sets always come earlier than those of the other sets; but this is a refinement in the culture with which a cottager need not trouble himself.

There are a great many varieties of the potato; some are very early ready for use, such is the *frame;* others finely-flavoured and handsome in shape, as the *lady's-finger kidney.* These, however, from their scanty yield, are unfit for the provident cottager. The best for his purpose, as uniting quality with quantity, are the *champion* and the early *Shaw;* these are best for immediate use as soon as their tops decay: but for long-keeping and storing, the *Devonshire apple* and *Yorkshire reds* should certainly be preferred. Two-thirds of the whole piece should be planted with reds, and the other third with the Shaws and champions; and as soon as the tops of these last decay, they should all be taken up and the ground immediately replanted with cabbage, savoys, or any other winter greens.

When the tops have risen 5 or 6 inches high, they should be earthed up for good, for once earthing up is enough; but the vacant spaces between the rows should always be kept well broken up and loose, by a heavy hoe, fork, or mattock, taking care not to go too near the roots to disturb the runners. When the flowers appear, let them be picked off, for this adds as well to the size as to the number of the tubers.

In choosing the kind or kinds for planting, procure, if possible, those which have been named above, and which have been grown on a different kind of soil and in some distant place; for no kind of potato succeeds long together in the same garden or district.

Much has been said and written as to whether potatoes should be planted whole or cut into sets; but it is now settled that a bushel cut into sets yields a much greater return than if they were planted whole. The yield, however, depends greatly on the quantity of manure bestowed: if dressed as thickly as a farmer dungs for wheat or turnips, it may be dug in before planting; but if manure is scarce, the next best plan is strewing it along the bottom of open trenches, on which the sets are placed, and covered with loose earth.

Where there is no shed or outhouse for storing potatoes from the air and frost, pitting them in the garden is the most convenient way. A narrow pit about 10 inches deep should be made on a dry spot, in this a bed of dry fern or straw is first put, then the potatoes are laid in a ridge of the required length, and covered with a good coat of straw. Over this, earth dug from the sides and ends is piled over a foot thick, forming it like a ridge, and patted smooth with the spade to throw off rain; a trench being left open all round prevents all surface-flow from soaking in. Parsnips, carrots, &c. may be pitted in the same way.

When the garden is all cropped, as above directed, the next object demanding attention is thinning the rising crops, and keeping the whole free from weeds by the hoe and hand. About the 1st of May a row of rough runners—or *scarlet runners,* as

they are more commonly called—must be put in, next to the peas if any are sown, between the cabbage and parsnips, pulling up a row of the former to make room. The ground for the runners must be dug; and a drill or furrow opened by line, in which the beans are dropped, 2 inches apart, and covered about 1 inch. When the plants have risen 2 or 3 inches they must be earthed up as high as the lower leaves. If rods can be had for this crop 6 or 7 feet in length, so much the better; but long rods are not absolutely necessary; low branches, stuck regularly along the row, about 3 feet high, are quite sufficient, providing the leading shoots are kept stopped—that is, pinching the points off—this causing a branchy growth and great fruitfulness. But the runner is not nice as to station; they climb up the side of a hedge or paling, cover a porch or arbour, with very little assistance. There is one thing relative to the rough runner which behoves every grower to know; it is, that if the pods be not regularly gathered as they become fit for use, the plants cease to be fruitful; or if they get too dry at the root, the topmost flowers drop without setting pods. But a few of the first pods should always be allowed to ripen as seed for the next year. Attention to these particulars will render the plants fruitful for the whole season. A handful more may be planted about the middle of June, and will grow till they are killed by the frost. The dwarf sort of kidney-bean are not worth the cottager's notice, unless he grows them to sell for pickling.

The broad beans that were sown in January or February, among the cabbage, may now want topping, especially if the black fly has attacked them; this will at once encourage the pods to fill, and get rid of the insects.

The seed-bed of cabbage which was sown in March must be looked to: and as the pieces of radish and turnip which were sown at the same time will now be used, a barrowful or two of dung should be laid on and dug in, and immediately planted with cabbage-plants from the seed-bed.

The Silesia lettuce sown in March should be thinned by drawing part, to be stuck in round the edge of the onion-bed. The plants will be ready for the purpose about the 1st of May: those left in the bed should not be nearer than 12 inches from each other, it being a very large growing sort.

No directions are required by the cottager concerning cauliflower, broccoli, celery, &c., these not being either necessary or profitable to him. In April, however, he may sow a small bed of Scotch kail; which, if planted on the onion-ground, without digging, in July, will be very useful stuff, if the winter happen to be severe. Two or three rows of savoys may be dibbed in among or between other crops about the same time.

The crops above specified will come into use in the following order: viz., every intermediate row of the cabbage planted in October may be used for greens during the winter, and their places taken by broad beans and peas, according as the greens are cleared off. Next, every intermediate plant of the rows of cabbage intended to stand to head may be pulled as wanted, to serve till the prime cabbage come in during May and June. The Christmas-sowed radish (if any were sown) will be ready in April; and in May there will be also the thinnings of onions, carrots, turnips, and lettuce, to eke out a meal or give a relish to the rasher.

Cabbage will be plentiful in May; and soon afterwards a row or two of potatoes may be taken up; not that we would advise beginning on the potatoes so soon, but that the ground they occupy may be had to get in upon it another crop of cabbage, savoys, or any other sort of winter greens.

Another seed-bed of the sugar-loaf or Battersea cabbage should be sown in June, to supply coleworts (that is, open cabbage) during the autumn and winter; and if any piece of ground is empty at the same time, it may be sown with turnips for winter use. If a little leek-seed was sown among the onions, the plants may be drawn and planted in a drill by themselves in some vacant spot, 4 or 5 inches apart, to stand for good. But if the leek be preferred to onions as a pottage plant, a little bed should be sown in March, to furnish plants for putting out in rows about Midsummer.

It is lucky that about this time of the year, June and July, the labourer has not much to do in his garden, except gathering some of the crops, destroying weeds, and collecting everything which can be turned into manure for the service of the next season: but, in the last week of July, or in the first of August, he must not forget to sow a seed-bed of early York cabbage, to raise plants for putting out in October and the following months. If sown a week or two before the times stated, many run to flower without forming heads; and if sown later than the last-mentioned date, they do not come into use soon enough.

About the end of August, if the duties of harvest allow, a bit of ground must be got ready at the upper end of the potato ground—which crops are supposed to be taken out of the way for this purpose—three small beds, one for onions, another for spinach and lettuce, and the third for radishes. The onions should be sown pretty thick; and, unless the winter prove very severe, the crop will be very useful in the spring, either for present use or for transplanting into an open spot of ground to bulb in the summer. The spinach and lettuce, if they survive the winter, will be acceptable at a time when greens are scarce. Ra-

dishes sown in August, if the autumn is not too dry, are in fine perfection in October and November, and are then a kind of dainty.

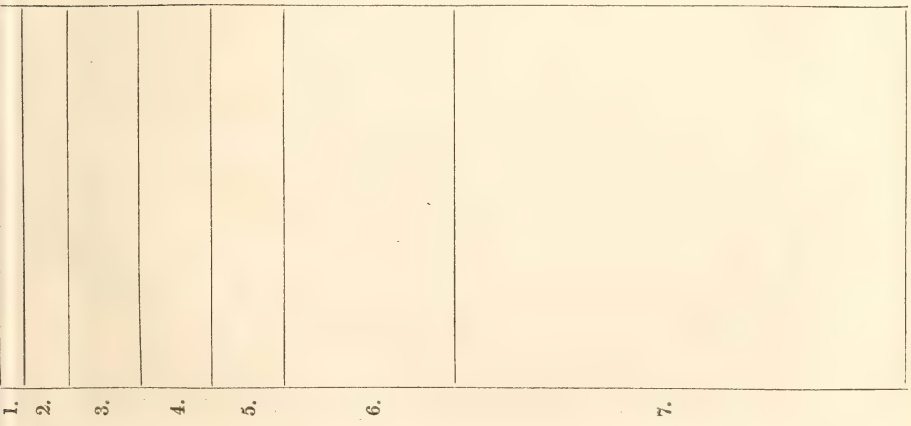
In August, too, the principal crop of onions must be pulled and laid together thinly to dry, previously to their being roped and stored. And when October arrives there will be both carrots and parsnips, as well as the potatoes, to be taken up and stored in safety, either in pits or otherwise: besides getting part of the same ground dunged and dug ready for cabbage to be planted, as directed in the autumn of last year.

Having sketched a plan for cropping twenty poles of ground with the most useful kinds of kitchen vegetables for a labourer or mechanic, we may now make a moderate estimate of the principal products, to show the benefits accruing to the tenant for his expenses, time, and labour.

We have supposed that the form of the garden is a long square, 38 yards in length and 16 yards wide. This area contains 608 square yards, being somewhat more than one-eighth of an acre, or 20 poles. The ground is divided into seven portions, and marked by yards lengthwise, in order to make the division easier for the tenant.

The following plan shows the divisions of the garden for the first year's cropping, which are arranged as follows:—

		Yds.	Sq. Yds.
No. 1.	One yard for pot-herbs and rhubarb, &c.	1	16
2.	Two yards for seed-beds and radish	2	32
3.	Three yards for onions, with a pinch of leek	3	48
4.	Three yards for carrots	3	48
5.	Three yards for parsnips	3	48
6.	Seven yards for cabbage	7	112
7.	Nineteen yards for potatoes	19	304
		38	608

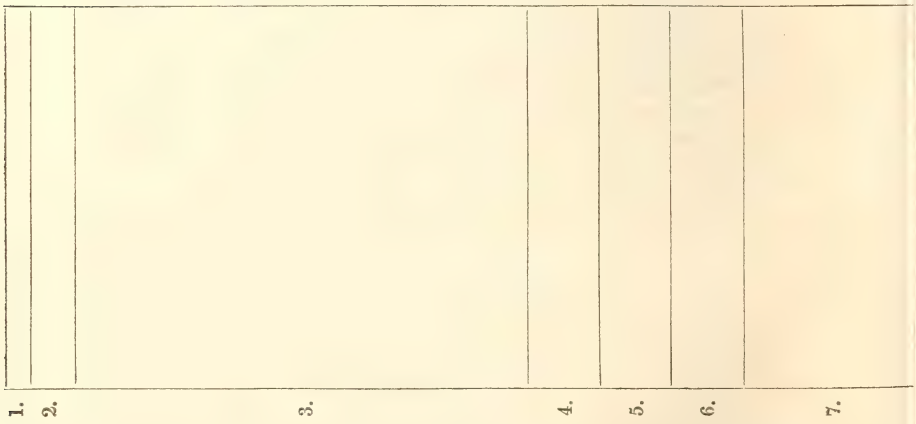


Supposing the above crops are sown or planted at the proper seasons, as directed—the soil being previously prepared by digging or trenching, and manured if possible—the crops may be expected to turn out as follows:—

Potatoes, 20 bushels, besides 2 or 3 rows taken up in summer.
Onions, 4 ditto, besides the thinnings for summer use.
Carrots, 3 ditto, besides the thinnings.
Parsnips, 4 ditto.
Cabbage, 250 full grown, besides twice as many used as greens.

The roots, together, make above 30 bushels of excellent vegetable food for winter use; allowing that the bushels, one with another, weigh 60 lbs., there will be an amount of 1800 lbs., or above 9 lbs. per day for the winter half-year. And, besides this winter store, there are cabbages in use, either as open greens or as full-headed, from January until June: saying nothing of radishes, lettuce, common beans, peas—all of which will be in use before the end of that period, and soon followed by early potatoes and the runner kidney-bean, one of the most profitable crops a cottager can raise.

The cropping for the next year will be arranged according as is represented on the diagram or sketch No. 2, and which will be the easiest change: and in the third year another change may be made by placing the potatoes in the middle, and the other crops at each end.



Reference.—1. Herb border—2. Seed-beds, &c.—3. Potatoes—4. Onions—5. Carrots—6. Parsnips—and 7. Cabbage and beans, same as preceding year.

The above plan of cropping 20 poles of ground will serve as a scale to the cottager who may have either more or less than the

quantity mentioned. For instance, if he has but 10 poles, then he has only to take half the measurements, and expect only half the amount of produce; and so of any other proportionate quantity.

It is to be observed that 20 poles of good ground, well cultivated, will yield a greater quantity of vegetables than can be economically used by a labourer, his wife, and three or four children. In which case the overplus must either be sold or employed in fattening a porker for Michaelmas and a baconer for Christmas. This, with such a garden, a labourer may safely attempt to do, provided he has the conveniences of a sty, an enclosed yard, hog-tubs, bins, &c.; and provided also he has a little ready money to buy his pigs, bran and pollard to mix with the boiled vegetables, and barley-meal to fatten off with. *A pig-sty and a garden assist each other greatly:* and, at the same time, a cock and two hens, of a good breed, may be kept for their eggs—a pleasant addition to the household fare.

There are many labourers happily placed in such circumstances, who are well to do; and it would be a public as well as a private good were *all* so circumstanced. But this is rather to be wished for and aimed at than expected. It is, however, a most obvious truth, and universally admitted, that every day-labourer, whether a cottager or only a lodger in a cottage, should have the privilege of renting a piece of garden-ground, to raise his own vegetables, and thereby improving his condition.

Such allotment should not be less than 10 poles of good soil; which he can cultivate without encroaching much on his employer's time, and with great advantage to himself and his family. The management and results would be in accordance with the proportions already given: or, in other terms, one-half of the whole for potatoes, two-sixths for cabbage, one-sixth for parsnips, one-sixth for carrots, one-sixth for onions, and one-sixth for sundries, as before mentioned. Of course, the crops might be expected to be only *one-half* of those already stated as arising from a garden twice the size.

A labourer, having even this portion of ground, may manage to fatten a pig of from six to eight or ten score; especially if he can buy a spayed sow which has had but one or two litters of pigs: such an animal fattens much faster than any other description of pig stock; and, with well-supplied hog-tubs, with kitchen washings, and boiled vegetables, thickened with brewer's grains, pollard, and barley-meal—the mass being allowed to ferment before using it—will be found excellent fattening food. The silly custom of throwing down raw potatoes, carrots, parsnips, and cabbage-leaves to the pig is great waste, half their nutritious qualities being thereby lost.

A cottager so situated, having bacon in his rack, and vegetables in store or in his garden, and to which he might add baking his own bread and brewing his own beer in a small way, would soon feel himself a happy, and show himself a contented, being—at once one of the most useful, valuable, and even most respectable, members of society. Advancing our resident rural population into such circumstances is an object of the first importance, and worthy of the attention of every patriot, and of every agricultural society.

It is neither the want of inclination nor ignorance of the ordinary processes of gardening among labourers in general that prevents them from improving their condition by raising their own vegetables; but it is the extreme difficulty of obtaining a piece of land for such a purpose. Farmers, who are tenants in almost every case, are debarred from subletting land; and this, co-operating with a natural dislike of giving up any of their best fields for allotments, shuts out the labourer from renting a small share; and hence arises much of their destitution. It is with the landowners, then, that this national improvement rests; and, for its furtherance, the least they can do is to relieve their tenants from the restriction alluded to, as relates to cottagers' allotments. There are many farmers, no doubt, who, from motives of interest only, in securing the services of able and trusty labourers, would otherwise grant them a spot of ground, to rivet and strengthen the connexion between them; a connexion, moreover, that would be mutually advantageous—to the master, in having in all seasons the best and instant assistance—and to the man, in enjoying a comfortable home, which he could pay for by his labour.

If such a feeling were more prevalent it would greatly advance the condition of farm servants, and consequently improve rural society. Many friends of the labouring poor have in some measure injured their cause by requiring or proposing for them larger allotments than can possibly be obtained: for, allowing allotments of an acre or more, as has been recommended, would involve them in all the difficulties of small farmers, as well as withdraw them from their natural stations as agricultural servants, and cause derangement in the establishments of their regular employers, for which there could be no agreeable remedy. But the rule, as already said, is to keep the labourer in his natural station, and by all means make that station comfortable by giving a piece of ground to rent on which he could employ his spare time, rendering that unoccupied time beneficial to himself and family which is often spent in listless idleness.

It is pleasing to see how much cottage gardening has been advanced in those places where societies exist who offer and award prizes for the best specimens of cottagers' productions; and it is

to be regretted that there are so few competitors, owing entirely to the want of gardens among that useful class of men.

To the foregoing directions and remarks may now be added a few general rules, of which no cultivator of a garden should be ignorant, as success depends on circumstances which are often unheeded or neglected:—

First. Never work the soil, either by spade or hoe, if heavy and drenched with rain, for if moved in that state it naturally settles down too closely together again, and remains in the worst condition for encouraging the spread of roots. Soil cannot be too dry for working; and moving it in dry weather causes it to attract moisture from the air.

Second. Always sow in time and upon freshly-stirred soil, and while it is loose and moderately moist. Some seeds, as the common bean and onion, affect a firm bed to strike root in, and consequently the first are best dibbed, and the last trodden into the soil.

Third. Always plant in newly-digged ground unless the surface be already occupied with a crop shortly to be cleared off, in which case strong plants of a succeeding crop may be profitably introduced.

Fourth. Destroy weeds before they come into flower; and when any kind of earth or rank herbage of grass or weeds is collected for the compost heap, see that the whole is well fermented, and turned once or twice to kill the seeds of weeds, or promote their germination before the compost is used in the garden.

Fifth. Never allow a single square yard to remain vacant during the growing season; and that this may never be, the cottager should always have seed-beds of lettuce, and particularly cabbage or some one or other of the cabbage tribe, to supply plants for both regular and irregular cropping.

Although the cottager may amuse himself by cultivating a greater variety of eatable vegetables than we have mentioned, he must not neglect the more useful kinds, for they require unceasing attention. He may, to be sure, grow cucumbers and pumpkins; the first are always an agreeable relish to the bacon in warm weather; and the second make an excellent family pie or pudding in autumn, mixed with wildings or crabs gathered from the hedges.

A labourer may grow cucumbers plentifully in the simplest way: about the beginning of May he digs a pit 3 feet square, on a border lying well to the sun, making it 1 foot deep, and laying the broken earth round the sides: this pit he fills with any rank growing weeds, nettles, flags, or long grass, from the sides of ditches; let these weeds be somewhat withered before they are shaken and trodden into the pit; the weeds are then covered with

about 10 inches of loose rich mould: when the heat rises to the surface (if the labourer can neither beg nor buy a pot of plants from a neighbour) he may drop a few seeds in the centre of his little bed: when the seedlings rise and have produced one rough leaf, they will require a little fresh and dry compost put round and among the stems, and the little bud at the bottom of the rough leaf pinched off. The pit is hooped over and covered every night with a mat or old sack to keep in the heat, which will continue till that of the season is sufficient. Pumpkins may be grown in the same way; but they require the richest soil that can be got to swell the fruit to a good size.

No directions have been given about growing cauliflower, broccoli, celery, endive, asparagus, artichokes, and several other kitchen-garden vegetables, because these should never encumber the garden of a cottager, being to him unprofitable plants; but in order that he may not be in ignorance concerning these things, they are all mentioned in the calendar at the end.

There are, however, a few more particulars which may be of use to the cottager in the management of his garden; and first, of saving seeds. The only seeds worth his while to save are those of onion, scarlet runners, radish, and coss lettuce: as to cabbage, savoy, carrot, parsnip, &c., there is such risk in saving them true, and they cost so little if bought, that the amount can be no object to the buyer. When attempted, however, the finest and truest specimens of the crop should be chosen to produce seed. A few plants of radish and lettuce may stand where they were sown; a score of the first pods may be left on the runners; and half-a-dozen of the best onions planted in a row on an open spot of the garden in the month of February will yield seed enough for the following season. Indeed, saving onion-seed should be a particular object with the cottager; as having a few ounces to sell will enable him not only to buy all his other seeds, but a load or two of dung besides.

Quantities of seeds required in a small garden, viz.:—

1 pint of peas is enough for a row of 20 yards in length.			
1 do. of beans	do.	27	do.
1 do. runners	do.	36	do.
1 do. dwarf kidney	do.	26	do.
1 do. marrowfat peas	do.	32	do.

1 oz. onion seed sows 15 square yards; ½ oz., 7 square yards; 1 oz. carrot, 15 square yards; 1 oz. parsnip, 15 square yards; ½ oz. of cabbage, savoy, borecole, broccoli, cauliflower, is enough for a seed-bed of 4 square yards; ½ oz. of turnip sows 11 square yards; of radish, 2 or 3 oz. for spring sowings, and 1½ oz. for autumn; a bed of asparagus, 5 feet by 30, requires 160 plants; an acre of potatoes requires from 15 to 20 bushels of sets.

The above particulars will serve as rules for apportioning other kinds of seeds, according to their size and the extent of the ground to be sown or planted.

We have not mentioned fruit trees: as there is not room in a cottage-garden for any thing of the kind, except, perhaps, a row of upright growing gooseberry-trees, to be planted across the lower end of the garden; these should not be too much thinned out in pruning, but be kept in a thick bush-like form, for the sake of having an abundance of fruit; all of which to be *used green* for puddings and pies in the season. Ripe gooseberries or any other fruit are of but little use in a labourer's family. A few red and white currant-trees may be mixed with the gooseberries if desirable.

A Calendar

Of Work to be done in every Month of the Year in a well-managed Kitchen-garden.

January.—*Sow* early frame and Charlton peas, early mazagan and long-pod beans, towards the end sow various sorts of coss and cabbage lettuce. In the first and fourth weeks sow short-topped radish. *Transplant* early York cabbage and lettuce, if the weather be open. Mould up the stems of broccoli, savoys, and others of the cabbage tribe; also peas and beans if above ground, and celery if necessary.

February.—*Sow* the same sorts of beans mentioned in the preceding month, and the first sowing of Windsor and other large sorts, in the last week; horn-carrot, short-topped and salmon radish, twice; small beds of early York, sugar-loaf, and red cabbage, near the end; spinach twice; mustard and cress, thrice. *Transplant* cabbage from the seed or nursery-beds for a summer crop, if not previously done.

March.—*Sow* succession crops of beans, viz., long-pod, Toker, Sandwich, and Windsor; Prussian, dwarf, and Knight's marrow peas, coss-lettuce, salmon and red and turnip-radish, small salad, spinach, asparagus, sweet herbs, and nasturtion; red beet, carrot, and parsnip, for principal crops; a small bed of early Dutch turnip; Spanish and other sorts of onions for main crops; sea-kail, either to stand or be transplanted. *Plant* horse-radish and Jerusalem artichokes, new plantations of asparagus and artichokes, near the end; also, cuttings of all the half-shrubby sweet and bitter herbs; also shallots and garlic, if not done in the autumn. *Transplant* cabbage and lettuce from the early sown seed-beds. *Mould up* peas, beans, cabbage, &c., and give asparagus-beds their spring dressing.

April.—*Sow* succession crops of peas and beans; of cabbage

the red, Battersea, and Barnes varieties; savoys, borecole, Brussels sprouts, beet, salsify, scorzonera, skirret, orange and Altringham carrots, lettuce, small salad, spinach, onions, leeks, celery, celeriac, broccoli of sorts, cauliflower about the 20th; turnips, radish, the turnip-rooted, and black and white Spanish. *Plant* potatoes for principal crop; also new beds of asparagus, artichokes, cuttings of the roots of sea-kail, rhubarb, and other plants which may be propagated by division of the roots. *Transplant* lettuce, cabbage, and all other seedlings requiring removal; hoe and thin spinach, turnips, and all drilled crops that stand too thick. *Mould up* peas, beans, and other rowed plants; and stick peas when 6 inches high, and top beans if the fly appears.

May.—*Sow* scarlet-runner, kidney beans, and dwarfs, on a warm border; also peas and beans to succeed former sowings; purple Cape broccoli and late purple and white ditto, cabbage to come in as coleworts, turnips and carrots to draw young; cucumbers for pickling, lettuce of sorts, and scorzonera, salsify, and skirret, if omitted last month. *Plant* late potatoes. *Transplant* cabbage, and prick out in nursery beds celery, cauliflower, broccoli, &c., and ridge out cucumbers, the plants being previously raised on heat. Hoe among all crops to destroy weeds and loosen the surface.

June.—*Sow* vegetable-marrow, gourds, and pumpkins; Prussian-blue and Knight's marrow peas may still be tried, and the pearl variety for the latest crop; sow again runner and dwarf kidney beans, turnips for autumn use, and endive of sorts for main crops; potatoes may still be planted; cabbage, broccoli, borecole of sorts, and savoys, may be rowed out for good; celery also may be put in trenches, and row out leeks into their final stations. Draw earth to drilled crops; stick peas and runner beans; destroy weeds; and gather flowers for drying.

July.—*Sow* broccoli for late crops, and dwarf kidney-beans endive twice, and small salad twice; lettuce on a north border; mazagan and white-blossomed beans for late crops; cabbage for winter coleworts; turnips for succession; and Spanish radish. *Transplant* cabbage, broccoli, cauliflower, savoys, and celery, into trenches; prick out celery seedlings, lettuce, and endive; attend to the ridged cucumbers and picklers, giving water if necessary, and securing the vines with hooks; pull onions, shallot, and garlic, if done growing; stick peas and runners. *Mould up* potatoes, cabbage, broccoli, cauliflower; gather herbs for drying, and hoe up weeds.

August.—In the first week *sow* early York, early dwarf, and sugar-loaf cabbage, onions, prickly-seeded spinach, radish, lettuce of sorts, and cauliflower, about the 22nd day. *Transplant* broccoli, cabbage, savoys, Brussels-sprouts, borecole, celery into

trenches, and endive a full crop. Earth up celery in trenches in dry weather, and all other drilled or rowed crops; tie up the forwardest plants of endive to blanch it, and destroy weeds.

SEPTEMBER.—*Sow* onions, lettuce, horn-carrot, to stand the winter; radish the last sowing; small salad twice. *Transplant* coleworts and last crops of broccoli; prick out cauliflowers; and plant celery into shallow trenches; also lettuce and endive under shelter; gather seeds as they ripen.

OCTOBER.—*Sow* lettuce on warm borders; also mazagan beans and Charlton peas to stand the winter. *Transplant* endive and lettuce into frames; cabbage, a full crop for spring supply. Dig up potatoes, carrots, parsnips, beet, scorzonera, salsify, skirret, and Hamburg parsley, for pitting, or storing in dry sand in a shed out of the reach of frost and moisture; earth up celery; blanch endive; hoe out winter spinach; and draw earth to the stems of all rowed crops; and lay down broccoli.

NOVEMBER.—*Sow* early peas, mazagan beans to succeed those sown last month; if they survive the winter they will come in very early in the spring. Cabbage may still be planted; finish earthing up all crops requiring such care. Secure all full-grown vegetables which may be injured by frost, such as lettuce, endive, and especially cauliflowers and broccoli, which should be pulled up and hung up by the heels in some airy outhouse. Dress asparagus, and give artichokes their winter protection.

DECEMBER.—The operations of this month are chiefly in preparing the ground for spring crops while the weather permits. If open and dry, other sowings of mazagan beans and Charlton peas may be made: and towards the end of the month the first crop of spring radishes may be sown on a south border, to be protected by a thick covering of litter on nights and in frosty days, till they are nearly ready for use in March.

N.B. As seeds cannot be sown nor plants removed always at the times set down in the calendar, it should be understood as a general direction, that such work should be done as soon afterwards as the season allows. The above calendar (which includes the business of every kitchen-garden) will supply the cottager with the time of sowing or planting any vegetable, not mentioned before, which he may be inclined to try.

XXX.—*On the Hopetoun Wheat, and on Comparative Trials of Wheat.* By Patrick Shirreff.

To Ph. Pusey, Esq.

Sir,—When calling upon a friend in the autumn of 1832 I was struck with an ear of wheat which had been culled from one of his fields on the farm of Drew, East Lothian, and resolved to propagate from its seeds. Before coming into my possession 3 corns appeared to have been lost from the apex, and with the point of a pin I pricked out 99 corns without ruffling the chaff; and the ear may still be seen in the Agricultural Museum at Stirling.

The produce from the ear proved a new variety, which has been named Hopetoun wheat, and which was sold for the first time in 1839. After numerous trials in East Lothian for two seasons, this variety is rising in public esteem, and has been successfully grown in many parts of Scotland as well as in Gloucestershire, Kent, and Buckinghamshire. Everywhere this variety has put forth ears of large size, supported on tall and strong straw, and yielded grain of fine quality; and in England it is represented to have been much less affected this season with red gum, blight, and mildew, than other varieties growing contiguous. Last year a comparative trial was made by Mr. George Bell on the farm of Inchmichael, Perthshire, with Chevalier and Hopetoun wheat, the crop of the latter being represented as too thickly planted. Both kinds yielded 36 bushels per acre; but the grain of Hopetoun wheat was best in quality, and weighed 2 lbs. per bushel heavier. Another comparative trial was instituted in East Lothian by Mr. Alexander Begbie, on the farm of Seggarsdean, with Hunter, Chidham, and Hopetoun wheat, the latter being thinnest in plant, and the yield was found to be 34, 30, and 37 bushels respectively. These trials appear to me to show the yield of Hopetoun wheat to have been increased in the one case and diminished in the other by the state of the plant, and tend to illustrate the difficulty of making trials from which sound deductions can be derived regarding the respective merits of varieties. There is, however, no way of estimating wheats but by comparative trials; and the importance of the subject will, I trust, excuse the following remarks:—

In making a comparative trial with varieties of wheat it is necessary to select a portion of land uniform in texture, subsoil, and exposure, and which for a series of years has been cropped, manured, and laboured in all respects alike. The previous crop should if possible have been potatoes, as after this preparation

insects scarcely ever injure the plant of wheat-crops.* The extent of ground occupied by each variety should not be less than one acre; and after a careful measurement the lines of separation ought to be well defined to guard against the intermingling of varieties in the operations of sowing and harvesting. I recommend the seed to be deposited by a drill across the ridges, with a vacancy of 2 or 3 feet intervening between the varieties, and the seeding of all the land to be executed on the same day.

Respecting the quantity of seed I can testify from experience and observation that, even with the same variety of wheat, any material difference in the state of the plant, all other circumstances being alike, influences the size of ear, length of straw, time of ripening, and the quantity and quality of produce, as well as the effects of red gum and mildew. To particularize some of these effects, it may be stated that a thin "plant," that is to say, a small number of the young plants of wheat standing upon a given space of ground, generally enlarges the ears and corns, retards the ripening, and aggravates the effects of red gum and mildew, while the straw is shortened both by a very thick and a very thin plant. In some seasons a moderately thin plant is found to be advantageous both to quantity and quality of grain, and in others highly injurious. It is therefore desirable in comparative trials to have all the varieties of the same thickness of "plant." This, however, cannot always be attained by sowing the same quantities of each kind of wheat, because the seed may vary in size, and perhaps 3 corns of the Bellevue Talavera will be found to occupy more space than 4 corns of Chidham wheat. Another source of error may lie in the different propensity of different wheats to tiller or send out side-shoots. I therefore recommend, first, that the trial-wheats be sown, not by equal measures, but by measures calculated to contain an equal number of seeds; and, secondly, that the seeds be sown so thickly as not to call forth the tillering property.

I have found portions of wheat-crops, consisting of the same variety and growing on the same field, under a parity of circumstances, except as to time of sowing, differ in quantity of grain produce from 20 to 50 per cent., the quality being nearly alike. These defalcations principally arose from the wheat-fly, a minute short-lived insect seldom noticed by farmers, that generally confines its attacks to ears escaping from the sheath, and they were the result of the ears of such portions having appeared at the very time when the fly was depositing its eggs. Wheats, however, sown at the same time, are found to come into ear at different

* Although it is not uncommon in Scotland to sow wheat after potatoes, in many parts of England potatoes are a very bad preparation for wheat, as exhausting the soil and in some way affecting the wheat.—C. E. Lefroy.

periods, and thus, in a comparative trial, when soil, time of sowing, and state of the plant are alike, it may so happen that some varieties may be injured by the fly and others escape. I therefore recommend that journals of comparative trials be kept embracing the appearance of the crops at all the different stages of growth, with the state of the weather, and other influential agency which may intervene. Without such a document it will not be possible to determine whether differences of produce can be ascribed to peculiarities inherent in varieties of wheat or to some natural contingency.

Many agriculturists are of opinion that wheats transmit the influences of soil and climate to succeeding crops, and in consequence advocate changes of seed. I am well aware of the corns of wheat possessing different powers of vitality, but I have never witnessed in the case of this grain the advantages which are said to arise from a change of seed. Leaving, however, this point undecided, I recommend the seeds of all varieties used in comparative trials to have been grown under a perfect parity of soil and climate, and, when this has not been the case, advise a repetition of the trial, and conclusions to be drawn from the results of the second year.

Comparative trials with different varieties of wheat may justly be considered experiments in the laboratory of nature. The farmer, like the chemist, ought to pay strict attention to all the disturbing causes in the workroom affecting his investigations, for without careful execution and accurate observation comparative trials will lead to error. Repeated trials by the same individual may not end in uniformity of result, but by experience an approximation to truth will be attained sufficient to guide practical agriculture.

Prestonkirk, 2*nd October*, 1841.

XXXI.—*Report of Results obtained in Thorough-Draining and Subsoil-Ploughing, in the years* 1840 *and* 1841. To the Honourable Robert Henry Clive, M.P.; from Richard White.

[Continued from Journal, Vol. I., Part iii., p. 252.]

Sir,—I beg leave to state to you a continuation of my report of the result of the thorough-draining and subsoil-ploughing in the last year, together with some remarks I shall have occasion to make upon general matters connected therewith, as well as the cultivation and management of the farm; and in doing so I think I cannot make it more clear than by continuing the former abstract,

remarking upon each number as I proceed, and adding to that abstract what has been done. This I hope will be explicit, and clearly understood.

I will now commence with what has been lately done, and add the same to the former abstract.

A. R. P.	£.	s.	d.
No. 5..4 0 0..3004 yards. The surface and subsoil of this piece vary much; it is the opposite end of No. 5 in former report: the field altogether is a little more than 12 acres; and the middle part is rocky sound soil: the end now drained is about 4 acres; part of it is stiff soil, and a part more free, with a mixture of rocky gravel. The drains are 18 feet and 24 feet apart; the stone is got on the ground, and the greatest part wheeled to the drains; the expense for cutting open, laying the drains, breaking the stone, and filling in, and wheeling the stone thereto, at 1½*d.* per yard . .	18	15	6
Five horses two days carrying stone to distant drains	1	10	0
Six horses subsoil-ploughing the above four days, at 21*s.*	4	4	0
	£24	9	6
Per acre .	£6	2	6

The above field was wheat 1839; and this part was drained in April, and subsoil-ploughed in May, and worked for turnips, upon which I shall remark in its proper course.

A. R. P.	£.	s.	d.
No. 8..9 1 14..7214 yards. The surface and substrata of this field vary; part is a clay loam, and part more porous and gravelly. The drains are 21 feet apart. For cutting open, breaking, and laying the stone, &c., at 1*d.* per yard .	30	1	2
Raising 360 yards of stone, at 8*d.* per yard .	12	0	0
Filling 360 loads, as above, at 1½*d.* . .	2	5	0
Six horses fourteen days carrying the same, at 18*s.*	12	12	0
Subsoil-ploughing the above 9 A. 1 R. 14 P., at 21*s.*	10	0	0
	£66	18	2
Per acre .	£7	3	3

A. R. P.

No. 9..8 2 0..6064 yards. The surface and subsoil in this field vary much; one part is a strong loam, and another part mixed with clay and stone; the remainder of the field a dry, sound, rocky gravel.

	£.	s.	d.
About two-thirds of it (8 A. 2 R. 0 P.) are drained at 18 feet apart. The crop of wheat upon the part now drained was very bad: there was little upon it, owing to the wet season, and the seed perished. For 1976 yards the stone was got in the ground, and wheeled to the drains at 1½*d.* per yard; but for 4088 yards was carted: the total expense for the whole, cutting open, laying drains, breaking stones, and filling in	29	7	8
Carting 205 loads of stone to drains, 4088 yards, in the same field, five horses six days, at 15*s.* .	4	10	0
Filling stones into cart, 205 loads, as above, 1½*d.* per load	1	5	7
Raising 205 loads of stone in the quarry, 6*d.* per load	5	2	6
Subsoil-ploughing the above 8½ acres, at 21*s.* .	8	18	6
Total .	£49	4	3
Per acre	£5	15	9

THE ABSTRACT.

	A.	R.	P.	Yards.	£.	s.	d.
No. 1 .	10	1	29	8436	69	6	9
2 .	11	2	5	7314	47	3	0
3 .	7	0	14	3866	27	17	9
4 .	14	1	30	7133	55	1	0
Pt. 5 .	5	0	0	3166	22	14	11
6 .	10	3	37	7459	66	11	4
7 .	7	1	0	6376	45	9	8
	66	2	35	Subsoil-ploughing at 21*s.* .	70	1	1
					£404	5	6
Pt. 5 .	4	0	0	3004	24	9	6
8 .	9	1	4	7214	66	18	0
9 .	8	2	0	6064	49	4	3
Ac.	89	2	9	60032	544	17	3
Average per acre .					£6	1	9

In commencing my report, I will state the facts which have transpired in the cropping and cultivation of each field, as they stand numbered in the foregoing abstract, and will be as little tedious as I can avoid in giving a detail of the result.

No. 1.—Barley 1839, of which in my last report I was at a loss to estimate the number of bushels per acre, owing to the wet season, and the broken-down, lodged state of the crop. I then supposed it to be about 26 bushels per acre, but it only

turned out 24 bushels per acre.* It is now sown with wheat: the presser was used; and the wheat is looking well. The land is quite flat, and no failure whatever in the draining has occurred.

No. 2.—Wheat 1840: a pretty level crop, with the exception of about two acres injured by the wire-worm. I estimate it altogether averaging 20 bushels per acre. The field is now ploughed for turnips; about 8 acres are ploughed a foot deep, and the remainder 9 inches. The subsoil turns up quite mellow, and it is now near four years since this field was drained and subsoil-ploughed: no part of the draining has failed. The wet percolates into the drains where it falls, and the land is perfectly dry and sound.

No. 3.—Barley 1839, very similar to No. 1; and the season was so wet and unfavourable that the produce was stacked together; and the average of No. 1 with this turned out to be 24 bushels per acre: the clover and rye-grass the same, 20 cwt. per acre. It is now sown with wheat, and the presser was used: the wheat is looking well, and the land quite flat, and perfectly sound, with every prospect of a fine crop.

No. 4.—Barley 1840, succeeding turnips; the crop good, which I estimate at about 35 bushels per acre. It is seeded with a mixture of clover and rye-grass, and there is a good stock on the ground. The barley was lodged in some parts, and rather injured the seeds. The ground is quite flat, clean, and perfectly satisfactory.

No. 5.—This field varies much in the surface, as well as the subsoil. I have before stated the whole was deep-ploughed after wheat (1839), worked for, and sown with, turnips, 1840, a good crop, with the exception of about three acres, which were much thinned by the slug: the whole is eaten on the land by sheep. The field is now in a good state, and likely to produce a good crop of barley.

No. 6.—The wheat upon this field, as I stated in my last report, turned out bad, from being so much lodged and sprouted; a great portion of it was given to the pigs and poultry. It was ploughed 9 inches deep, and prepared for turnips (swedes), which were sown from the 5th to the 12th June: about three-fourths of the field, bone manure was used to the extent of about 12 cwt. to an acre; and on another portion, the sweepings of Ludlow streets, about 15 tons to an acre; also a part with fold manure: the whole of the crop exceedingly good, with the exception of about an acre and a half, which was thinned a good deal by the wire-worm and rooks; however, the crop has been much admired.

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* Clover and rye-grass sown in the barley, a good crop, cut for fodder, about 20 cwt. per acre.

The whole of this crop is drawn and carried to feeding cattle: the land is perfectly clean and satisfactory.

No. 7.—This field was subsoil-ploughed after oats, and worked for turnips, 1840; is a clay loam, with a stiff subsoil; about three-fourths of the field sown with swedes, and the remainder with White Norfolk; all a very good crop; fold manure used: the draining and subsoil-ploughing very effectual.

No. 8.—This field is now subsoil-ploughed, and will be prepared for turnips, upon which I shall have occasion to say something in my next. The draining is effectual.

No. 9.—A part of this field is just drained, and ready for the subsoil-plough, intended for turnips. The part now drained was previously very wet, with very little wheat upon it.

Having gone through a detail of the different fields which have undergone the operation of thorough-draining and subsoil-ploughing, together with a statement of the produce, which I have given in the most correct manner I can, I beg now to offer some further remarks generally upon the different matters carried on, which I think may be more satisfactory to you, as you have taken an active part in the inspection of the proceedings.

First. I have to observe, that the produce of the different fields is below the average which might have been expected, more particularly after thorough-draining and subsoil-ploughing; but to account for this I have to state, that when you took the farm in hand at Lady-Day, 1836, it was in a most impoverished, foul state, and little could be effected the first year to increase the produce, therefore very little manure was made: lime has been applied liberally; and the manure now obtained from the farm is more than doubled; the land consists of a great variety of surface, and the substrata are of an inferior quality. I mention this because it must be considered that with the very light manuring of the arable land, and its quality, though thorough-drained and subsoil-ploughed, the crops could not be expected to increase rapidly: my reason for making this observation is, because I have pledged myself to give you a report of the crops and mode of management, and I am now looking for an increased produce from the fields that first underwent the operation, which I think is now just coming into action. In the field No. 2, which was subsoil-ploughed in 1837, three parts of it have now been ploughed one foot deep, bringing up a variety of soil; and the other part has been ploughed 9 inches deep: the whole field is intended for turnips; and I have little doubt of succeeding. I am more sanguine because No. 6 was ploughed 9 inches deep in February last year, and the soil turned up open and mellow; it was not ploughed again, only worked with twins, harrows, and roll; no land could be in finer order, and this clearly shows that the

working of the subsoil-plough ought not to be added to the expense per acre, as the saving of frequent ploughings is great, from the open state in which the land is left after the subsoil-plough: at the same time I do not think the deep ploughing should be done under three or four years; and I do expect that No. 2, now ploughed 1 foot and 9 inches deep, will not have occasion to be ploughed again before the turnips are sown: on the whole of the land done, the crops are progressively improving, and I still have to report, with much satisfaction, there is not the least failure.

FURTHER REPORT.

In addition to my report up to February last of the effects of thorough-draining and subsoil-ploughing, I now beg to avail myself of the opportunity offered to state to you the crops of this year, carried on from that time to the present period; and I shall commence with the different fields as they are numbered, beginning with No. 1, and go through the whole separately, with some further remarks.

No. 1. Wheat this year after clover; a fine even crop, and may be estimated at upwards of 20 bushels per acre; the whole lay in a slanting direction, but not to the ground; but yet I think it will not yield quite so well in consequence. This field is intended for turnips next year.

No. 2. Wheat 1840; the crop was estimated at 20 bushels per acre, but turned out only 19, the quality very good. It was deep-ploughed after the wheat-crop, as stated, and only ploughed a second time, but well worked with the turns and frequent harrowings and rolling; the land was made perfectly clean and fine, and now growing swede turnips. The crop upon the most inferior part of the land is much the best; on the best soil there is some failure, but upon the whole a fair crop of turnips.

No. 3. Wheat this year after clover; the crop very similar to No. 1, and the same number of bushels per acre estimated.

No. 4. Barley 1840, estimated at 35 bushels per acre, but turned out not quite 34 bushels; the clover this year exceedingly good, mown, and the after-crop very great, which has been eaten off by sheep and working horses. It is now ploughing up for wheat in fine order.

No. 5. Barley this year, a fine crop for this land; it may be estimated, upwards of 30 bushels per acre. The clover has come well.

No. 6. Barley this year, a good crop; it may be estimated at upwards of 30 bushels per acre, and the clover has come well.

The turnips were all drawn off, and there was no visible difference in the crop of barley between the different manures.

No. 7. Barley this year, and very good, estimated nearly the same as the other. The clover has come well.

No. 8. Subsoil-ploughed, worked well, and sown with swede turnips. Bone-manure used at the rate of very near a ton to an acre; the crop throughout very good, sown about 27 inches apart; the swedes are very good, healthy, and look rich, but will require open weather to swell more.

No. 9. This field was subsoil-ploughed in April, worked for and sown with Scotch yellow and common turnips. Three-parts of the field are very good, the other part failed, owing to the grub having taken them soon after they made their appearance above ground. Fold-yard manure and bones applied. Great change is made in this land by draining and subsoil-ploughing.

I shall now proceed to make some remarks on the different crops of this year and general state of the land.

The wheat and barley throughout were very good and quite clean, and I believe I may safely assert that the whole crop has been carried into the stack-yard free from thistles, docks, or any other weed. Since subsoil-ploughing the thistles and coltsfoot are nearly eradicated; and as a proof, I beg to state that the weeding of the whole crop of grain (near 50 acres) did not cost 10*s.*, and would not have been so much, but that the women were obliged to walk over the whole of the ground, and some ketlock was to be drawn from the barley. One most important thing I have to observe is this, that the whole of the grain-crops were cut and carried at least a week before those of the adjoining neighbours, which formerly was not the case, and I have no doubt this will be the future result.

The turnips upon the whole may be said to be good, and particularly so when the quality of land is taken into consideration, and I can safely say that they are perfectly clean.

The clover-ley now ploughing for wheat is in a fine clean state; it ploughs up well, free and open, and is likely to produce a good crop of wheat; indeed the soil appears quite changed.

The whole of the land that has been drained and subsoil-ploughed is now ploughed close to the hedges, all ditches are covered and filled up, and there are no furrows; the whole is a flat surface, and, notwithstanding the very wet season we have experienced, not the least portion of any crop has suffered, neither has any wet appeared on any part of the surface; the appearance of the whole is most satisfactory.

There are two fields now drained, the one ready for the subsoil-plough, having produced a crop of oats, and the other now fallow for a crop of wheat, and preparatory to the subsoil-plough

next year, leaving now only one field to be thorough-drained and subsoil-ploughed, and preparation is now making to carry the draining into effect this season, to sow with oats in the ensuing spring.

I have the honour to be, Sir,
Your faithful and most obedient humble servant,
RICHARD WHITE.

October 7, 1841.

To the Hon. Robert Henry Clive, M.P.,
Hewell.

XXXII.—*Practical Instructions for Improving and Economically Maintaining Turnpike and Parish Roads upon the Mile System.* By C. B. CHALLONER.

AT this time, when railroads are constructing in every part of the kingdom, and the reduction in the revenue of turnpike-roads is so great that assistance has in many instances been required from the parish highway-rate for the maintenance and repair of the *adjoining* turnpike-road, and as the principal part of highway-rates is drawn from the land, I am induced to consider the following observations, founded on the practical experience of the last ten years as to the most economical method of repairing and maintaining roads in general, to come fully under the head of information connected with agricultural interests.

The chief item of expense in the repair of roads will be found under the heads of cartage of materials and manual labour, and the reason is, that there is no check whatever under the present system as to the quantity or quality of either, for it is notorious how uncertain and unsatisfactory are the accounts rendered of the quantities of material carted on the roads for repair, and the number of days of manual labour performed. My principal object in the following pages therefore is, to point out the means whereby the full quantum of materials charged to the public, parishes, or trust, shall be put on the road in the most efficient and best manner, and that whatever portion of manual labour is required shall be judiciously appropriated, by which it will be found that an immense saving in the quantity of materials supposed to be necessary will invariably be the result; and secondly, to throw so many obstacles in the way of peculation by parties connected with furnishing, procuring, or carting materials, that the smallest attention on the part of a sub-committee (if a turnpike-road), or two or more intelligent and active rate-

payers, or a single magistrate if a parish road, could, with very little personal trouble or inconvenience, render imposition to any extent next to impossible; and if the system is carried out as it ought to be, the farmers would have the benefit of being able to send their corn to market upon good roads instead of bad ones; and where they at present use four horses for that purpose three would do, and one remain at home for other jobs, always wanting on a farm.

A few lines will explain generally the plan, of which the details will be found as we proceed. It is to put a certain portion or district of road under the sole care of one man, from which he is never removed so long as he conducts himself properly, and that the materials, instead of being carted and laid on the road at the time of repairing, should be contracted for so as to be brought and laid on the sides of the road and trimmed up in one uniform way ready to be measured up some months before they are wanted for use.

Before entering into the details of this system, which we call the "mile system," I may mention that upwards of five-and-twenty years ago I first endeavoured to introduce a system similar to the one now in use upon the Great Western road, near Virginia Water, and at that period it was so far partially adopted that a mile-house was erected upon what then was a wild part of Bagshot Heath, for the purpose of having a resident mile-man; but at that time the art of road-making was imperfectly understood in the South of England, and as the traffic increased the roads continued getting worse every year, until it was agreed by the trustees to call in the assistance of Sir James M'Adam, under whose direction the roads were certainly improved up to the year 1830, but were still very far from being so good as they now are under the improved system which was called into operation on my return from a long residence on the continent in 1830, when I obtained the consent of my brother-trustees to make an experiment of the present system over a portion of the road; and with the aid of a sub-committee we set to work in earnest to establish the present mile system, and it was found to work so well that the two trusts from the Powder-Mill Bridge on Hounslow Heath to the Golden Farmer Hill, west of the town of Bagshot, were put upon the same footing; and I am here in honour bound to remark that Sir James M'Adam, as general surveyor, though not absolutely opposed to the system in the beginning, did not anticipate that it would work as well as it has done; he has, however, been ever ready to give me any assistance that from his experience and scientific acquirement he is so well able to do; and upon better acquaintance with the details, he has so far approved of them that he has established the same

system upon some other trusts where he has had power to do so; and I now think that I have his unqualified approval of it where it has been properly carried out: but it must be borne in mind that some sub-surveyors will be opposed to it on account of its tendency to check abuses.

Perhaps the most ready way of communicating information will be to state what we have done upon the trusts now under the mile system. Beginning with the choice and duties of the mile-man, who himself must be the very reverse of the incompetent decrepit old persons who, unfit for every other labour, were always appointed to take care of the roads, he must be an active, intelligent, steady man, who will take pride in his portion of road to which he is appointed; his wages should be such as to make it worth his while, and he should have common sense enough to see that the more attention he pays to his road the less labour he will have to keep it in order in future. The distance or portion of the road which each man will have under his charge must entirely depend upon local circumstances; the materials of which it is composed, the traffic, whether it is on a level surface or hilly, and whether through towns or villages—all which circumstances make a difference as to the portion of road which each man can take charge of. During the time of the great traffic on the High Western road, no man had more than 1 mile allotted to him, and some less than $\frac{3}{4}$, but I generally observed that 1 mile in a favourable situation was easier kept in repair than $\frac{3}{4}$ or even $\frac{1}{2}$ a mile in a less favourable one; but since the railroads have been established, and we have lost two-thirds of our traffic and two-thirds of our revenue also, we have allotted about $1\frac{1}{3}$ mile to each man; and should it be necessary, from the decrease of our funds, the men seem confident they can look after even a greater portion, in consequence of the road having by constant attention attained one even and uniform surface. It is necessary that the mile-man should be at all times at work on his road, summer and winter, wet or dry; he should at least once in the day pass over every part of his mile or portion, to level or rake in any uneven surface; and during rain his presence is more absolutely necessary than at any other time, as it is then that he ascertains any unevenness in the surface, and where the water requires letting off; and thus three hours' work during hard rain assists in forming the true level of his road more than a week's work in dry weather; it is then that the intelligent mile-man is seen with a little fine gravel in his wheelbarrow, filling up little hollows, to dislodge the water and to obtain the perfect form, and it is by these means that a true and regular surface is produced and maintained at a considerable *saving of materials.* Every mile-man has the number of his mile on a plate about 6 inches long and 4 inches wide, fastened round his

hat; he has a barrow, shovel, pickaxe, spade, rake, scraper, stone-hammer, and garden-line—all numbered according to his mile; and, to enable the men to take advantage of wet weather, they have a cape, similar to a policeman's cape, given to them, made rather longer behind, to prevent the water running on their backs while stooping to work in wet weather. It has been repeatedly asked whether the mile-men might not be allowed to go from the road during the summer months, when it is alleged by some that there is not enough for the mile-man to do: but experience tells us that it is upon his constant, every-day attendance upon his portion of road, be that great or small, at all parts of the year, that the economical maintenance of the road depends, as it is necessary for the mile-man to become acquainted with the peculiarities of every part of his road, varying according to the substratum—some parts breaking up in dry weather, other parts particularly after frost—some parts requiring the gravel when laid on to be put on thick at one time, others will only bear a slight coating, a little at a time, and, perhaps, two or three times in the course of a season: it requires quite as much observation on the part of the mile-man to ascertain the necessary treatment of every part of his road as it does for a groom to ascertain the constitution of his horse; and all hills require nearly double the attention that level ground does, particularly where the materials for repair are of a soft nature; the near side of every hill is torn up by the horses in stage-coaches and waggons holding back in descending the hill, and, either in very wet or very dry weather, destroying the even surface or gradual descent to the water-table, by which the road would soon lose its proper form if the mile-man's attention was not constantly called to it. Thus it is that, by a regular and well-organised system of manual labour, we have been enabled, with the worst possible material, to establish a uniform and even surface of road with less material: and to show how much depends on that attention, it has repeatedly happened that, where a mile-man has been the least attentive or intelligent, we have been obliged to lay on a considerable quantity of extra gravel beyond the apportioned quantity; when the very contrary has been the case with a good man, who in most instances saves or reserves for the following season a portion of his depôts of gravel, and in many instances accumulates enough, by saving, to lay on a thick coat to some low or bad part of his road; thereby effecting a permanent and lasting improvement to the road, without additional expense to the trust.

I think I have shown the necessity of having active and intelligent men for the service of the road; and, to secure such men, their situation should be made rather better than that of a common labourer; and, as they have no opportunity of making any

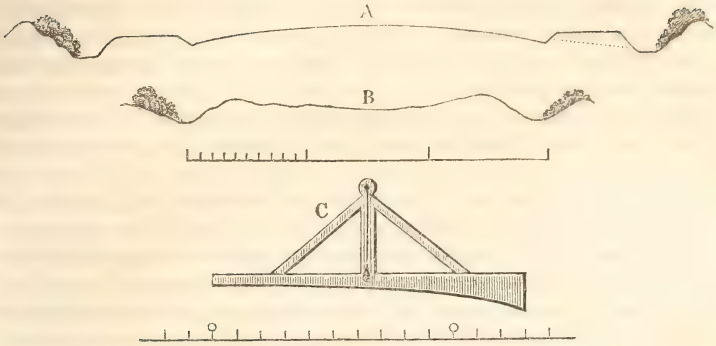
harvest-money, it should be made up to them by presenting them with a pair of strong, serviceable half-boots every year, to be given to them in the beginning of winter; and, about Lady-day, there should be some gratuities distributed among them, in proportion to their merit and conduct during the preceding year, and which we have found to be of the greatest value and encouragement to the men, when awarded in the manner following, as to the points of merit, which may consist of—

General good form and state of road;
Punctuality to hours of work;
Obedience and observance of instructions;
Consumption or saving of gravel, and extra assistance.

The attention of the sub-surveyor and sub-committee of management is called to point out those men who have merited rewards under those several heads, as it will sometimes happen that a man of superior skill will have his road in very good order, and yet be inattentive to his hours of work. It would be hard not to reward him for his good road, and yet he is setting a bad example to another man, who does not possess the same skill while at work, but would also wish to follow the example of the skilful man, and pass as much time in the public-house, and less on the road. To meet this difficulty in adjudging the rewards, we will suppose two marks or crosses in favour of each separate head of merit to be the maximum: one man may get two crosses in his favour upon the first head, one on the second, two on the third, and none on the fourth; being five crosses in his favour, and entitling him, say, to 25*s.*, or whatever less sum each cross of merit may be fixed at. When these are determined on, the men are called together, and their different points of merit read over to them, and also where they have been found wanting. The practical advantages of these rewards have gradually but steadily shown themselves in the punctuality and activity of the men; and, above all, in the saving of materials, which has amounted to more than twenty times the amount of the rewards or gratuities given in the year. All this may appear complex, but the slightest attention of a sub-committee of management, to report to the trustees at their quarterly meetings, will very soon render the whole perfectly simple.

In treating this part of my subject, it is not my intention to trespass in the smallest degree upon the scientific publications of those who have made road-making their professional study, and who have pointed out with mathematical precision the different forms which each writer has considered best adapted under different circumstances, and in different situations; but as an improved form of road, and consequent improved surface-drainage, is so intimately connected with the *mile system,* I must hope for

the patience of my readers if I dwell some little time on this most important matter, the "form of the road;" for, without it, time, labour, and materials are thrown away, or, to say the least of it, uselessly and lavishly expended. A slightly convex form, which can be most accurately described as being a *small segment of a large circle,* by which you get a clear and open drainage, is that which is the nearest to perfection, which every one appears to know, but which is seldom or never perfect in any road repaired in the usual manner, and left to the mercy of carters and labourers to shoot down the repairing materials where they please, without considering for one moment whether the road is or is not in proper form or state to receive the materials then laying on. Nine roads out of ten, repaired in the usual manner, have hollow places in the middle, and from whence the water can never get off; others will be found to have too high ridges or shoulders just at the edge of the water-table; and oftentimes the water-table cut down so low and so precipitous from these ridges or shoulders, that a heavy-laden coach or waggon, in dark nights or foggy weather, would inevitably be upset by going into these ill-formed and dangerous water-tables. The first thing that should be done is to lower these two ridges or shoulders, and where the water-table is too deep the earth or gravel removed from these ridges or shoulders should be thrown into the water-table until the road assumes the form above mentioned. This operation will always be met with great opposition by old-fashioned surveyors and men who have worked many years on the roads, as they say "the shoulders keep up the road." However, until these unseemly ridges are removed, no road can be got into proper form to receive fresh materials; and, where it is practicable, every road should have an edge or verge on each side, one of which may be the foot-path, and the other side where the depôts of gravel are to be placed, and it is the mile-man's business to keep these edges well defined and neat, forming the boundaries of the water-table, which should be about 7 inches, but never exceeding 12 inches, lower than the centre of the road, upon a road 25 or 30 feet wide, with one regular easy fall for the water to run without any impediment. I met with difficulty at first to make the men understand the form, having to work against the before-mentioned prejudice of the "shoulders keeping up the road." I at last had a level made 7 inches or 1 foot deeper at one end than the other, describing the proper form for one half of the road, the deep or broad end of the level placed in the water-table and the narrow end in the centre of the road; and until the bob-line hung true the road was not in proper form for receiving the fresh materials to be put on, as shall be hereafter described. It would far exceed the limits of



A. Perfect form of road 28 feet wide.
B. Usual form of road when shoulders are allowed to remain.
C. Road-level 13 feet long.

this paper if I were to attempt to detail the various prejudices I had to overcome under the head of "form of road." Whilst we were forming one of the first miles with the level according to the above rule, a person came up and introduced himself to me by saying he was a road-surveyor of forty years' experience, and he wondered to see us taking such unnecessary trouble in forming the road before laying on the gravel, as the desired form could be obtained in so doing; and it was not until I made an experiment with gravel in his presence, by which I proved to him that, acting on his principle, the gravel would in some places be 6 inches thick, and in adjoining spots not one inch thick, consequently could never wear down and bind well together, and form an equal and elastic body which it is so desirable to obtain, that he had the honesty to admit he had been acting for forty years upon a wrong principle.

There is a tendency on every road, particularly where the materials are not of the best description, for them to be pushed down towards the water-table, eventually forming the before-mentioned shoulders or humps, and more especially so if the gravel be injudiciously laid on, so as to force the carriage to form two lines, one of each side the centre of the road, instead of the traffic being equalised over the whole surface. To correct this, great care should be taken by the mile-men to rub and rake upwards from the water-table towards the centre of the road, by standing in the middle of the road, and drawing the loose material upwards. There should be one or two of these levels upon every trust or district of road, so that the sub-surveyor should occasionally, by trying the level, point out to the men the spots where the form has become imperfect, and those spots should be corrected during the spring and summer, when the mile-men are not so busy. With

proper attention to this point, I am quite sure a mile of road may be kept in better condition without fresh materials than it would be with 60*l.* worth of materials put on in the usual careless manner upon each mile.

The next points for consideration are the manner of procuring the materials, and the time and method pursued in laying them on the road.

By the latter end of the month of February it is generally determined by the committee of management with the assistance of the sub-surveyor the quantity of gravel that each separate mile-man's portion of road will require for the following year, and advertisements are issued accordingly for such quantities to be delivered in depôts on the sides of the road at equal distances, each depôt containing, when properly trimmed up, according to given form in the contract, so many square yards or loads of gravel, to be delivered ready broken and sifted, and free from dirt or hogging,* the whole to be delivered prior to the 1st of August, except only on such narrow part of the road, or through towns or villages, where the heaps cannot lie without inconvenience to the public; in which case so many hundred yards remain by side of pit, or other convenient place, to be carted on the road at such times as the sub-surveyor may call upon the contractor to do. Thus it will be perceived that, the whole quantum of material being brought to the sides of the road some months previous to being required for use, and every depôt containing the same quantity, trimmed up in the same form, a very trifling variation in the size of any one of the depôts is immediately perceivable; and then it is that the full quantum of gravel charged to the trust is brought upon the road. Having now every mile-man's portion of road furnished with depôts full of gravel, we will proceed to state how that gravel is to be laid on. The depôts on the Western road are placed about 36 yards one from the other, and are from 14 to 18 yards long; and during the time when the traffic was very great each depôt was supposed to contain sufficient to coat the road entirely across from water-table to water-table about 1½ inch thick, to the amount of 18 yards in each depôt, which was laid on the road by barrows.

According to the different soils and materials for repair, different seasons may be chosen for laying on the general annual coating. On the Western road the first rains after the middle of October is the most favourable time to commence; but in no case should it be deferred after the second week in November, otherwise the frost may come before the material is sufficiently worked down, and the road will show it during the whole of the

* Local term for the siftings or fine part of gravel.

following summer. We will suppose, then, that we begin the last Monday in October, when each mile-man has an assistant labourer appointed to him for the purpose of helping him to lay on the gravel, which simultaneously commences upon every mile-man's portion of road on the same day, each man beginning with his first depôt, and coating the road from water-table to water-table the 25 yards on each side of his depôt; when that is done, he misses two depôts, and in like manner spreads his fourth —and so on, missing two and spreading one, until he gets to the end of the mile, taking great care to properly rake down every day his fresh gravel that he has previously spread until it is thoroughly worked in, otherwise the road will lose its proper form, as before described; and when the first depôt is thoroughly worked down (and not until then), the men commence with their second, fifth, and eighth depôts in the same way, to the end of the mile again, and with the same precaution; when that is worked down, they begin on the third, sixth, and ninth, until they have finished coating the whole road, without inconvenience, or, at least, with as little as possible, to the traveller, because, wherever there are 50 yards of fresh gravel laid on, there will be 100 yards free from loose gravel, so that the coaches, waggons, &c., go straight on without caring for the short interval of fresh gravel, and thus it is equally worn down, and by the constant attention of the mile-man raking and rubbing over with an old scraper the portions he has laid on the previous days, a fine even and perfect surface of road will be obtained. A month or six weeks has always completed the operation of the general coating of the road in the very best manner, and there is no longer any occasion for the assistant to the mile-man.

There is an old prejudice in favour of putting the fresh gravel only along the centre of the road, and leaving the sides with little or none—by which means all the traffic is thrown to the two sides of the road, and which at all times creates a most objectionable form of road, which causes great trouble and expense to correct; whereas, by coating equally all over, the road is worn equally, and no one part has to bear an undue proportion of traffic.

Being unwilling to extend these remarks to a length that may be inconvenient, at the same time being desirous to enter so fully into the details of the system, that, should any trustees be desirous of adopting the plan, they may do so from what I hope is clearly explained; and perhaps in the anxiety to do that, I may here expose myself to the observation by some of having gone too much into detail, or by others it may be said "that there is nothing new in it," every part of it "was known before." I will admit for a moment it was known before, but in reply I would ask, if it was known, was it ever practised? I have been told a hundred times

that the M'Adam roads are not new, that roads were so made 150 years ago; in like manner I would ask, Could you travel by a coach 140 miles in 12 hours before M'Adam, Telford, and others so *systemised* the art of road-making, that wherever there was good material to be procured there was sure to be a good road? Allowing, therefore, that the component parts of the mile-system are not new in themselves, I must beg to lay claim to the successful arrangement and organization of it; and I feel convinced, in the midst of the difficulties in which turnpike-roads are now placed, provided there was an all-powerful central board established in London, who would enforce strict attention to the details as here laid down, that the expenses may be so easily apportioned to the traffic and revenue of every road, that (separate from any accumulation of debt that there may be) every turnpike-road could be repaired and maintained upon this system by its own revenue.

I also propose a modification of it for all parish-roads, by having the gravel delivered into depôts by the side of the road some months before it is wanted, in such places as are likely most to require it, and in such proportion as the funds of the highway-rate will allow of. One intelligent, active labourer, apportioned to a certain district, to be occupied at all times on that district, keeping the water-courses clear, ruts filled in, throwing into a hollow place two or three wheelbarrows full of stones, which, when done in time, would save as many carts-load of gravel when allowed to become saturated with water for a length of time without repair. By these means the roads would gradually become of a proper form and uniform width, with the sides and edges nicely marked out and defined, and which might be done in most situations and soils by means of a strong plough, throwing out a furrow or two as it may require on each side of the road as a water-table, and which was practised by the surveyor of a large neighbouring parish at my suggestion, a year or two ago, with complete success, and at a very trifling cost, some miles of road being done in a day.* But so long as the surveyors of parish-roads permit the neighbouring farmers to pare away the edges or verge of the roads, to take to their compost heaps, the width of road never can be properly defined, the traffic and wear of the road must always be unequal, to say nothing of the danger

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* The cost of clearing out the water-tables of the roads of a large parish was as follows:—

	£.	s.	d.
Cutting out the sides of a road with a plough, one mile, both sides	0	3	4
Shovelling out by contract	1	6	8
Total per mile . .	£1	10	0

in a dark or foggy night of no check or impediment whatever between the *centre* of the road and the bottom of the adjoining ditch. The district man would be answerable that the sides of the road were not destroyed, but that, at the same time, a free and open passage was left for the water to get off; and, in fact, all the advantages that the mile system possesses for a turnpike-road may be most readily adapted to parish-roads; and in no point would it be more advantageous than in laying on the gravel in such places only where the road was in a fit and proper form to receive it, instead of the careless and improvident manner in which fresh gravel (whenever it is put on a parish-road) is thrown down by some farmer's team employed to carry out so many loads of gravel, and of course the carter throws it down in the place most convenient to himself, without the least reference to the wants of the road. Thus it happens that in nine parishes out of ten complaint is made that the roads are bad, and the highway-rate oppressive to the farmer. So long as the present system is continued of employing nothing but a few old men three-parts worn out, or perhaps a drunken old butler or gardener (that the squire of the parish can no longer permit to remain in his service), as the only labourers on parish-roads, so long the highways in general must cost large sums, and still remain in bad repair.

It may be interesting to some of my readers that I should mention having made extensive green rides in a very economical manner by means of the plough, taking three or four half-bouts on each side of the intended ride, beginning very shallow, and going gradually deeper towards the edge or water-table, throwing the furrow always inward; after which the furrow-slice is thrown into a one-horse cart with a fork, being previously cut across into convenient sizes by a sharp spade, and carried to the manure-heap, the value of which pays the expense of ploughing and removing; and, without further trouble, (when all the furrow-slices are removed,) you will find a very well-formed ride. A few grass-seeds thrown in in the spring completes at very little cost what, were it done in the more ordinary way, by labourers, would be found extremely expensive.

XXXIII.—*Observations on the Natural History and Economy of the Turnip Saw-Fly, and its Black Caterpillar, called the Black Palmer, Black Canker, Black Jack, Black Slug, and Nigger, or Negro.* By John Curtis, F.L.S., Corresponding Member of the Imperial and Royal Georgofili Society of Florence, &c.

Paper II.

In studying the economy of insects, the striking irregularity in their appearance is not one of the least curious and remarkable facts that presents itself. We know from observation that what has up to a certain period been an unnoticed or unknown species of insect suddenly becomes abundant, and then disappears as unexpectedly.* This will render it necessary to give the history and details of all such as have at any period proved injurious to the crops of Great Britain. It is deeply to be regretted that so little notice has been taken of these events in standard works; even the few data which we obtain from such sources are so vague, that it is frequently impossible to identify the insects alluded to;† and yet such data are probably as essential to the understanding of the eccentric succession of these phenomena, as astronomical observations are to explain the beautiful revolutions of the planetary system.

The unaccountable presence of the turnip saw-fly, and especially of its black caterpillar, producing marvellous conjectures in the country, first led me to entertain a hope that the knowledge and services of men of science might do much towards smoothing the way to a correct knowledge of the natural history of insects injurious to the farmer. It is to be hoped that the veil of superstition has long since departed with our ancestors; but it is still necessary to dissipate the clouds of error which obscure the beauty of truth: this is the pleasing province of the naturalist, especially of the entomologist; and the natural history of the black caterpillar being perfectly understood, its progress can be traced from the egg to the fly so circumstantially, that the most sceptical need no longer remain in doubt respecting its economy. It may be admitted that the sudden and unexpected appearance of

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* Innumerable instances might be adduced, but one will be sufficient—*Allantus flavipes*, an insect of the same natural family as the subject of this memoir, which did not exist, I believe, in a single English cabinet previous to 1838, when all at once it became abundant in Battersea-fields, and the following year at Hampstead, feeding upon the common and white mustards, and it is now quite lost sight of again.—Curtis's Brit. Ent., pl. and fol. 764.

† In various accounts of the wireworm, totally different animals have been confounded under that appellation.

such multitudes of *caterpillars* might lead to the idea that they had fallen from the clouds; but when it is well ascertained that every caterpillar must have been produced from a minute egg, which egg must have been laid by a parent fly, it is not possible to reconcile such an idea with their habits and economy;* especially when we recollect that in most instances the caterpillars were at least half grown when discovered, which proved they had been living on something more substantial than air. When we take, however, a philosophic and more rational view of the subject we shall see that it is quite possible that the parent *flies* may have been transported to our shores by winds setting in from Norway, Holland, or France, and, after attacking the turnip-crops on our coast, spread themselves over the country, if not in the same year, in the following season; and as *one* female would lay several hundreds of eggs, the rapid increase from myriads would be incalculable.

Fortunately for the farmer the visits of this angel of darkness "are few and far between," otherwise the cultivation of this invaluable crop would become so uncertain as almost to compel him to abandon its culture. We have seen by a former paper † that the attacks of the turnip-fly are sufficiently vexatious; but the effects of the black caterpillar are infinitely worse, because the crop is destroyed after all the labour and expense attending its cultivation have been bestowed upon it, and generally at a period so advanced that it is in vain to attempt to repair the loss by diligence or industry. The only remedy is importation; and it is stated that, when they last appeared, many ship-loads of turnips were transmitted from the continent to supply the deficiency along our coasts.

As it will be curious and interesting to take a retrospective view of the records of various writers regarding this insect, and useful in future investigations to watch the periods of its appearance, I shall now proceed chronologically with its history. In 1782, Mr. Marshall, whose observations are recorded with great accuracy, and with a truly philosophic spirit, stated that in July of that year the turnips at South Reps, in Norfolk, situated about three miles from the sea, which looked remarkably well after a moist spring and fine weather, were observed to be covered with the saw-flies in such numbers that they were like flights of bees; and it was found that they had already traversed the coast, as the under-sides of the leaves swarmed with young caterpillars, so

* It seems to be well attested that *aquatic* animals, as fish and frogs, have fallen from the clouds with rain; but such occurrences are very rare and extremely *partial;* and that the negro caterpillar should *always* fall in turnip-fields would be very extraordinary.

† Journ. of Royal Agr. Soc., vol. ii. p. 193.

that in ten days or a fortnight the turnip-plants along the shore were entirely stripped of their leaves. Several days previously the flies had been noticed at Cromer, and Mr. Howse of Overstrand (who lived near the beach, and who was a man of good credit) declared, as well as the fishermen at Beckhithe, that they saw them arrive "in clouds so as to darken the air;" that, fatigued with their flight, they lay upon the cliffs two inches deep, and might have been "taken up by shovelsful." * From these circumstances Mr. Marshall considers the flies had come over from the continent; and fairly calculates that they might be transported from the southern cape of Norway to the coast of Norfolk in ten hours; and as they can live five or six days without food, they could cross from the most eastern confines of Russia, probably, before they were exhausted. Mr. Marshall subsequently remarked that the flies were very wild the third week in August, which he attributed to their being bred in the field; for those which he had captured three weeks before were not so alert; and this tends to prove, if it were necessary, that they had visited our shores from foreign countries.

If the insects take advantage of a gentle breeze lying off the shore in fine warm weather, they would have everything in their favour to depart; but as it often happens that a certain condition of atmosphere produces the same effects on the opposite coast, the flies would have the wind opposed to them on their arrival, which would account for their falling into the sea, and alighting in such multitudes on the cliffs; but this I am induced to believe is agreeable to their instinct, as flying against the wind when on land leads them to the plants they are in search of.† Mr. Milburn, however, viewing its flights in the turnip-field, says,‡ "it never flies far; and thus the theory which would have them come from Norway is exploded, especially in the absence of all evidence of their existence there." § Now, we know that the flight of locusts is generally very limited, and rather by leaping, at the same time expanding their wings to support them; but when impelled by instinct, they can fly to a very great distance; and who would think that the little quail, avoiding to rise on the wing by every art, had crossed the channel before it could arrive at our shores? It has long been my opinion that the appearance of rare insects in this country is owing to their being brought over, guided by

* Vide Mr. Marshall's paper in the Philosophical Trans. for 1783, vol. lxxiii., and an abstract from his "Rural Economy of Norfolk," with a very excellent preface by T. S. N. Published by J. Fletcher, Norwich, 1836.

† Vide Journ. of Royal Agric. Soc., vol. ii. p. 201.

‡ Journ. of Yorksh. Agric. Soc., p. 50.

§ *Athalia spinarum* is found abundantly in France and Germany: it is common in the southern portions of Sweden; is an inhabitant of Holstein; and is met with everywhere in Lapland.

instinct and favourable circumstances. Indeed in some instances there cannot be a doubt of it;* and probably the stocks of our innumerable common species are occasionally augmented by the arrival of their cousins-german. The sudden disappearance of certain insects is only a proof that our climate is not suited to their habits and constitution for any long period. But to return.

Like the *Cicada septendecim* of America, the appearance of the turnip saw-fly has been supposed to occur about every seventeenth year; but this is not correct, for their visits have been so irregular that nothing can be determined from the data before us. The earliest record of their appearance was in 1756. Then we have notices of their being observed in 1760, and perhaps two years after, and again in 1782, 1806, 1818, 1833, 1835, 1836, 1837, and 1838, leaving intervals of three, twenty-one, twenty-three, eleven, fourteen, and one year. Probably they escaped notice in 1834; and, if such were the case, they were ravaging our turnip-crops for five or six successive years; and it is far from improbable that the fly may be found every year in small quantities, and that the recorded dates are merely the periods when their ravages called the attention of the country to the subject.

I believe its effects were severely felt in 1760, and in 1782 many thousands of acres of turnips were entirely destroyed in Norfolk, and Mr. Marshall thought it probable that two-thirds of the turnip-grounds had to be ploughed up and re-sown; and, from the farmers not being thoroughly acquainted with the economy of the insects, they allowed those plants to remain in the fields which had escaped by being under the hedges and trees, by which means the second crop was not unfrequently lost, as the turnips left, supported the caterpillars until the fresh crop came up.

I do not find any account of the extent of the mischief in 1806, but in 1818, which was a very dry summer, they were in great numbers.

In 1833, Mr. Newport says, the fly appeared in very large flights on the turnips at Meon Stoke, Hants, and nearly throughout that part of the country;† possibly they received some check

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* Numbers of a large and beautiful moth, called *Daphnis Nerii*, figured in Curtis's Brit. Ent., pl. 626, were several years migrating from Africa to the north of France, and at last reached England, where that insect had probably never been seen alive before. Moths unknown as inhabitants of these islands have been caught at night at the North Lowestoft lighthouse, to which common species are attracted in such multitudes that the attendant, I have been informed by Captain Chawner and Mr. C. J. Paget, is obliged to take a broom in humid summer nights and brush them off, on account of their obscuring the revolving light.

† Observations, &c., on the Saw-Fly of the Turnip, by George Newport, Esq.

at this time, as no notice seems to have been taken of them in 1834.

But 1835, which was an unusually dry summer, might correctly be designated the "Canker-year," for they then seemed to have reached their maximum. Our journals and periodicals teemed with the ravages of the black caterpillar; and in walking through the turnip-fields the most casual observer must have been struck by the mere skeletons which the leaves often exhibited, the fibres only remaining, the membrane being entirely consumed. From the middle of August to the 20th of October, at which time they were full-grown, I observed them feeding on the leaves of the turnips.* In September in many districts the mischief ceased; and some farmers, who sowed for turnips again immediately after the first rains, were as successful as the lateness of the period would admit.† In the south of England the second brood hatched, but in the north the weather set in cold, and no second brood came to maturity; seven-tenths, therefore, probably perished.‡ On a farm at Coomb-bottom, near Kingston, in Surrey, the turnip-fields suffered considerably; and in July Mr. Manning § had 24 acres of English turnips quite destroyed at Elton in Bedfordshire, except about 2 acres, which were not hoed out. "On Saturday morning," he says, "I first noticed the caterpillar very numerous, about three weeks after the turnips were up, growing luxuriantly and looking well; on Monday that part of the field which had been hoed about four days was entirely destroyed, and so they went on with this work of destruction, which was the most complete I ever saw." "I then stopped the man hoeing the two acres that were left, and which came to a good crop."‖ The swedes close by the side of the white turnips were not touched. Early in July the fly was universally abundant, and about the middle of that month they were showered down in clouds at Godalming.¶ I did not notice the fly in any great numbers until August and September, but I have found them as early as the 29th of March, and as late as the middle of October; I first observed them in abundance in a potato-field at Battersea, and afterwards in a field near Heron Court, Hants.** Mr. Saunders

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* Curtis's Brit. Ent., vol. xiii. fol. 617.

† Observations on the Economy of an Insect destructive to Turnips, by W. Yarrell, Esq., in the Trans. of the Zool. Soc., vol. ii. p. 50.

‡ Report on the Natural History of the Black Caterpillar, by M. M. Milburn, Esq., in the Journal of the Yorkshire Agr. Soc., p. 49.

§ Transactions of Entom. Soc. of London, vol. ii. p. lxiv.

‖ It is remarkable that in a field of Mr. Goodlake's, at Wadley, near Faringdon, the unhoed part of a crop of swedes escaped exactly in the same manner.—Ph. Pusey.

¶ Entomological Magazine.

** Curtis's Brit. Ent., vol. xiii. fol. 617.

states that he never witnessed so great a destruction in turnip-fields by the black caterpillar as he did in August near Dover. Very few fields had escaped, although some were less damaged than others, and the ravages were not confined to particular spots, but were evident in places far apart; that in many instances scarcely a vestige of green remained, and the tendrils and nerves which they at first refused became in the end necessary for their subsistence. He adds, "In a field at the back of the Castle, which was half planted with swedish turnips and the other half with the common kind, the former were untouched, but the latter greatly injured, although separated only by a furrow, the plants touching each other."* In Buckinghamshire the blacks were so abundant and destructive that a meeting of the farmers was convened to consider the best mode of cure; and it was stated that the swedes had suffered equally with the others. At Compton, in Surrey, a turnip-field of 8½ acres was completely demolished; and a thunder-storm, accompanied by heavy rain, destroyed myriads of the larvæ, so that basketsful of the blacks might have been swept up the following morning.

At Long Ditton, Ham, and Guildford, their ravages had been equally severe; † indeed it was difficult, perhaps, to find a turnip country that had not been visited by these black armies; even as far north as the county of Durham they had proved very injurious to this crop; and in Essex, Bucks, Kent, Sussex, Hants, Wilts, Dorset, and Somerset, the turnip-crop was altogether a failure, for the produce of a second and even a third sowing was consumed by them.

In 1836 less was heard of them, yet in August I saw the flies coming out of the ground in myriads in a ploughed field in the neighbourhood of Bristol, where potatoes had apparently been grown; and a great many hundreds of acres were destroyed in Norfolk. Mr. Manning also, of Elston, had about 70 acres of swedes more or less infested, but not one was to be seen on the English turnips; and he says hoeing increased them a thousand-fold.

In 1837 the only notice seems to be from Mr. Sells, who says that near Arundel, in Sussex, the turnip-fields in July were in some places completely laid waste.

Thus their attacks became gradually enfeebled, when the intense cold of January, 1838, arrested their increase; the severe frost, unaccompanied by snow, left the ground exposed, so that the inmates of all those cocoons that were not deeply buried were

* Notice of the Ravages of a Black Caterpillar, &c., by W W. Saunders, Esq., in Trans. Ent. Soc., vol. i. p. lxxvi.

† Vide a communication by W. Sells, Esq., in Trans. Ent. Soc., vol. ii. p. lxxviii.

frozen; and it is probable that the thaw acted as beneficially, by subsequently destroying the remainder, either by decomposition or rendering the earth too wet and cold to bring them to maturity. They did not, however, finally take their departure, for, if I be not in error with regard to the date, I find one instance recorded of a brood making its appearance the year following at King's Weston, near Bristol. But I will transcribe Mr. Miles's own account, as it is interesting for several reasons:—"The turnip-crops went on together very well until the 8th of July, when I perceive by my farming-book that the black caterpillar first appeared. Its ravages were extended to both crops indiscriminately; as usual, however, with me, it attacked the field in patches, making sad havoc with the swedes, and entirely skipping over four rows of mangold-wurzel, which had been placed between the swedes and red-rings by way of experiment—to ascertain whether that plant could escape when surrounded by a crop infected by the caterpillar." *

Before entering upon the history and economy of the turnip saw-fly, a few remarks upon the tribe to which it belongs will not be uninteresting, for amongst the hymenoptera, the order in which it is included, there is no family which does so much mischief to plants as the tenthredinidæ; indeed a very large portion of the innumerable ichneumons and sand-wasps are of essential service, being the parasites which infest and devour noxious insects. Neither trees, bushes, gardens, nor fields are, however, exempted from the attacks of the caterpillars of the saw-flies. The largest species feed upon the birch, willows, and white-thorn.† The coniferæ, or fir-trees, are stripped of their leaves by *Lophyrus rufus, pallidus*, and *pini*.‡ Fruit-trees, as the peach, plum, cherry, and the pear especially, suffer from a bottle-green shining slug-like larva, with several other species, and amongst them a *Lyda*.§ Gooseberry and currant bushes are often entirely stripped of their leaves, and the fruit rendered small and unsaleable, by the depredations of *Nematus trimaculatus*;‖ and our beautiful roses do not escape the ravages of several species, amongst them *Hylotoma Rosæ*¶ and *Athalia Rosæ*, which are so nearly allied to the turnip saw-fly that a casual observer would consider them to be

* Royal Agr. Journ., vol. i. p. 417. Experiment with Poittevin's manure, by Wm. Miles, Esq., M.P. I have since learned that a crop of turnips belonging to the Rev. C. Clarke, of Hulver, in Suffolk, was seriously injured in 1838.

† Vide Curtis's Brit. Ent., plates 41, 47, 49, 89, 93, and 97, where dissections and descriptions of six genera will be found.

‡ Ibid., plate 54.

§ Ibid., plate 381.

‖ Ruricola, in the Gardener's Chron., No. xxxiv. p. 548.

¶ Curt. Brit. Ent., fols. 65, 436, and 457.

the same species: they are, however, confined to rose-trees, and the first is distinguished by the shape of the horns and the nervures of the wings. If it were immediately applicable to the subject, many more species could be added to the above; but enough has been stated to show how necessary it is to be acquainted with this branch of natural history, if we desire to comprehend the causes that are hourly operating to thwart our labours.

It will be remembered that the turnip-beetle, commonly spoken of as the turnip-fly, belongs to an ORDER called Coleoptera, but the turnip saw-fly is included in one called HYMENOPTERA, from the four wings being membranous and generally transparent; and this order embraces an extensive FAMILY called Tenthredinidæ, which is composed of many GENERA, one of which is termed ATHALIA, comprising six or seven SPECIES, natives of Great Britain: to this genus our turnip saw-fly belongs, and is called SPINARUM by Fabricius; it was subsequently named *centifoliæ* by Panzer, which is to be regretted; but it was done unwittingly by that author, he not knowing that it had been previously described.

Athalia spinarum may be thus characterised:—both sexes are of a bright orange colour, and shining; the male, however (fig. 6), is considerably smaller than the female (fig. 7), and more slender in shape. The horns are inserted near the middle of the face—short, black, and club-shaped; they are of a dull yellow colour beneath, excepting the base and apex, but in the male the two basal joints are also yellow beneath, and more or less so above; they are composed of nine joints, the two first are nearly oval, the third is long, the fourth not longer than the first, the following joints decrease in length, but increase in diameter, the terminal one being the stoutest, oval, and nearly as long as the third, with a suture across the middle (fig. 11). The head is black, short, and broad; the mouth, yellow; the *labrum*, or upper lip, is somewhat quadrate, bowed before (*m*). The teeth, or *mandibles*, meet in front, their apex being curved and forming a claw, of a chesnut colour, with a small tooth on the inside (*n*). The jaws, or *maxillæ*, are drawn out and terminated by a leathery lobe, with a long lance-shaped one on the inside, which is very downy (*o*). The two feelers, or *palpi*, are long, angulated, downy, and six-jointed; the basal joint is short, and the remainder nearly of equal length, the sixth being the slenderest, and slightly spindle-shaped (*p*). The chin, or *mentum*, is long, horny, and obovate (*q*): the two feelers, or *palpi*, are much shorter than the others, and attached to the anterior angles of the chin; they are four-jointed, and bristly towards the apex, the joints being nearly equal, the terminal one having the apex excavated on the inside (*s*). The underlip, or *labium*, is large, leathery, nearly orbicular, formed of three lobes, the centre one being narrow (*r*). Eyes lateral, oval, and black, with three minute eyes, called *ocelli*, on the crown of the head, forming a triangle. Thorax, globose, broader than the head, especially in the female, the anterior portion forming three reddish-orange lobes; a spot on

each side, the scutel and the tip of the hinder scutel of the same colour. Abdomen, or body, short, somewhat cylindrical in the male; the apex rounded (12); much broader and more depressed in the female (13), the apex pointed, with an ovipositor partly concealed in a slit beneath (*t*), and porrected between two rigid spoon-shaped lobes or valves (16), hollow inside, but convex and very hairy outside; they are ochreous, with a black patch at their apex (*u*), and enclose four fine lancets, the lower or outside ones (17) being the longest, and the upper and more inner ones being a little shorter (18); they are all thickened at the back, the sides have twelve or fourteen ridges, and the thinner margins are slightly serrated at the points, which seem to be most acute in the inner pair: there are also two united blackish spots at the base of the body, and a black dot on each side. Wings, four, ample, all reticulated, iridescent, yellowish at the base, the thickened costal margin and the callous stigma pitchy; the superior wings are the longest, with two marginal, four sub-marginal, and various other cells, formed by reticulated nervures. Legs six, rather short (19); thighs stoutish (*v*); shanks or *tibiæ* clavate, all hairy, with a pair of acute unequal spurs at the apex, and tipped with black (*w*); *tarsi* or feet rather long, whitish, and five-jointed (*x*), the four first joints having little appendages or suckers beneath (*y*); tips of all the joints black, the apical one entirely black, as well as the two acute claws with which this joint is furnished; there are also attached to them two little suckers, called *pulvilli* (*z*).

The males are hatched first, and appear a few days previously to the females, which sex is not only larger, but, the size of her body being greater, she looks of a brighter orange colour, and may be thus detected even when upon the wing. It generally happens that the female saw-flies are much less abundant than the other sex, and this is believed to be the case with the kind of saw-fly we are now describing, the males being as six to one when they have been bred; but it has been exactly the reverse in those I have caught in the fields, for out of fifteen specimens there were only three males. Both sexes can be equally active, but on being touched they feign death; closing their wings and contracting their legs and horns, they look like shrouded bodies; they are also torpid in moist and cloudy weather, but very alert when the sun shines, the males playing with each other or sporting with their mates. They use their wings much more than their legs; and when a female is observed walking about a leaf, it is for the purpose of depositing her eggs. They are frequently found on cruciferous and umbelliferous flowers, upon the pollen of which the flies subsist; and Mr. Marshall says they are partial to honey, and will sip the sap which oozes from the broken end of a turnip-leaf.* The fœces are cream-coloured, and of a similar

* Other species, as *Tenthredo scrophulariæ*, *T. viridis*, &c., are not satisfied with this light food, but live upon soft-bodied insects, and will even attack the Telephori (Curtis's Guide Gen. 317, and Brit. Ent., pl. 215); so that the *larvæ* are phytivorous, whilst the *imagos* are insectivorous!

consistence, but become a white powder when dry. Like many other animals, they repose after the heat and fatigues of the day, and generally rest beneath the leaves or in the flowers, with their heads and bodies bent down, and their antennæ lying close, until the rays of the morning sun awaken them to their toils.

The saw-flies generally appear in May, sometimes earlier, when the males fecundate the eggs in a few seconds, but this only takes place in the hottest sunshine, whilst the female rests upon a leaf, as is the case with the white cabbage-butterfly; after which she immediately begins to deposit her eggs: she first examines a leaf with the point of her ovipositor, and then, fixing herself upon the edge, with her legs equally placed on both sides, holding particularly fast with the hinder, for which purpose the suckers are admirably adapted, she thrusts her saws into the margin, makes a shallow slit, and insinuates the instruments (figs. 17 and 18) obliquely, sometimes nearly parallel, into the edge of the leaf backward: having forced them in nearly to the base, she brings them round, forming the segment of a circle, and thus separating the cuticles she forms a cavity with her saws or lancets, which may be readily seen with the aid of a lens, by holding the leaf up to the light. The cutting this cavity often occupies half a minute, when the oval, whitish, and semitransparent egg passes through the united lancets, which form a tube to conduct it to its nidus; the fly, at the same time, injecting a small portion of fluid,* which keeps the eggs moist, and prevents the cuticles from withering and collapsing upon, or exposing it to sudden changes of temperature and other casualties. The four lancets are then leisurely withdrawn and returned to the abdomen until the operation is repeated, and five or six eggs (figs. 1, 1) are thus laid, in distinct cells, in about twenty minutes.† Such are the care and instinct manifested by the female, that, if she commence to penetrate a leaf where there is not room, or if there be any danger from the leaf being curled, or too near an egg already deposited, she relinquishes her object until she finds a more suitable spot; and she has never but once been detected laying her eggs in the seed-leaves, so provident is she of the future wants of her progeny, well knowing such leaves would possibly be withered before the eggs hatched. Mr. Marshall placed a female upon a succulent leaf of the rape (*Brassica Napus*), but she refused to deposit any eggs, although she did so immediately on being put upon a young turnip-leaf; this she effected twice, and afterwards laid an egg on the margin of a large hole eaten in the leaf, which is attended with greater difficulty than in her more usual way on

* Vide Mr. Newport's valuable Essay.

† We were first indebted to Mr. Marshall for these careful details, which have been verified by Mr. Milburn and Mr. Newport.

the outside edge: the outer rough leaves are undoubtedly those which best suit her purpose, but she often selects the leaflets near the base, where the eggs rest more secure, and scarcely ever places them near the upper end.

It is supposed that the flies live twelve or fourteen days from their birth, but the females die as soon as they have finished laying their eggs; yet such is the vitality of that sex, that she will not only survive the separation of the head from the trunk, but has been able to walk, run, and attempt to fly, three hours after decapitation. Mr. Marshall had one, standing and dressing its wings for many hours after losing its head, and it actually lived in this state upwards of three days.

A single female is capable of laying from 250 to 300 eggs, and sometimes she deposits 20 in a single leaf; in five days, or perhaps less, in fine warm weather, the eggs are hatched; but if the atmosphere be chilly or wet, it is six, seven, and even ten or eleven days before the young caterpillars eat their way through the shell with their little jaws (fig. *f*) and crawl through the shining and dilated cuticle; and, their heads at that period being larger in diameter than their bodies, they soon extricate themselves with their fore-feet; this takes them, with intervals of rest, from fifteen to twenty minutes. When they first emerge from the shell they are scarcely visible, being only about the tenth part of an inch long; at that time they are nearly white, excepting two dots on the head, but soon become of a dull semitransparent greenish-white colour, the head jet black and shining. In less than two minutes they begin to feed upon the tender underside of the leaves so voraciously, that in a few hours these are often drilled through. At this period it is difficult to shake them off, so closely do they cling to a leaf; but when they are about six or seven days old they cast their first skin, and then they are easily dislodged: they have now doubled their length, being one-fifth of an inch long; some of them, probably the female caterpillars, are much longer, and almost jet black, a stripe on the side of the belly being considerably paler, and at first the head is whitish, with two black dots. They are at this time very voracious, and may be traced by their large green pellets of dung; and, having fed for some time, their skins will no longer expand to the extent required, when each caterpillar again fixes its membranous legs, especially the hinder pair, to a leaf or the denuded fibre, and, bursting the seam behind the head, the caterpillar crawls out, leaving its skin attached to the object it stood upon: it has now greatly increased in size, and consequently its ravages are much more evident, and it soon has to cast its skin again; they now have a more transparent but wrinkled skin, and are of a slate or grey colour, with a pale line along the sides, the underside being pale also, but the head is

black, as well as a varying line along the back, being the alimentary canal: thus they change their skins three times, at intervals of from six to seven days. When full grown they are often three-quarters of an inch, rarely an inch, long, and about as thick as a crow-quill, but frequently do not attain to more than half an inch in length; and after changing their last skin they decrease in size: this takes place in about three weeks from their birth, but when well fed in confinement, they have arrived at maturity in nineteen days.

The full-grown caterpillars are nearly cylindrical, not in the least hairy, and composed of twelve segments besides the head; each segment is covered with minute warts, and formed of six or seven rings of muscles, which give them a wrinkled appearance, and there are plaits of muscles on the sides (figs. 2); the head is much smaller than the body, especially the thoracic segments, which are a little inflated, the remainder taper slightly to the apex; the face is orbicular and pubescent (8), with a short conical six-jointed antenna seated on each side near to the base of the lip (*c*), and above each is a minute black hemispherical eye (*b*); the upper lip is horny, semicircular, and notched in front (*e*); the jaws are very strong, horny, and subtrigonate, one with two, the other with four unequal teeth at the apex (*f*): maxillæ (*g*) with a leathery lobe, and a smaller one on the inside, pectinated at the apex (*); the feelers are short, conical, and five-jointed (*h*); chin abbreviated, producing two very short conical feelers composed of three joints, the second notched, with a curved spine on the inside (*l*); the under lip is fleshy, rather large, notched in the centre, where there is a small lobe (*k*). The larva is furnished with twenty-two legs, the six pectoral are short and horny, formed of five joints, and terminated by a minute claw (2*a*); the fourth segment has no legs, but the seven following are each provided with a pair of short cylindric ones, and the apical segment has a fleshy pair at the extremity, with which the animal can hold very fast.

The larvæ delight in the sun, and lie curled up upon the leaf (2*) enjoying its piercing rays, and from this capability of enduring heat, as well as from their colour, they may well be designated "the negro caterpillar." When they feed they either fix themselves by their six pectoral feet to the edge of the leaf (2†), or begin to eat off the surface for a small space, when they perforate the other cuticle, making a hole, which they enlarge until it is one or two tenths of an inch in diameter, and as the leaf grows this increases, provided the whole leaf is not consumed, so that, when the succeeding brood is hatched, abundance of secure niduses are thus provided for their eggs. Mr. Newport discovered that whilst they were in their first skins they had the power of emitting a silken thread, to let themselves down when shaken from a leaf, like the caterpillars of the geometræ and smaller moths, which enables them to regain their position after

the alarm is over; but when farther advanced in life they lose this power, and are consequently obliged to crawl up the stem until they reach a leaf; after this period they fall on the slightest touch, and lie curled up as if dead until their apprehensions of danger have subsided.

They are not long, after assuming the slate colour, before they descend from the leaves and enter the earth, and are sometimes two hours and a half engaged in burying themselves 1 or 2 inches below the surface, where they form an oval silvery cocoon of silken threads and gluten,* more or less brown outside (fig. 3), but of a beautiful smooth silvery texture within: it is impervious to wet, and its glutinous nature when first spun causes it to adhere to the particles of earth and sand in which it may be imbedded, so that it appears like a small lump of earth, and is not easily detected; but when formed in a box it partakes of its colour on the outside, and requires a knife to detach it, and then it cannot be well separated without making a hole in the case. Some of the early broods pass very rapidly into the perfect insects, three weeks being sufficient, and the females were found already to be full of eggs; but later in the season it is three months before they change to pupæ, and, in order to secure a succession the following season, probably one-third remain in the cocoons in the caterpillar state through the winter (fig. 4): eventually, however, the caterpillar casts its skin in the cocoon, and becomes a whitish-yellow nympha or pupa, the limbs and figure of the adult fly being distinctly visible through the thin skin (fig. 5).

Having traced their progress and economy from their first appearance as flies to the pupa or chrysalis, the next object for consideration will be the remedies; but before we enter upon this subject there are some facts that we have collected in our investigations which deserve especial notice; one of which is, that light soils seem to be most attractive; for instance, the coast of Norfolk, where the saw-flies were first observed in such multitudes, is exceedingly sandy; Mr. Yarrell says they affect light and chalky soils: in another district the sharpest gravel was infested the most; and where it was a sandy loam upon mountain limestone they proved very destructive, and attacked the crops in patches;† but the most inexplicable trait in their economy is, that, whilst in some places and in some seasons the caterpillars refused to eat the swedish turnips,‡ in other instances they shared

* This substance is said by some to be an exudation from its body, but I believe it to be spun like the cocoon of the silkworm from its mouth.

† Royal Agric. Journ., vol. i. p. 417.

‡ I myself so invariably witnessed this preference, that I unhesitatingly stated in 1836 "they would not touch the swedes" (Curtis's Brit. Ent.,

the same fate as the English varieties, or were even exclusively attacked. At first this led to a belief that the leaves of this variety of *Brassica campestris,* containing a greater portion of oily matter, and being more pungent to the taste, than *B. Rapa,* they were altogether secure from the black caterpillar; this however in the sequel proved unfortunately a decided fallacy: yet how interesting, and perhaps beneficial, would it be to reconcile these anomalies, if we had sufficient recorded facts to assist in such an undertaking! There seem to be fair grounds for believing that the saw-fly does give a preference to the English turnip, but rather than be disappointed, she will deposit her eggs in the leaves of the swedes, and it is possible that they afford the larvæ more wholesome food in wet weather: it would be easy to enlarge upon like inquiries, but, as we have no means of answering them, it seems idle to do so. The caterpillars appear to be naturally fastidious, for when feeding on an old leaf they do not relish a younger one, being clearly partial to that which gave them birth, the juices I conceive being more congenial to their constitutions, especially in their early stages, which may account for the silken thread with which they are then provided to guide them back to their native spot; when half grown they spare none of the older leaves of *full-grown turnips;* indeed their instinct shows that the outer rough leaves are best suited to their wants, for the eggs being laid in them they first fall a sacrifice, whilst the central ones nourish the plant, daily becoming more developed, and consequently better adapted to their increasing and inordinate appetites. The charlock (*Sinapis arvensis*) is decidedly their favourite food, for they always attack that first, and will feed upon the flowers as well as the leaves. The period of the caterpillar and eating state is about three weeks, during which an individual will consume a very great quantity of food, but how many times its own weight, when fully grown, has not been calculated at this time they are exceedingly voracious, and of course most to be dreaded. The caterpillars are generally discovered under the leaves when the plants are about three weeks old, and they daily increase in numbers from the successive hatching of the eggs, so that they vary greatly in size and colour in a short space of time, and, as the swarms of flies pass in a body from one spot to another, the larvæ do not appear simultaneously; indeed they may be seen full grown in one field, whilst in a distant locality the saw-fly may be depositing its egg, but this arises from another cause—the numerous broods that hatch in one year, for the larvæ arrive so soon at maturity, that a second brood of flies is produced in July and August, whose eggs are deposited forthwith, and thus

vol. xiii. p. 617); and in the Entom. Mag., vol. iii. p. 340, Mr. Newman says, "It was remarkable that at Godalming the swedes were untouched."

a third brood is feeding in congenial seasons until the middle or end of October, which is frequently a warm and dry month, but, should hoar-frosts set in at this declining period, multitudes will be seen perishing on the leaves and ground. A low temperature generally arrests their progress, but as soon as it becomes again mild, all flattering hopes vanish with the suspended growth of the bulb; it pines away from the loss of the leaves, which are the lungs of the plant, and, even should it survive their attacks, it never can arrive at its full size.

Mr. Marshall states that in about ten days after the arrival of the saw-flies the young caterpillars were visible beneath the leaves, and in about ten days more the plants were entirely eaten up, excepting a small patch or two towards the centre of the field, and a space round it by the side of the hedge, proportioned to its height, and varying in this respect where trees occurred: this was accurately ascertained and is a very curious fact, for in small pieces called pightles, set round with high trees, the plants had almost entirely escaped; and, as might be expected from this evidence, large open fields and smaller enclosures lying exposed to the sea suffered most, and lands dipping from the sea were less affected. It seems probable that the shade produced by the trees and hedges, or the moisture under them, would not prove favourable to the hatching of the eggs, for, as soon as the other parts of the field were consumed by the caterpillars, they proceeded to devour the space on one side, and then "travelled with wonderful instinct in bodies towards the other." The whole field being finished, the gateway and the adjoining roads had, it was said with great confidence, been seen black with them.

In Mr. Newport's Prize Essay we find that, when he inspected a field in Hants, of healthy white turnips of 15 or 20 acres, which had been sown about a month, the saw-flies swarmed over about an acre at one end. They seemed to have arrived very recently in a swarm or cloud, for they had not been observed there before, and were hourly increasing. But the remarkable fact was, that the great mass of the flies was confined almost entirely to the eastern end of the field at first, while there was scarcely a fly to be met with in the middle or at the western end; now it appears there was a light westerly wind at the time, and the saw-flies had come in an opposite direction, confirming the opinion, given in the Report of the Turnip-fly, that insects, being directed by scent, frequently fly against the wind. In four days they had passed over in a body to the western end, depositing eggs in their progress, from whence they would proceed to other fields hitherto free, if the ovaries of the females were not exhausted: Mr. Newport had observed in another instance that they came from the east.

It is well known to all practical entomologists that caterpillars are attacked with purging when fed upon wet leaves, and this disease makes sad ravages amongst the "silkworms," if proper precautions be not taken in rearing them. Rains are consequently singularly destructive to the black caterpillars, by rendering the turnip-leaves very watery, which speedily kills them: the caterpillars can undoubtedly resist a shower, yet, if they be brushed off in wet, cold weather, after casting their first skins, I doubt if they would recover; and on the contrary, if the earth be very dry, I expect they would not regain their position without difficulty, especially on sandy soils, over which they travel very indifferently, and for this reason probably, they migrate in troops at night when the earth is moistened with dew; but these are merely hints thrown out for the more mature consideration of those most interested in the subject. There are, however, many other causes in operation to decrease this formidable enemy, which probably might be taken advantage of; for instance, if a caterpillar be removed after it has fixed its fleshy feet to any substance in order to cast its skin, it has not the power to attach itself a second time, consequently it cannot disengage itself from the old skin, and it dies: this operation takes place every six or seven days, as already shown, and such would be the best periods for disturbing them: when the caterpillars are preparing for this moult they become unsettled and will not eat, but as soon as they have cast off their skins all their vigour returns with redoubled force, and they are more ravenous than before. When they have overcome the exertions of their final moult, if the earth be very dry it is greatly against them, for the larvæ do not like to enter it, I have repeatedly observed, as they do when it is moist. Probably they are obliged to bury themselves deeper under such a condition of the soil, until they arrive at damp earth, which will allow them to form their cells; they are also longer burying themselves when the earth is dry, and I believe descend close to the bulb of the turnip as the most protected from drought, and this operation requires several hours when they are in any way enfeebled, but is otherwise speedily accomplished.

Rooks as usual are eminently serviceable in diminishing the caterpillars, and Mr. Marshall observed that "a large piece of turnips lying in an open field had escaped in a remarkable manner; it lay near a rookery, which was a general rendezvous for these birds; and I recollect" (he adds) "to have seen this piece more than once covered with them." The swallows also soon become attracted by the flies, and are constantly skimming over the fields in pursuit of them; and when it is remembered that the capture of one female may prove the destruction of a very extensive brood of the caterpillars, the benefit conferred by a

single bird, by the prodigious number it would destroy in a few days, is scarcely to be calculated.

It is remarkable that so few parasitic insects seem to be attached to this insect, which may be one cause of its rapid increase; but I believe that the currant saw-fly is equally free from such enemies. I have bred a considerable number of both species, yet I never detected a caterpillar that had been stung, or in any way inoculated, by parasites; I am therefore led to conclude that it is of rare occurrence. A friend, however, sent me an ichneumon which appeared to be bred from a cocoon the beginning of May; it is, I believe, a *Bassus* of Gravenhorst,* and is black, minutely punctured and finely pubescent; the horns are as long as the body; the mouth and lower part of the face are white, with a black stripe down the middle, and two points on each side of the clypeus of the same colour, the labrum and tips of the mandibles are ferruginous brown; the wings are iridescent, the costa and stigma fulvous, the nervures brown, and there is no areolet; the legs are rather stout and rufous, the coxæ ochreous, the tarsi and hinder tibiæ are tawny, the latter with the terminal half and the tarsi black. It is $2\frac{3}{4}$ lines long, and the wings expand nearly $5\frac{1}{2}$ lines, not quite $\frac{1}{2}$ an inch. As it does not appear to be described by any author, I propose calling it *Bassus athaliæperda,* the "Athalia-destroyer." Mr. Yarrell has also figured "a dipterous parasite (one of the Muscidæ), which, having completely devoured the interior of the larva, has undergone its change to a coarctate pupa within the skin of the larva of the athalia, portions of which (greatly stretched) are seen remaining on the outside of the dipterous pupa, as well as the head of the larva, which remains entire."† From our present knowledge, therefore, we have no just grounds to expect assistance from insectivorous parasites, which are often so admirably employed to keep in check the insects that are injurious to man; it is consequently to his own resources that the agriculturist must look for either a preventive or cure; and with this view we will now proceed to the remedies proposed: many of them, however, are mere palliatives, being limited, imperfect, and uncertain in their operations, whilst others have been attended with universal and complete success.

Mr. Saunders says that "lime-dust or powdered chalk had been spread over the attacked half of a field, and apparently with beneficial results, but few caterpillars remaining;" in another instance strewing quick-lime, and renewing it as often as the wet or wind rendered it necessary, was most beneficial; but other parties found sowing with lime in the middle of the night, when

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* Curtis's Guide to an Arrangement of British Insects, Genus 520.

† Trans. Zool. Soc., vol. ii. pl. 14, f. 12.

the plants were moist with dew, had no effect; quick-lime and soot were tried with no better success, and scattering slaked lime or coal-ashes over the plants is said to be useless; as it is admitted that in consequence of this application the larvæ rolled off the leaves, I do not concur in its inutility, and I think that it might be attended even with good success, if it were done after rain or in damp weather, for on being touched the larvæ curl themselves up and fall to the ground; if therefore they were brushed off in the evening, and the dusting of lime with wood or other ashes were immediately to follow that operation, I doubt not but myriads would perish, especially if the succeeding night proved cold and frosty, as is not unfrequently the case in September, and I believe even in August; indeed, such is reported to have been the result. As, however, it is stated that when shaken off, the active caterpillars will regain the leaves by day in five minutes, except under circumstances already alluded to, it is evident that such applications must not be delayed, if any advantage is expected to be derived from dusting or watering them upon the ground.

A heavy roller passed over the field in the evening and at night, is said to have destroyed the caterpillars whilst feeding, and to have checked them, especially when repeated two or three times, but it did not save the crop. It is only at an early stage of the turnip's growth that rolling can be of service, for when the plants have arrived at any size, as they generally have when I have seen them thus attacked, they must be injured by such a process, and the roller itself cannot come in close contact with the soil.

Whilst any attempts are making to diminish or to extirpate the caterpillars, the turnips should not be touched with the hoe; few of the larvæ are killed by the operation, and, as their food is thereby reduced possibly one-half, the remainder more speedily and with greater certainty falls a sacrifice to their ravages; moreover hoeing by loosening and refreshing the earth renders it more agreeable and better suited to receive the full-grown larvæ, when they are led by instinct to bury themselves; but as soon as the caterpillars have disappeared, the hoes may be set to work with great advantage where the crop is only partially injured, for then it will disturb and destroy multitudes of those that have entered the earth; and if this could be immediately followed by throwing salt and water from a water-cart over the crop, it would have a most beneficial influence, and this could be effected without much difficulty or detriment where the turnips are drilled in, and the same liquid, or even common water, if thus applied the instant the saw-flies make their appearance, would drive them away also, as such a state of the plants is not adapted to the deposition of the eggs; and the saw-flies themselves, although, from their polished surface, the

pubescence which clothes some of their members, and probably from an oily exudation, can easily recover when they fall into pure water and escape from its surface, yet when they are forcibly washed off the plants and get entangled with the soil, as lime, clay, or any other earthy matter, especially in cold weather, the greater portion of them would be rendered incapable of doing further mischief. On the sea-coast, where they have generally first appeared, salt water from the sea might often be advantageously employed; and the dusting of finely-pounded salt over the field would do great service, if it were scattered whilst the turnips were wet from rain or heavy dews. Mr. Newport justly observes that sea-water or salt and water is likely to prove useful for two reasons—"first, from the known pernicious effect of saline matters *in solution* upon most young insects; and next, the circumstance of a greater amount of cold being produced during its evaporation, whilst the means applied as a remedy for the insect would on most lands prove beneficial to the soil, and hasten the growth of the crops."

Drawing a cart-rope over the turnips to shake off the caterpillars is sometimes very effective, but not always to be depended upon. Mr. Sells says that two men were employed in the middle of September to sweep 6 acres of turnips at Kingston, with an inch-rope about 30 feet long; it took them one hour each time, and was daily repeated for four days with great success, vast numbers of the larvæ being found dead under the turnips. This operation ought to be performed in the evening, taking advantage, if possible, of a wet day; and should the larvæ not have arrived at maturity, so much the better, as all those that are moulting must perish. A better plan perhaps is to take an axle-tree connecting two wheels, and lash some branches of the green furze* to it at such a height, that they would brush the turnips without pulling them up by the roots; this not only has the same advantages as the rope, but great numbers of the caterpillars are wounded and destroyed by the thorns; if furze cannot be readily procured, branches of the fir-tree or hawthorn may be substituted. A hurdle bushed with smooth boughs and drawn down the rows has also had a good effect, but it must be repeated two or three times.

The elder has long been celebrated for its virtues in repelling the attacks of insects, and in the canker years it has been tried in various ways, sometimes with success; but possibly many other trees, employed in the same manner, would have proved just as serviceable: for Mr. Marshall's experiments clearly showed that the elder is neither noxious nor disagreeable to the black caterpillar; even a turnip-leaf which had been *whipped* with the elder,

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* The *Ulex Europæus*, called in some counties gorze or gorse and whin.

was eaten by them when they were confined with it in a box. The benefit alluded to was derived from the use of a brush made of the young straight luxuriant shoots of the elder, about 2 or 3 feet long, and as thick as one's finger; these were tied to a cart-rope 20 feet long, with rope-yarn 4 to 6 inches apart. Two men then took hold near the twigs, the loose ends of the rope being tied together, and dragged the elder at a distance behind; of course the rope may be prepared of any convenient length for the men to walk along the furrows, but 20 feet will take in a rod at once. Mr. Marshall also reports another successful case. In a field that was partly sown early, the saw-flies* appeared when they were in rough leaf; this portion was entirely cut off by the black-caterpillars, so that it was necessary to plough and sow a second time; but the ploughing and harrowing did not kill all the larvæ, for thousands were seen on the surface travelling towards the portion of the field which had been late sown, the plants of which were of a considerable size; a trench was immediately cut to divide the two portions, and two men drew the elder-bushes over the turnips thrice a-day, at morning, noon, and night, which employed them an hour and a half each time to go over about 3 acres. This was continued for ten days, and the elder was renewed three times. Whatever might be the cause, "after looking attentively for some time among the plants, I saw only two caterpillars, and so healthy a piece of turnips I do not recollect to have seen; they have been sown only three weeks, yet they are now fit for the hoe."† Mr. Marshall attributes this success to the complete and continued vibration of the leaves given by the straight elder-twigs lying flat and even upon them as they passed over.

When turnips are sown in ridges a number of women have been advantageously employed with live twigs, to brush the larvæ off, crushing them with their feet as they passed on, being "closely followed by a man with a scuffler, set so as to cover the whole space between the plants; and by once or twice going over the field was cleared."‡

It was a universal practice in Norfolk, which had generally a good effect, when one portion of a field was swept off by the larvæ, and they were marching to a less infested portion, to draw a furrow between them, deepening it into a trench. The side next the part to be protected should be made, of course, perpen-

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* It is most essential for agriculturists to call these flies saw-flies, and not merely "the flies," in consequence of the turnip-beetle being also called the "fly," otherwise great uncertainty and confusion may be the consequence in future investigations.

† Abstract from Marshall's Rural Economy, p. 18.

‡ Trans. of Yorksh. Agric. Soc., p. 54.

dicular, or even overhanging at the top, if possible: thus a trap is laid, and the bottom of the trench will soon be entirely covered with them. It is likewise a very sensible precaution, when there are signs of the caterpillar in one field, to cut such a trench across a gateway connecting it with another enclosure where there are no symptoms of its presence. If water rise in the trench, so much the better; if not, the bottom may be filled with straw, and set on fire when the caterpillars have accumulated in sufficient numbers, which is a very speedy and excellent mode of destroying them.

Hand-picking and ducks are, however, most to be relied on: it is true that the former is tedious, if not expensive, where the caterpillars are so numerous that as many as sixteen score have been counted on one large plant; but in such cases they should be brushed or whipped off into fruit-baskets or sieves; otherwise pint or smaller pots are well adapted for collecting them, which can be emptied into large covered vessels at the head of the field, containing some salt and water, or lime-water, to prevent the caterpillars from crawling out. Mr. Sells states that a boy ten years old gathered the caterpillars in a field suffering in a slight degree, at the rate of 180 in an hour: eight hours per diem would give nearly 1500, or 9000 a week; so that ten or twelve children, from six to ten years old, would collect 90,000 or 100,000 in a week, where they are *not* abundant: in such a case, 6*d.* a pint, and 2*s.* a-day to the superintendent, would probably answer the purpose.*

Mr. Manning says "pigs will destroy the larvæ to a very great extent, and without injuring the crop in the *slightest* degree;" but that 160 young ducks soon put a stop to the black caterpillars. Ducks, having been tried with universal success, are decidedly the favourites: they are also useful to eat slugs and other small animals destructive to field-crops and vegetables. Poultry are said to be equally beneficial, with the exception of turkeys, which will not touch the negro caterpillars. Fowls are naturally fond of worms and caterpillars, so much so that hens' eggs, when they feed much on meadows and mountains, without corn-food, are not well flavoured. It is therefore not difficult to induce them to make the most of their time, when they are invited to such a luxurious banquet. Indeed it is supposed to be most judicious to turn in *poultry* where the caterpillars do not abound, as they will search them out, and leave the turnips uninjured; whereas the ducks, under such circumstances, would attack the turnip-tops, and thus the remedy might prove as bad as the malady.

Hundreds of ducks were turned into a field in Kent, which

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* Trans. of Ent. Soc., vol. ii. p. lxxviii.

saved the crop; and by this method Mr. Osborne, of Birdham, in Sussex, preserved his turnips. Eighty ducks from Leadenhall market did not work well the first day, but on the following they quickly accomplished their allotted task, thriving upon their new food. At Long Ditton the ducks and fowls proved equally useful. At Chertsey a farmer put 150 half-grown fowls into a waggon, which was drawn into the middle of a cankered field, and turned them loose, when they soon annihilated the caterpillars; and they rendered the same services on the adjoining farm immediately after. Even when a part of the field has been all but destroyed, the introduction of ducks has speedily changed its appearance; the sooner, however, this useful operation commences the better; the farmer should therefore be on the watch for the young caterpillar, and immediately set his ducks and poultry to do their duty. Nearly 400 ducks were at work at one time, on two farms in Norfolk, and saved all the crops intrusted to their care. When such large numbers are employed, they ought to be formed into detachments of not more than 100, and each must be attended by a boy or girl, to precede them with a long light pole or willow rod, to brush the caterpillars off the leaves, as well as to drive the birds to water and to rest three or four times a day: after drinking, the ducks will often disgorge the caterpillars in great quantities, and soon go to work again with whetted appetites: they must also be driven home at night, and put in a barn, where they ought to be fed with a little barley or other grain, to keep them in health and vigour, otherwise so much living animal food disagrees with them, and causes purging. Old ducks do not work well; select, therefore, those that are from three to five weeks old. Mr. Sells recommends that, after ducks and fowls had been made to fast a few hours, they should be tried with the larvæ, either alone or mixed with barley, by which means they would become acquainted with the insect to be sought for, and probably take a predilection for it.

I must not omit to state that Mr. Porter, of Covehithe, in Suffolk, derived great benefit from driving a flock of sheep over those turnip-fields which were infested with the black caterpillar.

Having now discussed the various methods that have been adopted to arrest the ravages of the black caterpillar, we wish to impress upon the agriculturist that to be successful in any plan of extirpation, whether as regards the black caterpillar, when he again visits our turnip-fields, or any other insect which ravages them every year, it must be resolutely persevered in, and above all things applied in good time. If we be dilatory or procrastinating, what chance have we in coping with an active enemy, which on the coast of Norfolk appeared in such myriads that the plants were stripped in a few days, so that it was too late when

they made their appearance to apply a remedy? And this proves how essential it is to be able to recognise the *saw-fly,* in order to be on our guard, and prepare at once for the worst. With this object in view, I have endeavoured to render the engraving as intelligible and complete as possible; and as a summary of the foregoing details will be useful for reference, I shall proceed to lay it before the reader.

It has been shown in a former report that the turnip-fly (*Altica Nemorum*) is only to be dreaded in its perfect or beetle state; but it is quite otherwise with the turnip saw-fly, the caterpillar or larva of which is the only state in which it is capable of doing any mischief.

The *turnip saw-fly* is called by scientific men *Athalia spinarum,* and also *Tenthredo centifoliæ.* These flies *come over* from the north of Europe, but are probably bred in small numbers annually in England.

It is *eighty-five years* since their first appearance was recorded.

Their *mischievous visits* are at extremely irregular intervals.

In 1782 many thousands of acres were entirely destroyed in the county of Norfolk by the black caterpillar.

Subsequently to 1782, the year 1835 has proved the most fatal to the turnip-crops from their attacks, the produce of a second and third sowing being destroyed by the black caterpillars.

In *July, August,* and *September,* the saw-flies are most abundant; but they have been found as early as the 29th of March, and as late as the middle of October.

The *male saw-flies* are the smallest, and hatch first: they are supposed to be most abundant, but my experience leads to an opposite conclusion.

On being touched they *feign death;* and are torpid in moist and cloudy weather, but very active in the sunshine.

They *rest* by night on plants and flowers, and *feed* upon the pollen.

They seem to *fly* against the wind, like the turnip-beetles.

Watering the plants as soon as the saw-flies appear would in all probability preserve the crop.

Scattering finely-powdered *salt* over the turnips when they are wet would keep the females from depositing their eggs.

The *eggs* are laid immediately after pairing, between the cuticles of the leaf, close to the margin, or in the edge of a large hole, and are deposited singly in cells.

Outside *rough leaves* are selected for this purpose; and the leaflets at the base are often preferred.

The turnip saw-flies *live* twelve or fourteen days, and the females are exceedingly tenacious of life.

A female will lay from 250 to 300 eggs; and they hatch in from five to eleven days.

The *black caterpillars* are about one-tenth of an inch long at first, but three-quarters, and sometimes nearly an inch in length when arrived at maturity.

They *change their skins* thrice during their lives, which extend to nineteen days, or three weeks.

Previous to changing their first skin they have the power of emitting a thread from their mouths, and are difficult to shake off: after the first moult they fall down on the slightest touch, and lie curled up.

If the *caterpillars* be disturbed whilst *moulting* they die.

They *descend* into the earth and there form a cocoon, in which they change to pupæ, often lying in the ground the whole winter; but in summer the saw-flies hatch in three weeks.

When they descend into the *earth,* if it be *fresh and moist,* it is better suited to their economy than when it is very dry.

Light soils seem to suit them best.

Swedes by the side of white turnips often not touched: in other instances they have suffered equally.

Swedes more or less infested, but not a caterpillar to be seen on the English turnips.

The *young larvæ* are *fastidious;* and when feeding on an old leaf do not relish a young one.

They are most *voracious* immediately after changing their skins; and when nearly full-grown do the most mischief.

They do not appear *simultaneously;* and there are often three broods in a year.

A *thunder-storm* destroyed myriads of the black caterpillars.

Cold checks their progress, and often kills them; and *wet* causes diarrhœa, which carries off great numbers.

Checked and destroyed in the ground by the *frost* of January, 1838.

Sometimes attack fields in *patches;* at others commence on one side, going regularly forward; and again leaving, perhaps, a space in the middle and all the borders untouched.

Large and *open fields* more liable to be attacked than small and enclosed ones.

Rooks and swallows are very serviceable in thinning their ranks, the former feeding on the caterpillars, the latter upon the saw-flies.

The caterpillars seem to be nearly free from *parasitic enemies.*

The *strewing of quick-lime,* coal-ashes, and soot has been attended with various success, and generally with beneficial results.

Repeated *rolling* has killed and checked the caterpillars; but its effects are partial.

Hoeing an attacked crop the most fatal experiment, until all the caterpillars have disappeared.

Drawing a *cart-rope* over the turnips to shake off the caterpillars has proved more or less effective, most so when a brush made of elder-boughs has been fastened to it.

An *axletree* with wheels, the former armed with *green furze,* drawn along the rows, wounds and destroys the larvæ, as will also a *bushed hurdle.*

Brushing the larvæ off with *live twigs* and stamping upon them, a man following with a *scuffler,* has cleared a field of the larvæ.

A *trench* judiciously cut will often preserve a portion of a field, or an adjoining one.

Hand-picking, when the larvæ are not excessively abundant, may be depended upon as a certain remedy; and when in great numbers they may be brushed into sieves.

Pigs will destroy the black caterpillars.

Ducks and poultry will devour them with avidity; and this seems to be the most easy and effectual method of extirpating the black caterpillars: the birds may either be carried or driven into the field, according to the distance.

Sheep driven over fields infested with the caterpillar have done essential service.

EXPLANATION OF THE PLATE.

Fig. 1. The eggs of the turnip saw-fly deposited in the leaf.

Fig. 2. The larvæ or caterpillars feeding and at rest.

Fig. 2 *a*. One of the fore legs magnified.

Fig. 3. The cocoon, open at one end, after the fly has emerged from it.

Fig. 4. The larva, as seen in the winter, when a cocoon is opened longitudinally.

Fig. 5. The pupa or nympha in a cocoon, opened longitudinally in the spring.

Fig. 6. The male turnip saw-fly, considerably magnified; the cross lines showing the exact natural dimensions of a living fly.

Fig. 7. The female fly, the size of nature; some specimens, however, are a little smaller.

Fig. 8. The head of a caterpillar, showing a front view of the face, which is highly magnified, as well as all the following figures:

b The minute eyes.
c The short antennæ.
d The mouth.

Fig. 9. The various organs of the mouth of the caterpillar separated:

e The labrum or upper-lip.
f One of the mandibles or teeth.


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g One of the maxillæ or jaws.
* The pectinated or comb-like lobe.
h The maxillary palpus or feeler.
i The mentum or chin.
k The labium or under-lip.
l The two labial palpi or feelers.

Fig. 10. The various organs of the mouth of the fly separated :
m The labrum or upper lip.
n The two mandibles or teeth.
o The maxillæ or jaws, uniting at their base.
p The maxillary palpi or feelers.
q The mentum or chin.
r The labium or under-lip.
s The labial palpi or feelers.

Fig. 11. One of the antennæ.

Fig. 12. Abdomen of the male, viewed beneath.

Fig. 13. Abdomen of the female, viewed beneath.
t The valves and ovipositor.

Fig. 14. The same forcibly separated.

Fig. 15. Lateral view of the abdomen of a female.
u The valves and ovipositor in profile.

Fig. 16. One of the valves detached.

Fig. 17. One of the outer lancets.

Fig. 18. One of the inner lancets.

Fig. 19. One of the fore legs.
v The thigh attached to the trochanters and coxa.
w The tibia or shank.
x The five-jointed foot or tarsus.
y One of the four suckers.
z The two claws and pulvillus.

Fig. 20. The underside of a turnip-leaf.

Obs. All the figures are drawn from nature, excepting the eggs, which are taken from the plate illustrating Mr. Newport's paper.

N.B.—Any Agriculturist having memoranda of years when crops have suffered materially from the attacks of this or any of the other noxious insects, would be rendering essential service by transmitting short notices to the Secretary of this Society, in order that the reports may be made as complete as possible, with regard to data, &c.

London, September, 1841.

XXXIV.—*On the Improvement of Peat Soils. Prize Essay.* By Cuthbert W. Johnson, Barrister-at-Law.

"The improvement of peat soils" now proposed as a question for investigation by our society is one of very considerable importance to agriculture.

It involves not only the permanent improvement of large estates, but these peat soils include a very large proportion of several counties of the United Kingdom.

In this essay I feel the advantage of confining my observations and the details of my experimental researches to those peat soils whose profitable improvement is attended with the greater obstacles —to those deep peat mosses, or bogs, which are naturally the most difficult to bring into cultivation. These often extend to a depth of many feet, contain but little earth, are usually tolerably level, and consist of a mass of light vegetable fibres. This peat, even in the midst of summer, is commonly saturated with water; at other periods semifluid, and very often a trembling dangerous quagmire. Its soil, if I may call it such, is usually of a dark brown, changing to a blackish colour when thoroughly dried by a gentle heat.

In this state the peat is easily inflammable, is commonly used for fuel, and has been occasionally employed by the gas-manufacturer, the lime-burner, the charcoal-maker, and even the iron-smelter.

The directions which I am enabled to give, and the suggestions I venture to offer, are of necessity general in their nature. It is in vain to hope that any can be given which will not require modifications according to the many circumstances under which the possessor of the bogs is placed.

Peat soils abound in almost all those situations where stagnant waters are for a long-continued period allowed to rest, and where the vegetable matters produced and very slowly decaying on the surface are not carried off.

The common masses of peat existing on the earth's surface in England, with which I have had most experience, are the products of the decay of the mosses, common heath-plants, coarse grasses, and the sedges which often accompany them. But the varieties of peat are numerous, according to their age and situation. There are some of the peats which are found *beneath* the soil, in the lower portions of the valley of the Thames, which are evidently the remains of considerable masses of underwood, and contain sulphate of iron. Many others, dispersed over the coast of Essex and in Ireland, abound with the remains of large forest-trees, and were most probably produced by some great convulsion of the earth in a distant period. In the southern counties,

except in those of the banks of the Kennett and the Thames, the depth of the peat has not in my experience often exceeded a few inches; but in the places I have mentioned, and in those with which I have come in contact in the northern counties, the depth generally extends to several feet.

The formation of bog-moss is first commenced in very many instances by the rapid-growing broad-leaved bog-moss (Sphagnum latifolium), a plant of very curious habits, whose growth under favourable circumstances (and it is strictly an aquatic) extends from an inch in length to two or three feet. In dry situations, or in those only periodically flooded, its progress is not rapid, but when it vegetates, always immersed in the water of low stagnant situations, there it increases with great vigour. It is true that this plant is an annual; but it sheds an abundance of hardy seeds, producing seedlings, which vegetate and easily support themselves in the water, with a slight assistance from the mere remains of their preceding generation. Their thread-like stems remain on the surface of the water till the seed is ripened, they then fall to the bottom and form distinct layers, which in some specimens of peat may be distinctly traced.

The bog-moss thus commenced gradually gets mixed with a variety of lichens, mosses, and scirpi, which annually add to the depth of the accumulating peat, and as the moss becomes firmer other plants gradually establish themselves, such as several varieties of the rushes and sedges. It is only when the peat-moss is raised by the gradually-accumulated remains of these peats from beneath the surface of the stagnant waters that the heaths, the cranberry, the bilberry, and the grass-weeds make their appearance.

The few plants which commonly tenant peat moors and bogs are of the most worthless kind, such as all live stock commonly refuse.

Besides the common heath-plants there are various rushes (Juncus), sedges (Carex), rush-grasses (Schænus), club-rushes (Cyperus), cat's-tail rushes (Typha), bur-weeds (Sparganium), &c.

Amongst the few specimens of the common grasses which are found in such places, struggling as it were for existence, are the marsh-bent (Agrostis palustris), the awnless brown-bent (Agrostis canina). This is a very common grass in bogs whose winter waters are deep. The awned creeping-bent (Agrostis stolaris), the small-leaved creeping-bent (Agrostis stolaris Ang.), the creeping rooted bent (Agrostis repens), the white bent (Agrostis alba), the hote fescue (Glyceria fluitans), tall fescue (Festuca elatior), turfy hair-grass (Aira cæspitosa), knee-jointed fox-tail grass, water hair-grass (Aira aquatica), water meadow-grass (Poa aqua-

tica), long-leaved cotton-grass (Eriophorum polystachion), and the sheathed cotton-grass (Eriophorum vaginatum).

It is of primary importance that the farmer should clearly understand the chemical composition of the peat with which he has to contend, and that of the watery solution with which it is usually saturated.

The common varieties of peat when dried by a moderate heat lose a very considerable portion of their weight, and are materially reduced in bulk. The dry mass consists chiefly of woody fibrous remains of a dark-brown colour, of which a very inconsiderable portion is soluble in water; and even by exposure to the unassisted action of the sun and air, under the most favourable circumstances, it decomposes with extreme slowness. When burnt to an ash the solid product thus obtained varies commonly in its composition with the nature of the stratum of earth on which the mass of peat rests. If this is of a gravelly or argillaceous nature, the ashes are generally chiefly composed of silex, and a small portion of alumina, oxide of iron, with some carbonate of lime and sulphate of iron: if, however, the substratum immediately under the peat is calcareous, then the ashes commonly yield a considerably larger proportion of carbonate of lime, the sulphate of iron (green vitriol) is absent, and the sulphate of lime (gypsum) abounds in its place.

The celebrated Dutch ashes, which are productive of such large crops of clover, are composed of—

Siliceous earth	32 parts.
Sulphate of lime (gypsum)	12 „
Sulphate and muriate of soda (Glauber salt and common salt)	6 „
Carbonate of lime	40 „
Oxide of iron	3 „
Loss	7 „
	100

The liquid with which peat is usually soaked is also equally varying in its composition. It almost always contains a very small portion of brown vegetable extract, a quantity of the red oxide of iron, and when pyrites (sulphur and iron) are contained in the gravelly or other substrata, these are gradually, by the action of the water and the oxygen of the atmosphere, converted to sulphate of iron, which dissolves, and is found in the water. When, however, this solution comes in contact with chalk or other calcareous matter, the lime decomposes the green vitriol, the iron is precipitated, and sulphate of lime, so enriching to some of the artificial grasses, is very commonly found with red oxide of iron, dissolved in the peat water.

The chemical composition of peat-soils of course varies in the

proportions of their constituents. The following analysis of a specimen of an entirely barren peat moss in a perfectly dry state will give the farmer a tolerable idea of their general composition :—

Fine siliceous sand	29	parts.
Inert vegetable matter . . .	289	„
Alumina	14	„
Oxide of iron	30	„
Soluble vegetable matter, with some sulphate of potash	11	„
Sulphate of lime (gypsum) . . .	12	„
Loss	15	„
	400	„

Such is the composition of a barren peat moss. The analysis of an active or fertile peat moss, with which it will be well to compare it, gave the following results, after being also dried in a gentle heat :—

Fine siliceous sand . .	156	parts.
Unaltered vegetable fibre . .	2	„
Decomposing vegetable matter .	110	„
Silica (flint) . . .	102	„
Alumina (clay) . . .	16	„
Oxide of iron . . .	4	„
Soluble vegetable and saline matter	4	„
Muriate of lime . . .	4	„
Loss	2	„
	400	„

Such is the usual chemical composition of peat. This, however, is occasionally varied by the presence of other substances, but the above sketch will afford a tolerably correct view of its ordinary properties ; and this kind of knowledge will very materially aid the farmer in proceeding to examine the mode in which the composition of such soils may be altered so as to be rendered tenantable by useful varieties of plants.

The most common delusion in which the possessors of peat soils are apt to indulge is the belief in the possibility of rendering them permanently productive without either previous drainage or the application of earth. The melancholy attempts of this kind which I have witnessed on the peat land of various parts of England, especially in timber planting, can only excite the pity of those who witness the effects of such misspent time and money. The young trees too, which are most commonly employed in these ill-judged attempts, are usually of the fir tribe, precisely the kind the least adapted to prosper in a bog of water and peat. Common reflection would suggest that, if any kind of trees could

be expected to vegetate with even moderate vigour in soils such as these, composed as they are often of merely a mass of hard inert vegetable matters, saturated with a weak solution of green vitriol—if any kind of plantations would progress, it would be the alder, the willow tribe, or the hardy birch-trees, tenacious of life, which can endure more moisture and subsist on poorer soils than most other plants. After the slightest consideration we should hardly decide upon placing on such swamps trees which delight in dry upland slopes, as the Scotch fir and the larch; yet we can hardly traverse a single line of railway, driven as their constructors have too often been to take for their line of country the most trembling, dangerous bogs, the most worthless heaths, without being struck with the ludicrous appearances of bright yellow-topped larches and ragged sickly-looking Scotch firs, soaking in bog-water—and that too not in mere patches, but over hundreds of acres. I do not confine these observations to the north of England—to Lancashire and Yorkshire—but the remark applies to many of the southern counties: for instance, by the road-side between Wareham and Poole, in Dorsetshire; may be seen similar wet peaty heath plantations of Scotch firs.

The peat soils with which I have had the chief experience have been either those on upland slopes or in the hollows of low grounds, such as near the rivers Kennett and Itchen, and in all cases placed in situations where it was possible to drain them by open or under-drains previous to commencing ulterior proceedings. The under-drainage of peats is usually, especially on high moorish grounds, conducted on very erroneous principles, and with little regard to the after-effects to be produced by it on the peat. The first error to be carefully avoided is placing the drains too near the surface. I have invariably found in deep peats that, where the drain cannot be placed beneath the peat, they should be constructed at least at a depth of from 4 to 6 feet or even more; and this is not adding materially to the expense, for the peat-owner will find that one drain at the depth of 5 or 6 feet will produce more powerful and far more permanent good effects than three drains at a depth of 3 feet. The good results of depth in peat-land drainage will be found by the farmer years after the soil is reclaimed—for, as the peat is dried and its upper portion decomposed and rendered solid by cultivation, the mass of peat gradually and very materially sinks, and this too in deep peats for a lengthened period. And as this contraction is chiefly confined to the upper portion of the peat, the result is that the improving soil of the surface gradually approaches the drains, and that in some varieties of the softer kinds of peat to a very injurious extent. Such too is the porous, spongy nature of most peat soils, that it is difficult to remove entirely the water from those portions

of them lying on a level with the sides of the drains, and in consequence the roots of many cultivated crops are apt to penetrate, under the shallow-drain system, into the corrosive water of the peat, which they never do without material injury.

For it is not, let me again remind the farmer, the mere presence of too much water which renders the peat-moss sterile, but the noxious, astringent, irony quality of that water. Some of the richest water-meadows of the valleys of the Kennett and the Itchen, in Berkshire and Hampshire, are formed on a deep stratum of peat, merely covered with a shallow dressing of chalk mixed with bog-earth; and these are periodically flooded and kept for many days soaking in the bright rapid waters of the Kennett and the Itchen: but then the excellent managers of those prolific meadows take especial care that no stagnant mineral waters shall be allowed to corrode the extreme roots of their grasses; deep drains and lands laid in elevated ridges carry off all these, and keep the surface-soil clear of the red oxide of iron and green vitriol, which are sure to accumulate in situations where chalk mixed with iron-pyrites exists in the immediate neighbourhood. It is only necessary to observe the bright, irony, rusty incrustations of the deepest drains of many of these celebrated meads to be convinced of the nature of the mineral substance against which their skilful owners are so sedulously and successfully guarding.

In the construction of open drains (and some peat-mosses require hardly any other) the improver must be guided by the extent of his field: the larger the peat-moss the more capacious must be the open channels and the greater the fall of the water. It is well to avoid forming these too narrow, so as to make the current of drainage-water too rapid; for the soft, peaty soil is not able to bear even a moderately rapid flow of water.

The materials for under-draining must also vary with the nature of the moss and the facilities afforded by the district. Tiles and stones are certainly the best. The bog itself generally affords heath and rushes: these, when well made, keep open for a long period: they both decay in such places with very considerable slowness.

There is hardly a situation to be found in which the drainage of the peat cannot in some form or other be profitably effected. If the surface of the peat is below the adjoining river, or in hollows, then the well or boring system of Elkington, or even mechanical power, as windmills or steam-engines, may be successfully followed. And again, in many situations where peat-bogs are not far distant from copious rivers, I am certain that great things are to be effected not only by draining the bog-waters, but by raising those of the river on to the surface of the peat. In those localities where this kind of water is to be readily procured (especially if

it abounds with earthy matters), the possessors of the peat-soil would require hardly anything else for their improvement. The steam-engine, I am convinced, has not yet been employed in the service of the farmer to one-half the extent to which it is capable. Its gigantic powers have hitherto been confined to draining the land, but little has been done with it in irrigation; and yet, when the landowner remembers how laboriously even by manual labour this is done in Oriental countries, and that in the fens of Lincolnshire one eighty-horse-power steam-engine raises 7 feet high 51,230 tons of water every eight hours, by the combustion of only 2½ chaldrons of coals; and that, allowing 150 tons per acre, this mass of water is sufficient to irrigate more than 340 acres of land; —when, I repeat, the landowner is reminded of these gigantic powers, he will feel convinced of the probable certainty that more yet remains to be done in the permanent improvement of the soil by the use of the steam-engine than many persons have sufficient leisure to examine or the courage to attempt.

The drainage being effected, the next important object is to furnish the soil with a sufficient quantity of earthy matter to support vegetation, and this may be done in several ways: that by paring and burning, so common in various parts of Cambridgeshire and Lincolnshire, I consider the worst of all modes; for it merely furnishes the soil by an expensively rapid progress with the freed earths of the peat, which its gradual decomposition would by other modes more profitably and steadily effect.

The first operation after the water has been drained off is to break up as deeply as possible, by the common and the subsoil-ploughs, the surface of the peat; and then, if good well-burnt lime can be procured, there is no earthy addition so rapid and so powerful in dissolving and rendering pliable the peat as this. A few ploughings, assisting the combined operations of the atmosphere and the lime, will in a few weeks bring the soil into such a state as to enable it to bear a first crop. The quantity of lime should be about 250 or 300 bushels per acre; but the quantity of necessity must vary with the readiness with which the lime is procurable; where it is very expensive the cultivator is obliged either to reduce the quantity or mix it thoroughly with a proportion of clay or marl before he spreads it over the surface of the peat. Where limestone is to be obtained in the immediate neighbourhood, and other fuel is not to be readily procured, peat may be employed in many cases in the process of lime-burning without much difficulty, it chiefly requiring that the peat should be thoroughly dried previous to its being used. For a first crop on the thus so far reclaimed peat-soils I have found no other crop equal to potatoes. These are best planted in ridges: the horse hoe-plough can then be easily kept at work, which not only con-

siderably promotes the decomposition of the peat, by facilitating the introduction of the moisture and gases of the atmosphere, but this very operation adds very materially to the vigour and produce of this valuable root, than which no other plant more delights in fresh soils, such as that produced by well-drained fresh earth-dressed peaty lands.

It is well to avoid for a year or two all attempts to produce corn-crops on land like that I am describing. The course of cropping which the farmer will almost always find the most profitable is to follow the potatoes with peas, then turnips, oats, grass-seeds, peas, wheat. In all cases, too, he must remember in what small proportions some of the essential ingredients of his crops are at first existing in this peaty soil, and how valuable even a slight dressing of clay or marl will be found in supplying such deficiencies.

And, again, it is here that the services of the manure-drill are available to an invaluable extent in applying bone-dust or any kind of organic or even earthy manure, especially to the young lands' earliest crops. For the natural results of the progress of cultivation—the gradual decomposition of the soil and tough vegetable remains—the accumulation of more easily decomposable vegetable matters—the application of the ordinary farm-yard compost, finally sufficiently enrich the ground with those salts of lime and of potash which form the essential ingredients of all fertile land.

To expedite the accumulation of decomposing soluble matters in the soil several expedients may be adopted. For instance, if the farmer has access to night-soil, an admirable compost may be made by mixing this seven or eight weeks previous to its employment with the peat itself. I know of no other compost so powerful on peat-soils as a compost of well-putrified peat and night-soil: four or five cubic yards of the night-soil is an ample dressing per acre with twelve or fifteen cubic yards of peat. If the farmer has not access to night-soil, let him substitute farm-yard compost with the peat in a rather larger proportion, or even urine or the drainage from his farm-yard. This plan, first, I believe, successfully adopted by the late Lord Meadowbank, is well described by Mr. Dixon, of Heathershow, in an essay for which our Society's prize was awarded to him in 1839.

The farmer must, to derive the maximum benefit from this plan, avoid certain errors, which will else materially deteriorate the richness of the compost. He must be careful to have the peat he intends to use dug for some time previously, and exposed in spits to the drying influence of the sun and winds. The peat, in fact, can hardly be employed too dry; and the farmer will find that, if he makes the compost in the dry warm weather of summer,

he may then use more peat in proportion to his farm-yard dung or night-soil than if he makes the mixture when the temperature of the air is less. In the warm weather of the spring and summer months the cultivator will find one cubic yard of fresh good farm-yard compost sufficient for three or four cubic yards of peat; but in colder weather the proportion of peat must be decreased. The farmer will find that the fresher and richer the animal manure the larger will be the proportion of peat with which it may be successfully mixed. Thus with the rich semi-fluid mixture from the slaughter-houses of London, with one cubic yard of this six or seven cubic yards of peat may be mixed; and I have found on several occasions every reason to agree with Lord Meadowbank, and others who have employed peat in this way, that it is very desirable not to mix more than half the intended proportion of peat at first, but to wait until the fermentation of the mass is somewhat advanced, and the temperature of the heap increased, before the last half is added to the heap. Some persons recommend the addition of a portion of lime to this compost; but this is a plan I do not consider either advantageous or even harmless: for the lime combines with and even partially decomposes some of the richest portions of the animal matters of the manure; and I have on some occasions suspected, from certain appearances, that it retarded, when thus used, the dissolution of the peat. In eight or nine weeks the compost will be ready for use; the peat and dung will be thoroughly mingled together, and the whole heap will have the colour of a dark garden-mould. Of the nourishing quality of this mixture of peat with night-soil or yard-manure, or urine, the farmer will readily convince himself by the fertile effects which it produces; and when drilled with turnip-seed, the roots of the young plants will be found to encircle the lumps of it, just as they do in the case of crushed bones.

If the possessor of a peat-soil cannot well prepare a compost of either night-soil or farm-manure with the peat, he may still furnish his soil with a valuable dressing, by mixing hot lime and peat together, at the rate of one cubic yard of the former with three or four cubic yards of the latter. In this case it is not necessary to dry the peat previously, for the lime readily absorbs the water contained in it, and in the course of seven or eight weeks the entire mass is reduced to the state of mould. From some experiments which I have made on a small scale, I have found that the addition of a portion of common salt to the lime, not exceeding one part of salt to three parts of lime, will still more increase the fertilizing powers of this peat compost; but my experiments on this head require repetition before I can confidently recommend this plan for the farmer's adoption.

When once the peat is well drained, a very thin covering of

earth will produce much greater effects in forming a solid soil than the farmer may imagine possible: the facility with which roads are made across the extensive deep Scotch peat-mosses and the great Irish bogs in some degree illustrates the same fact —the bog when once dried is found to require only a thin layer of gravel to make an excellent road. It is true that these are apt to tremble pretty considerably under the feet of the plough-horses, but they bear the heaviest carriages with perfect safety, even in places where the bog of peat is of a depth of from 20 to 40 feet.

Peat-moss lands are commonly divided by the deep ditches or channels by which they are drained. If hedges are necessary, there is some difficulty in raising them of quick, or any of the ordinary hedge-row plants, until the peat is thrown up into banks for some little time and is tolerably decomposed. A little manure, either earthy or from the farm-yard, materially adds, I have found, to their rapidity of growth, and is certainly not an expense thrown away. With hedges thus formed the failure of the young plants is but rare—the hedge is much more quickly formed—the expensive use of hurdles is diminished. The same remarks apply to the timber-trees: for such soils, birch, the larch, the Spanish chestnut, with a very slight dressing with lime, or marl, or clay, will do well on well-drained peat; and if the earthy additions are liberally bestowed, such plantations very rarely fail to abundantly reward in more ways than one the possessor of the estate for all the expense he has bestowed in their formation.

These I have found to be the chief points to be attended to in the improvements of peat soils, a description of barren waste which perhaps abounds more in these islands than in any other European kingdom of equal extent. Their improvement, either by converting them into cultivated fields or for the formation of timber-plantations, is a question of national importance; for every bog that is thus added to the farmer's possessions not only enlarges, as regards a supply of food, the internal resources of the state, but increases the demand for agricultural labour, banishes unwholesome stagnant waters, purifies the atmosphere, and even renders the climate of the district perceptibly milder.

XXXV.—*Some Account of the Practice of English Farmers in the Improvement of Peaty Ground.* By Ph. Pusey, M.P.

Although the improvement of peat is not a subject that can be of general interest, yet, as there are large tracts of such land in the country, and as I have had the advantage of observing in my own neighbourhood the mode in which it has been improved by good farmers, as well as of receiving information from members of our Society who have reclaimed peat in other districts, I think it may be of some use if I endeavour to describe their various methods of management. Our science, we may hope, would gradually advance, if we could obtain faithful accounts of our actual practice upon each variety of our soil. The peat I am most conversant with follows generally the borders of all the rivulets in this level stone-brash country. Along the margin of each sandy arable farm there runs a belt of such poor marshy ground. Long after the meadows are green in spring these pastures retain the brown of winter: in summer they are covered with rushes and coarse grass, but are of some use for the sheep in dry weather: in autumn they soon return to their withered hue; and in winter again they are scarcely to be passed on horseback. Almost every kind of tree has been planted upon them in vain; but the birch, the alder, and the abele, not the least ornamental of our trees, I have found to grow with some vigour: they are too poor for the willow.

The first step of improvement is of course to acquire command of the water and obtain an outfall by digging a straight ditch, about 8 feet wide, and 5 deep, down the middle of the hollow: this takes the place of the winding stagnant rivulet that is frequently found there. In wider bogs more of these ditches should be dug, and one may be placed on each side so as to divide the peat from the sound land, and thus cut off the springs which ooze from the higher ground. However slight the apparent fall of the ground, it is generally practicable, by carrying along the new watercourse to a sufficient length, to reduce the level of the water 3 or 4 feet permanently below the surface: this then is the first and indispensable step, the open drainage; the next is the under or close drainage: it has been done on the Deanston principle, thorough-draining. The parallel drains have been cut to a depth of 30 inches in the gravel underlying the peat, the materials being tiles and broken stones over the tiles, covered with a sod 16 inches below the surface; the distance between the parallel drains varying from 20 to about 80 feet. The levels are so flat that tiles have been often necessary. It is essential that these drains should be formed before the surface is broken up, that the work may be clean for the labourers: winter and early spring will be the most convenient seasons. In Lincolnshire, however, the heavy expense of under-draining has

not been required. Deep open ditches, dividing the peat into fields of 12 or 15 acres, have been found to lay it sufficiently dry.

When the draining, of whatever kind, is completed, the question next arises how the coarse and rushy swamp is to be brought into cultivation. I must say that the practice of paring and burning the surface employed by our farmers has been justified by its effects. As soon as the harsh easterly winds of spring have set in, the breast-ploughs are put to work, the surface is pared and turned over, and, when dry, piled in heaps and burnt to ashes. The proceeding may be defended I think on these grounds:—If the coarse sward filled with the roots of rushes were merely ploughed over, it would not decay during the whole summer, and would be far too tough and hollow for any crop that might be sown on it. Again, when a fertile well-dressed surface is burnt, the volatile parts of manure which it contains may be dissipated by fire, but on the land we are dealing with there is no fertility to be destroyed. Lastly, the ashes which are produced are a manure peculiarly adapted for the crop which experience has taught the Lincolnshire farmers to make their first crop on such land; that crop is rape, a plant not generally grown in this country. On such ground so prepared it shoots up with unfailing luxuriance, resembling the tops of strongly growing swedes, but forming a dense mass of dark leaves, about a yard high, through which it is difficult to make one's way. Although peat may be well suited to the growth of rape, it is to the peat-ashes I believe that the chief strength of its vegetation is due. In fields where the soil is moory but not a pure peat, when they have been pared and burnt in the same manner, a singular appearance presents itself which proves this point. On the spots where the heaps have been burnt may be seen dark tufts of rape growing in the vigorous manner already described. On the rest of the ground you can hardly distinguish the pale blue or purple dwindled plants of rape scarcely raising themselves from the surface and choked with grass. This fact illustrates in some degree the chemical laws of the food of plants; for Dr. Liebig states that peat-ashes contain a small proportion of potash: I believe that the rape itself also contains potash: hence probably the wonderful influence of peat-ashes upon its growth. There is also a further circumstance which may be remarked; the quantity of ashes which thus occasions the difference between a strong plant 3 feet high and a feeble weed of a few inches is very small: but, of that small quantity, the potash and other salts which enter into the composition of the plant and enable it to bring forth its tall stem and broad leaves are still more minute: the ashes cannot then be called the food of the plant; they can only aid the plant to make use of the other matters of which its vegetable

frame is formed; yet they act precisely as farm-yard dung, which is supposed to afford the substance of vegetation. Such is the fact; the explanation remains for that chemist who at some future day shall unfold to us the great mystery of the food of plants. I must return, however, to practice: the rape which has been sown in May is fed by sheep penned on the ground from the middle of July or from August.* As it shoots up again from the root it may be penned twice over, or even three times, before winter. On the best managed field of this kind which I have seen, a flock so penned received corn latterly with the rape, and was sold fat in November. Farmers will be well aware how much that field must have been benefited by the improvement which corn imparted to the dung of the sheep. Swedish turnips have also been grown upon this land instead of rape, and on the best of it, where the peat is not pure, answer well: as much as 16 tons, a fair crop for a southern county, may be raised on the acre. They are not, it is true, so certain as the rape, nor are they so firm and nutritious as swedes grown upon sound ground; hares will not touch them while other swedes are to be found. If sown early they are apt to decay on the ground, and they do not keep well in store; still they must be sown early as well as other turnips, because their growth is slow on such land when the days have shortened; and sheep are said not to thrive if penned upon it in winter.

I have omitted, however, to mention the manner in which the rape or swedes are sown; and, in now adverting to it, I have to state an instance in which the knowledge of a practical farmer was better than my own theory. I had been very desirous that one of my tenants should subsoil-plough his peat-land after it had been drained, in order to let down the water through the tenacious subsoil: this he was very reluctant to do, because in his opinion it could not be ploughed too shallow. He was unwilling even to plough it 4 inches deep, thinking the depth of 2 inches enough. Now it happened that in a peaty field of my own, which had just been broken up, one half of the 25 acres was ploughed 2 inches deep, the other half, contrary to my intentions, 4 inches deep. On the half which had been ploughed shallow I found a very fine growth of swedes; on the other, which had

* Mr. Wingate, however, writes to me that in Lincolnshire they "never sow rape alone so early as May, but chiefly in the middle and latter end of June, and stock it as soon as the weather becomes sufficiently cool, so that it will not injure the lambs, which in warm weather are subject to have the blood-vessels of the ears much enlarged, and often lose a part of the ear, if not taken off the rape for a few days, which generally sets them right again. It is generally consumed in the months of October, November, and December, before it is injured by severe frost. Of late years the crops have not been more than one-third of the original crops."

been ploughed deep, about 8 acres were almost perfectly bare, nearly every plant having been destroyed by the wireworm. The looseness of the ground arising from the deeper stirring may have rendered the progress of the wire-worm more easy; but I think the true cause of the destruction was the enfeebled state of the plant, in consequence of which it perished under the attack which greater vigour would have enabled it to survive. This I believe is often the case, and certainly under the strong swedes on the firmer land an equal number of wireworms was to be found. The farmers in fact here, led by experience, carry to a great length the principle of keeping such poor light ground as tight as possible. I should have mentioned that the rape is planted by sowing it broadcast on the unmoved ground after the ashes of the first breast-ploughing have been spread, the seed being afterwards covered by paring and turning over another thin slice of the surface in a second breast-ploughing. On one farm 50 acres of land, which though not peat are peaty, and equally loose in texture, were broken up from grass three years ago, and have been cultivated ever since by the breast-plough alone. I did try the subsoil-plough last year on 2 acres of peat, cutting through a subsoil of weak clay, and it appears to me that the present crop of swedes has suffered materially by the consequent looseness of the ground, the land being but half covered with plants: indeed, although it has been thorough-drained, it has returned to the state of bog, and is once more almost impassable. It is right, however, to mention that in Lincolnshire deeper ploughing is practised. Mr. Handley writes to me, "the peat is ploughed as deep or deeper than other lands. A relative of mine has for years been in the practice, when the surface has become exhausted by cropping, of ploughing with two ploughs in the same furrow, depositing the topsoil in the bottom of the furrow, and raising the subsoil from the depth of 14 inches to the top, with most beneficial results; but if that depth was exceeded the following crops were bad." But even there the practice is not unanimously approved, and Lincolnshire farms have been by no means exempt from the wireworm. On Exmoor, too, in Somersetshire, I have lately seen subsoil-ploughing practised upon peat by Mr. Knight with success; but there the peat, about 8 inches thick, rests on one or two inches only of retentive earth, to which its growth is owing. Below this crust a porous stone-brash is found. The wetness of the climate may also remedy the hollowness of soil produced by the subsoil-plough. The shallow ploughing of our farmers seems to me to be decidedly right upon our own peaty and other loose soils.

I may mention another mode in which this principle has been

applied with success for some years by Mr. Williams, at Buckland, on a light blowing sand, as it is called, as it seems to answer equally well upon peaty ground. In the common Northumberland system of growing turnips it is well known that the ground, when sufficiently ploughed, is thrown up into alternate ridge and furrow with the double-breasted plough, that the dung is placed in the furrows, the ridges split, so that what was furrow before now becomes ridge, and the turnips drilled upon this new ridge standing, of course, over the hollow earth which has been filled into the furrow. But upon a very light sand Mr. Williams, thinking it desirable to keep the ground firm under the root, whether turnip or mangold-wurzel, proceeds in this way:—The ground is ploughed first very shallow—upon peat it may be merely scarified; the dung is then spread upon the land, the double-breasted plough is used, as in the common mode, to throw up ridges; but the process is now complete, and the turnips are drilled at once on these first-formed ridges, so that, while the dung is collected round them as in regular ridging, they have a solid bed to stand on in this bastard-ridging, as it may be called; and I must say that a trial I have this year made of this method with swedes upon peat has confirmed Mr. Williams's experience upon sand. This operation, however, which I have mentioned in order to show the leading principle acted on here by farmers in the cultivation of peat—tightness of ground—applies to a later crop of swedes: at least in the first crop no dung could be required, the ashes being amply sufficient.

Rape or swedes being established as the first crop, after the breaking up of peaty land, in the system I am describing, the next crop is usually oats: they are drilled in upon a very shallow furrow, with plenty of seed, and well pressed with a press-roll as well before they are come up as afterwards, in order to guard against the wireworm, the enemy to be feared on such land. It is remarkable that by very late sowing, as late as the end of April or beginning of May, you may be almost certain to escape the wireworm—it is supposed, because the oat grows more rapidly out of their reach; but on the other hand it will be harvested late; and there is this further disadvantage, that the grain, which is always light on such land, will become so much lighter that you perhaps lose in weight as much as you gain in quantity. I may observe that the oats do not ripen together upon this ground: the farmers cut them while they are partially green, because they find that, if they wait until the whole crop has changed its colour, the best grains, which are those that first ripen, shed in the mowing and carrying, whereas these are preserved by early cutting, while the unripe grains and green stalks improve the straw as fodder for cattle.

This first crop of oats is generally beaten down by the weather, being weak and long in the straw, and, though not a bad crop, looks better than it really is.

On land which is not peat but peaty some farmers grow barley: there is a large crop of straw, and it is therefore liable to be laid; the grain, too, is but thin. The advocates of barley, however, assert that a bad sample of barley is better than a bad one of oats, because thin barley may be ground or may be used for seed, whereas seed-oats should be as plump as can be found. On the other hand, it has been stated to me by a gentleman residing in Lincolnshire that "he considers barley the most objectionable grain which can be sown upon peat-soil, and that its injurious effects are visible for five years."

The rape and the oats will generally have proved successful, and indeed by their luxuriance may lead one to suppose that more improvement has been made than is really the case. It is now that doubt and difficulty begin. The oats or barley are followed by rye-grass, which has been sown among them, but if these have been laid, as they often are, large patches of the rye-grass will have been destroyed. Even if they have not been laid, the peaty soil will perhaps throw out many of the grass-plants by the roots in the next winter, and still more in the succeeding one, if, as is usual here, the rye-grass be left for two years. The motive for so leaving the ground two years in grass is that it may regain solidity before it is again ploughed: still this is but a poor rotation which gives only one crop of corn in four years. On the other hand, if the ground were left permanently in grass, there is reason to suppose that in a few years the fine grasses would wear out, the coarse herbage return, and the land be no better for the expenses incurred in drainage. Nay, one farmer thinks he had observed it become worse, because the aquatic grasses natural to peat no longer obtained the moisture which they require, and the better grasses do not grow well. In order to meet this evil the gravel or rubble which has been taken out from the main drains is spread over the ground in the winter before the oats are sown: and, however sterile and hungry be the material thus used as a manure, there is no doubt that it produces a strong effect, for the rye-grass is much thicker and sweeter where this has been done: this is called firming or weighting the land; it is good as far as it goes, but the staple of the soil is still very weak. When wheat is sown on ground that is at all peaty, it will almost certainly lose plant in large patches, even though the land has been dunged, and the young wheat has been trodden in by women, as is sometimes done in the spring.* There is clearly

* If wheat be tried on land approaching to peat, it is thought that blue cone wheat affords the best chance of a crop.

some principle defective in the composition of the soil: that principle is cohesion, and can only be supplied by clay. The fen farmers of Lincolnshire accordingly apply clay to peat-land by a process which has been carried on largely in the fens for many years. The operation and its effects are detailed in the following letter with which Lord Sandon has furnished me: it is from Mr. Cooke, who manages Lord Harrowby's estates in Lincolnshire:—

"*Digby, March 5th*, 1841.

"My Lord,—I forwarded by Deacon's waggon yesterday from Grantham a small box, containing specimens of the soil of Digby Fen. The clay is 4 feet from the surface. The plan I pursue is to fallow the land for cole or turnips, laying on 15 bushels of bones per acre. In the winter I set out the lines for trenching 11 yards apart, and mark out 3 feet in width for the trench, to be dug down through the peat, which is 3 feet deep, with sides sloping outwards; so that, when the surface of the clay is reached, the lower part of the trench is 4 feet wide. We then dig out 4 feet in depth of clay, throwing it out on both sides, so that the mass of clay thrown out is 2 feet deep and 4 feet wide throughout the whole length of the trench. The expense is 54*s.* per acre.

	£.	*s.*	*d.*
1st year.—In the original state of the soil the produce is 5 qrs. of oats, 10 stone gross, at 20*s.* per qr. .	5	0	0
2nd year.—Seeds (herbage thereon), 4 sheep per acre, at 3*d.* per head, from the 1st of April to the 1st of October	1	4	0
3rd year.—20 bushels of very light wheat, say 16 stone gross, if clean enough for seed 50*s.* per qr. . .	6	5	0
	£12	9	0

	£.	*s.*	*d.*
1st year.—After trenching it produces 6 qrs. of oats per acre, 12 stone nett, at 24*s.* per qr. . . .	7	4	0
2nd year.—Seeds (herbage thereon), 7 sheep per acre, at 3*d.* per head, from the 1st of April to the 1st of October	2	2	0
3rd year.—30 bushels of wheat per acre, at 58*s.* per quarter, 17½ stone nett	10	17	6
	£20	3	6

Throughout the fen the soil is a vegetable surface, upon a clay or gravel bed; if the latter, the land is of but little value for want of clay to give it solidity. The calculations I have made are applicable to the fen-land in the following parishes:—Digby, Dorrington, Ruskington, and Anwick.

"I shall be very happy to leave the above remarks in your Lordship's hands to make whatever use of them your Lordship may think proper.

"I am, my Lord,

"Your Lordship's obedient humble servant,

"George Cooke."

This statement, coming from a man of business, acquainted with the practice which he describes, is well worth attention. The benefit effected is very great in proportion to the cost and labour incurred; for the cost is only 54*s*. per acre, and it is nearly repaid at the end of the second year. There is a marked improvement in the quality both of oats and of wheat, and in the latter grain a great increase of quantity. Indeed it hardly appears how it could be worth while to grow wheat at all on such land before the clay is laid on, whereas afterwards the produce, 30 bushels of good wheat per acre, is rather high. This Lincolnshire method appears, therefore, to be the cheapest of all improvements, where the clay is found under the soil, though even so deep as 4 feet, and its effect is supposed by Mr. Cooke to last fifteen years. It has also the strong recommendation of being not an experiment, but a practice. The great extent to which it has been carried, and its efficacy, are thus described by Mr. Morton, in answer to an inquiry which I addressed to him:—

"The fens of Lincolnshire have been increased in productiveness at least 100 per cent., merely by applying to the surface of the peat the clay which is found at depths varying from 2 to 5 feet below it.

"This application is made thus:—Trenches, parallel to one another, are made, 11 yards apart and 3 feet wide, down to the clay; and then 2 feet in depth of the clay is thrown out, one half on each side. The effect of this, after the second year, is greatly to increase the productiveness of the soil—in many cases to double it.

"This mode of improving peaty soils extends over a very large district; indeed it is equal in extent to the extent of the fens, for, although the whole of the fen-land in Lincolnshire, Northamptonshire, Huntingdonshire, and Cambridgeshire, has not been so treated, yet there is scarcely a farmer but what has and is now proceeding with this most important improvement. I have witnessed this operation for the last 15 years; and I believe it was begun long before. Mr. Wingate's estate at Leake has thus been clayed once every six years, and each repetition has the effect of adding to the permanent productiveness of the peaty soil."

This operation of claying peat is one of the methods by which English farmers have for many years been silently changing the face of the country, which now constantly come to our knowledge, but for which they have not hitherto received the credit due to them: its effect is so wonderful that I ought not to withhold a further account of it which I have obtained from Mr. Wingate himself, whose farm at Leake is mentioned by Mr. Morton:—

"Dear Sir,—I will endeavour to describe to you what we have done in our east fen since its great improvement by drainage, confining myself to that land which I consider decayed vegetable matter on a clay or silty subsoil at various depths, and which had been under water generally for ages in the winter season, and getting partially dry in the summer.

A great deal of wood in the first instance was taken out of it—nay, in fact, is still in many parts where the plough goes a little deep, chiefly oak, I believe, but in some instances maple, poplar, and aspens, all lying in one direction. At the time of the first enclosure, from what I hear, the land was brought into cultivation by paring and burning, sowing with cole (rape), then afterwards oats and rye, which oats it grew of very bad quality, being very light, say 7 or 8 stones the sack of 4 bushels, and I believe it nearly ruined the first class of occupiers. I did not myself begin to occupy land there before the system of claying was found out, and wheat had begun to be partially grown. Since that time it has been managed with very great success in various ways, until the late unfortunate attack of the wireworm, which has materially decreased its productive qualities. We have the 4-field, and in some instances the 5-field course, which I consider a sharp dose for any land, namely, 1. Turnips; 2. Oats; 3. Wheat; 4. Seeds mown or grazed; 5. Wheat. With regard to the management of my own farm, concerning which you inquire, I have occupied a small farm nearly in the centre of the East fen for some years, besides that on which I reside. It had been occupied before I took it by a tenant, and had been all clayed over once at my expense. After getting it into my own hands, the first thing I did (it being very much out of condition) was to fallow it thoroughly and sow it with cole, and I had some very fair crops. After that I clayed it again: we usually have our clay-dykes 11 yards from the centre of each, taking off the peat and putting on the clay, 3 feet wide by 4 feet deep, a very heavy dressing, being nearly 300 cubic yards per acre. After that it was sown with, 1st year, Oats; 2nd, Wheat; 3rd, Cole with manure; 4th, Oats; 5th, Wheat; 6th, Cole or Turnips well manured, and then clayed over a third time the same as before; and most certainly I had very productive crops, that is, as much as 5 qrs. of wheat per acre, and from 8 to 9 qrs. of oats, all of very fair quality. I began again to clay the fourth time, but not with the same favourable results, and have only done some little over again, thinking the lands have got quite sufficient solidity; in fact, some of it is, I consider, almost over-clayed, particularly in a season like the present. I do not attribute my getting less produce of late years to the over-cropping of the land, but to the destructive ravages of the wireworm. Still I do consider, on the whole, I have fared much better than my neighbours, who generally have some portion of their land in seeds either mown or summer-grassed. In my experience there never has been so destructive a season as the present for the wireworm—whole fields entirely destroyed, and what was left very much injured. Perhaps I ought to add, I have generally consumed 6 or 8 tons of oil-cake, with about 12 acres of meadow-land hay, to assist in converting my straw into manure. The size of that farm is about 100 acres. I ridged some peat-land for turnips one season, with but indifferent success; and I always find the corn much better and much less infected with the wireworm in the clay-dykes, where the land has been turned over perhaps from 3 to 4 feet in depth. We attempt very heavy rolling; tread the wheat-land with men or women in the spring; but if we have cold, backward weather, all we can do appears of but little avail against the destructive

insect. I might also add that there is a good deal of silt, or clay of a silty nature, lying under the peat in many parts of the fen-lands, and the wireworm appears there to be much more destructive if the lands are not very well manured, so that the crops, particularly the spring-crops, may grow right away without a check.

"I have mentioned your note to a neighbour and much-respected friend of mine, one of the best cultivators of the soil I ever saw, and he falls in partly with your views of shallow ploughing. I certainly do not. It is possible in the first instance, if you put on a small portion of clay, by ploughing deep you may lose it; then I would say in reply to that, I would clay the land, and sow the crop without ploughing at all, simply well harrowing or scarifying it, then breaking it up and well mixing it. On some peaty land of wretched quality where I live I have doubled, nay trebled, the produce by drainage and very heavy claying—say more than 200 yards of clay carted on an acre of land—in the first instance white marl, which I saw do little or no benefit; then blue clay, which did more to the wheat-crop than I could under any circumstances expect. The turnips, I know, cut no great figure only where some horse-manure was laid, and they promised to be of double the value of the others.

"I beg to remain, dear Sir,
"Yours respectfully,
"Wm. B. Wingate.

"*Hareby, Nov.* 13*th*, 1841."

Mr. Wingate, as is shown by his letter, has adopted a course of cropping which, in inferior hands, would be a severe one—two corn-crops in every three years; but that course is warranted by his high farming, the consumption of 8 or 10 tons of oil-cake in feeding the stock of 100 acres, and is justified by the produce; for he has grown on land, naturally an impassable waste, crops of corn so heavy, and in such rapid succession, as few of the old rich loams of the country have been supposed able to yield. Mr. Cooke, it will have been seen, observes in his letter, that, where peat lies upon a gravel subsoil, it is of little value for want of clay to give it solidity. Mr. Wingate, however, has carted 200 yards of clay to the acre upon such land with success. I have also carted clay upon peat, but with less activity, not more than 40 loads to the acre; yet, after this inferior dressing, the land is supposed to become capable of bearing wheat, and I can confirm the statement made by Mr. C. Johnson in his prize essay, that a very small quantity of earth has a surprising effect in rendering peat solid, which is the main object to be aimed at in its improvement. In wet weather, even where the peat has been thorough-drained and upon an oat-stubble, a horse will sink in to the fetlock; yet, where so slight a dressing of clay as 40 cartloads has been applied in the previous winter, he will find a firm footing.

I do not quite agree with Mr. Johnson as to the application of lime in the quantity of 250 or 300 bushels per acre, although he has high authority in the theory of Sir Humphrey Davy; not that I so much doubt its efficacy as fear the expense, for, where lime costs 4*d.* per bushel, there would be an expenditure for lime alone of 4 guineas or 5*l.* an acre, and at 6*d.* per bushel it would reach 6 guineas and 7*l.* 10*s.*—serious additions to the other costs of improvement. Indeed, Sir Humphrey Davy's opinion, that quicklime will dissolve peat, is now much doubted; lime, too, is generally applied not in a caustic but in a slaked state, and the advantage of burning lime for farming purposes is by many supposed to consist merely in its consequent reduction to a fine powder.

As this is a point, however, on which the farmers of one half of England, the western side, would probably give an opposite opinion to those on the eastern side, while in Lincolnshire a most important improvement has been made with clay only, and lime has been often tried without any advantage, it is right that I should now mention two instances of great success effected by means of lime. For the first case I am indebted to Dr. Buckland, on whose application Sir Charles Monteith furnished to him the following account of some extensive operations on peaty land in Scotland:—

"*Edinburgh, Nov. 7th*, 1841.

"My dear Sir,—It is the general opinion amongst improvers of peaty soils that lime is absolutely necessary to produce crops of grain well filled with farina; and I found from experience, in the improvement of part of my peat-meadows in view of my house, that when the first crop grown upon it was potatoes, well dunged but without lime, the potatoes were found to be hollow in the heart of them and very watery, while in other parts of the meadows upon which dung was employed potatoes of a good quality were produced when lime was employed in addition to the dung.

"The farmers in Scotland think that they cannot raise good crops of grain without lime, as the greatest part of the south of Scotland is composed of new red sandstone, grauwacke, and granite, and therefore devoid of lime, which forms a very considerable portion of every fertile soil; indeed it was found that the soil in Dumfriesshire did not produce well-filled barley-crops till the farmers employed lime, which they now do to a great extent, and find it equally useful for potatoes and turnip-crops, which is amply testified by the farmers purchasing lime to the amount of 3000*l.* annually from my lime-quarry at Close Farm.

"You are correct in saying that a considerable part of my peat-bog improvements have been made by lime alone, and have been productive of very tolerable crops of hay. I have always considered peat more suitable for crops of grass than corn. In addition to the lime I have commonly employed 50 or 60 tons of sandy earth to the imperial acre of peat-bog.

"I have improved about 200 acres of peat-bogs, the average not worth

6*d*. the acre in their natural state, now worth fully 3*l*. A considerable part of it was very expensive to accomplish, as it was necessary to fill up large holes from which peat had been dug for fuel: many acres of it cost me upwards of 30*l*. the acre; but still this ground remunerates me for the expenditure of so large a sum, besides removing an ugly object in the middle of the low grounds in the neighbourhood of my residence; every hollow, of which there were many within a mile of the house, was filled by an ugly, useless, black peat-bog.

"I do not recollect whether I pointed out to you some grass-fields that had been improved from black moor-land, by first paring and burning, and then ploughing the first season, the ground being exposed to a winter's frost, and during the next summer laying about 160 bushels of lime upon the imperial acre, and sowing out the ground in July or August with 5 bushels of the holcus lanatus without taking a corn-crop. The reason why I did not take crops of corn from moor-ground generally having a peaty surface of 4 or 5 inches was to keep it in a compact state; as I have found that soil of this kind, after bearing crops of corn and being frequently ploughed, becomes so loose and pulverised that the feet of cattle completely destroy the pasture, and that the roots of the grass are injured by the loose state of the ground. This grass-land has given me upon the average from 12*s*. to 14*s*. per acre annually, in its original state not worth 1*s*. 6*d*. The moor-ground upon grauwacke after this improvement is much more valuable than where the subsoil is sandstone.

"I have employed lime as it is practised in Derbyshire to great advantage upon the surface of moor-land; but as it requires a very large dose of lime, it can only be done where lime is cheap, as it requires from 200 to 300 bushels of lime per acre to destroy the great quantity of vegetable matter in moor-soils, which it soon accomplishes, as is shown by the land being soon filled with moles, which are drawn to it by the decayed vegetable matter producing worms, the food of moles.

"In Craven, in Yorkshire, lime is employed very extensively as a top-dressing even upon a limestone-soil. I have found that cattle feed upon pasture well top-dressed with lime much quicker, and that the meat is much richer and better mixed, than upon pastures apparently equally productive of herbage.

"I remain, dear Sir,

"Yours truly,

"C. G. Stuart Monteith.

"*The Rev. Dr. Buckland.*"

It is certainly a very successful operation to have improved, at whatever expense, 200 acres of land from the value of sixpence per acre to that of three pounds. I have lately seen as great an improvement upon the property of Mr. Blake, at Upton, in West Somersetshire. The peat-bogs there lie on the slope of a hill. The mode of treatment was this:—To underdrain at depths varying from 3 to 6 feet, to pare and burn the surface, to grow turnips two years successively, dressing twice with 50 bushels of lime

per acre, then to lay the land down with grass-seeds to permanent pasture. The grass is let yearly at sums varying from 3*l.* to 4*l.* per acre. It is singular that in one field so treated, and afterwards watered, no trace of the peat remained in the upper part of the soil, which had become a pale-coloured earth—I suppose by the entire destruction of the peaty substance. The grass on this land is sweet and close, like the turf upon chalk downs, and the land almost as firm. This land is on the same subsoil with Sir Charles Monteith's, the grauwacke or shillet, an imperfect clay-slate, which in Somersetshire, as in Scotland, is considered favourable to grass.

It is proved then, by the success of farmers generally in the fens of our eastern counties, of Sir Charles Monteith in Scotland, and of Mr. Blake in West Somerset, that peat, which by nature is the most unpromising of all wastes, can be profitably improved, and even be raised to the rank of our most productive soils. But, in order to effect this great benefit, it is considered necessary that either clay or lime should be applied to the surface—which, however, of the two is not certain. Finding this variety of practice, I have endeavoured, in the course of drawing up this statement, to obtain fresh evidence in order to clear up the point. I cannot say that I have succeeded in clearing it up; but the facts which have come to my knowledge may serve as materials for future inquiry, and I ought therefore to lay them shortly before the Society. It occurred to me that, as the Lincolnshire farmers, who had been so successful in the use of clay, had derived no benefit from the use of lime, the Lincolnshire clay possibly contained lime already. Mr. Cooke, at my request, sent me two specimens of clay from Digby Fen: one of these, a very strong clay in appearance, effervesced much with muriatic acid, and consisted entirely of finely-powdered lime mixed with fine sand. It contained, I believe, scarcely any true clay; it is, in fact, a strong blue marl. The second specimen contained no lime at all, some true clay, and a great deal of fine sand. Mr. Cooke stated, as I expected, that the first specimen was a much more effective dressing than the second: but I learn on the other hand from Mr. Handley, that a clay resembling Mr. Cooke's second specimen had been used with great success by a relative of his own; and a clay of Mr. Wingate's, which I examined three years since, certainly contained no lime at all. Lime, therefore, is not indispensable for the improvement of *some* peat. Dr. Buckland suggested to me that such peat may contain lime already; and I have since found his conjecture perfectly right in the following instance. On my mentioning to Mr. Wingate that some of the Lincolnshire clay is in fact marl, he replied that he had carted marl upon peat without benefit, but had found clay to answer upon the same peat. I

asked him therefore for specimens of the two substances. The marl, which had entirely failed, proved to be a white tenacious marl, consisting entirely of powdered lime, apparently unmixed with any other description of earth. The blue clay, which had succeeded, was in fact a marl also, containing a large quantity of lime mixed with clay and fine sand. The peaty soil when mixed with acid threw up bubbles copiously; so that, as Dr. Buckland had anticipated, it contained enough lime in its natural state. In another part of the fens a white marl lies so near the surface of the peat that it is purposely brought up by the plough, and thereby forms what is locally called grey-land, a soil of known fertility in that district. I am not aware whether this peat contains lime naturally.

But although we must remain for the present uncertain as to the application of lime to peat, there are some rules which those who are desirous of reclaiming their peaty land may gather from the practice of English farmers, to serve for their guidance until further discoveries shall have been made. Peat must in the first place be laid dry by open ditches, and further, where necessary, by under-drains also. It may be pared and burned, and sown with a shallow furrow (for all farmers agree that this first ploughing should be shallow) to rape, swedes, or turnips—sown early for the reasons already given. It is next necessary that some other earth should be laid on the peat; if the subsoil be clay, that clay should be brought up from wide trenches—if it be gravel or sand, I would bring up a portion of it, however poor it may be: if clay be near at hand, I would cart* it upon the peat.

There is, however, some difficulty in carting clay upon peaty ground, for the lumps of clay must be spread on the ground and exposed to alternate frosts and thaws, expanding and contracting them, which gradually break them down by the spring. The peat, however, is generally so soft in winter, that it will scarcely bear up a loaded cart, unless during a frost, so that the work is often interrupted. The clods may also be reduced by exposure to alternate drought and moisture in summer; but this is a less convenient time for carting the clay, and it must take place on the rye-grass, which is therefore lost. If spread in

* I find, in a recent publication by Professor Johnston, of Durham University, that carting clay upon peat is also practised in Scotland. Professor Johnston states "that Mr. Garden, of Glense House, near Dumfries, has found it necessary to lay on a coating 6 inches thick, at an expense of 15*l.* per acre. A coating of 2 or 3 inches on *their* peat, he says, sinks down, and in a few years descends beyond the reach of the plough; and hence it is more economical to lay on at once an entire soil of 6 inches." The labour of this operation seems to me formidable.

winter after rape or swedes, the clay is harrowed in dry spring weather, and ploughed in with a 2-inch furrow, or scarified. I would on no account burn the surface again after it has been spread, because it is well known that clay once brought to the state of brick, however finely ground, never recovers its quality of cohesion.

It must be remembered, also, that there is a wide difference among clays; and, where the heavy expense of carting is incurred, it is of course important to choose the most effective clay, in order that a smaller bulk may be sufficient. The Lincolnshire plan when tried here seemed at first to fail; for it had the singular effect of making a crop of swedes run up entirely to stalk, without forming any bulb: the subsoil thrown up, however, turned out not to be a true clay; when dry it fell to pieces, and showed itself to consist chiefly of a yellow limestone gravel, and sand. Some marly clay applied to the same peat has evidently improved the swedes. Clay for this purpose should be, I believe, of the most solid and glutinous kind, so that, when it is dug, as much, according to a farmer's expression, should come up on the back as on the front of the spade. However wet the place from which it is taken, it should feel solid when rolled in the hand: if it be loose and liquid, it probably contains too much fine sand; if gritty, coarse sand. When tried in water, according to Mr. Rham's process, it should not fall to pieces, but dissolve with great difficulty, and should afterwards remain suspended in the water, not letting fall much sediment of sand; when dry, it should be hard, compact, and rather smooth. If it throws up air-bubbles on being mixed with an acid, I should like it the better. If no clay is to be found, I would try carting sand. If, after these additions have been made to the soil, the corn still yields a lean grain, I would try a dressing of quicklime, at the rate of 50 bushels per acre, but in the first instance on a few acres only. Mr. Cooke recommends bones for peat; and I have found them answer myself. The second crop is oats. These, if sown late, are more likely to escape the wireworm, and with that object, although the practice of good farmers is divided as to the depth of ploughing, I would also try shallow-ploughing. Rolling, pressing, and treading with sheep, may be also necessary. In the Western parts of England, however, where there is a greater tendency to produce grass than corn, and where lime is an established manure, I should follow local experience by giving at once heavier dressings of lime, and laying the peat down with the rape or swedes to permanent pasture. Yet even there, though lime be made the foundation of the improvement, I think it might be worth the farmer's while to try whether the application of some

other earth* to the peat would not enable him to dispense in some degree with the serious expense incurred by very large doses of lime.

I have been led into greater length than I had intended in describing the practice of farmers upon peat-soils, and far greater than I should have ventured upon if I had been stating not their practice, but my own notions. Members of the Society, in answer to inquiries I thought it right to address to them, have obligingly furnished me with more and more fresh information too valuable to be suppressed. There remains but a single point of detail to which I must advert, of no great importance indeed, but farming, like other arts, is made up of details.

Generally in draining, but almost always in peat-draining, it is necesssary to dig deep open ditches as main outfalls for the water. The strand or clay thus thrown out should not be left in a high ridge, but should be spread by wheelbarrows over the peat-land in winter. The steep banks, however, of a ditch 5 feet deep will crumble in year by year, and, unless the watercourse be constantly cleared, there will arise some obstruction. Yet the attention thus required may in time be relaxed, at least under a new owner, so that the whole improvement may in the end be dilapidated, and the original bog be restored. But in Scotland, as Mr. Morton informs me, there is a very neat practice of shelving back the banks from the water's edge by a gradual slope of 15 or 20 feet into the field, so that the new level of the watercourse is thus placed for ever beyond the chance of neglect; and if the field be arable, the plough works down to the very brink. A good example of it may be seen on Lord Ducie's farm at Whitfield, near Bristol. Still this must usually be an expensive operation. It is not, however, so expensive upon the kind of land we are now dealing with, provided the first 2 or 3 feet of soil from the surface be peat; for the farmer can burn the soil which he must otherwise draw away. Heaps of it are made near the water-course, which sometimes burn down deep under the surface, and thus the greater part of the ground to be moved is converted into peat-ashes, a manure of known value. The gravel below is then wheeled out upon the peaty land, and care should be taken to replace the upper soil on the newly-formed slope. The appearance of this Scotch practice is exceedingly neat, and its application to peat-land is, I see, very easy.

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* On my farm in Nottinghamshire I occupy a tract of peaty meadow lying lower than the surface of the adjoining river Idle. I have drained it by the use of a steam-engine, and have found that a thick top-dressing of sand improves the pasture more than lime or any other dressing which I have tried.—Spencer.

These are the principal rules which I have learnt from practical farmers for the management of peaty ground, and which in their hands have answered. Other rules will probably be required for peat of different districts; in these and in most improvements, I am sure that, for many reasons, every land-owner who is desirous of introducing new practices will be more likely to attain his object, as well as to save useless expenditure, if in endeavouring to carry them out he consults the judgment of intelligent farmers conversant with the land on which he is desirous to operate.

Pusey, November 30, 1841.

MISCELLANEOUS COMMUNICATIONS AND NOTICES.

IX.—*On the Application of a Marine Peat in Carnarvonshire as Manure.* By the Rev. J. V. Vincent.

To the President.

Sir,—As the subject of manures so properly engrosses much of the attention of the Society, I have thought that an account of the following experiments might possibly not be deemed entirely devoid of interest.

On the sea-coast of Carnarvonshire in several places, about 2 feet beneath the surface of the sand and below high-water mark, there is a decayed vegetable deposit, or turbary, of the thickness of from 4 to 5 feet, strongly impregnated with sea-salt. Of this I have been for several years in the habit of making a compost, such as was recommended by Lord Meadowbank, by mixing it with fresh dung. In a few days after incorporation a very strong heat is produced ; and as soon as the fermentation began to diminish I have had it carried on the turnip-land, and it has proved invariably as effective as an equal quantity of rotten dung.

Last year, having seen an account of the advantage derived from the admixture of lime and salt as a manure, I thought this saline turbary if mixed with lime might be equally beneficial ; I accordingly caused seven cart-loads to be carried from the shore into a shed, and when well pulverized it was thrown into a heap and mixed with a cart-load of coal-ashes ; during the operation of mixing about a barrel of soapsuds was poured upon the heap. I then procured a cart-load of quicklime, and, having reduced it to powder with water, it was thrown into another part of the shed. The two heaps having remained separate for a month, and each being quite cold, they were then well mixed together. In three or four days the compost became as hot as a dunghill, a strong fermentation taking place: it was allowed to remain in this state for a few days longer, when, the heat beginning to decrease, it was carried into a field preparing for turnips, and spread in the drills in the same manner as bone-dust. The crop proved a very good one, from 30 to 35 tons per acre, and was considerably superior to those manured with bone-dust the year before on land of better quality. Although there may not be many localities which afford this submarine turbary, there are several in which turbary abounds, and which, with the addition of lime and salt, may be turned to good account. Common mountain-turbary does not heat with lime in the same manner as that saturated with sea-salt.

I am, Sir, your obedient servant,

James V. Vincent.

Gorddinog, Bangor, Oct. 13, 1841.

The land on which the compost has been used is rather light,—the subsoil in one instance gravelly, in another a mixture of clay and gravel, with a considerable portion of oxide of iron.

X.—*On the Necessity of Compounding Mineral Manures.* By F. Falkner.

I have seen in the Journal of the Royal Agricultural Society several reports of experiments on the application of nitrate of soda as a manure, which were attended with various degrees of success and failure, and which have occasioned no small perplexity to the experimenters. These varying results are, however, such as might reasonably be expected, upon a due consideration of the nature of manures. Farmyard manure, being derived entirely from plants, contains all the substances which are essential to the formation and nourishment of new systems of vegetable life, and accordingly such manure seldom or never disappoints the expectations of the farmer. The desired effect being constantly produced, the agriculturist seldom thinks of inquiring into the nature of its composition: but when this means of fertility fails, and recourse must be had to some foreign substitute, it becomes indispensable to learn of what this continually successful manure consists, in order that proper substitutes should be selected. Now, plants, and by consequence the manure produced from them, are found to contain most or all of the following matters:—oxygen, hydrogen, carbon, nitrogen, chlorine, sulphur, phosphorus, soda, potass, lime, magnesia, silica, and iron, all of which, as they are constantly found in plants variously combined, are unquestionably essential to their existence and nourishment.* If we deduct from these the three first elements, oxygen, hydrogen, and carbon, which are abundantly furnished by the atmosphere to the living plant, there are ten substances remaining, which are equally essential, and most of which are not sufficiently supplied by the hand of Nature to maintain fertility, and therefore must be artificially restored to the soil from whence they were taken: these exist generally in the state of salts of ammonia, lime, and magnesia, potass and soda, formed by an union of those bases with phosphoric, sulphuric, muriatic, nitric, and carbonic acids. As all these substances are contained in farmyard dung, which seldom or never fails, is it reasonable to expect that one only of the salts above mentioned, containing no more than three elements out of the thirteen enumerated, such as nitrate of soda, or nitrate of potass, or muriate of soda, when used separately, can be depended upon as a manure: in other words, that one acid and one base should supply the place of five different acids and as many bases?

It is true that each of these salts has often produced beneficial effects, but this can happen only when all the other materials essential to the growth of plants are already present in the soil, the effect of previous

* "It is stated by Sir Humphry Davy that living plants are composed of certain constituent principles which are derived from the air, water, and various soluble and dissolved substances, mixed with the earths, and which are taken up by the roots of plants and afford them nourishment and support. The results also of the long experience of Du Hamel led him to the conclusion that no single material can afford the food of plants, and that no manure can be taken up by the roots of plants unless water is present; that it is neither charcoal, nor hydrogen, nor azote, nor oxygen alone, but all of them together in various states and various combinations, that afford the pabulum of vegetable life, and that an excess of any one sort of manure may be detrimental, and cannot be useful."—G. Kimberley.

manuring: in such cases the abundance of the substance applied probably enables the plants to assimilate more of those other substances than they otherwise would have done had this one been deficient; the effect thus produced is called stimulation. If, however, the same manure be continued to be used alone on the same land, the other constituents of plants will soon be exhausted, and it will cease to have any effect. If, on the other hand, the manure so applied, or the elements of which it is composed, exist already in the soil in sufficient abundance, the effect will be less, or not at all, perceptible, in which case some other substance than that applied might be deficient, and would produce the desired effect, if chance had led to its application instead of that which failed. This view of the subject corresponds with the varying effect of the same substance on the same soil in different years.

Seeing the great uncertainty of the effect of such manures, and it being very difficult, if not impossible, to know what substances are deficient in the soil, it is desirable, in using a substitute for farm-yard dung, that it should contain, not two or three only, but most or all the substances or elements which the dung-cart supplied. These may be united factitiously; but those substances are the best, and can more surely be relied upon, which are derived from refuse animal matter in which the elements of plants are already compounded.* If this view of the subject be well considered by agriculturists, I think it will have the effect of preventing the losses and disappointments so often attendant upon the empirical application of such imperfect manures as those above mentioned. A few well-conducted experiments instituted with this particular object would, I have no doubt, prove the correctness of the views I have taken, and thereby solve a deeply interesting problem which has so long perplexed the agricultural community.

13, *Camden Terrace, Camden Town, London,*
Oct. 18*th*, 1841.

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* The salts of ammonia and the earthy phosphates are the most important substances in concentrated manures; not because the muriates and sulphates of potass, soda, and lime are less essential to most plants and to general fertility, but because they are more abundantly supplied by the hand of nature; and therefore it is always found that manures containing a large portion of the salts of ammonia and the earthy phosphates are more constantly successful than such as consist entirely of inorganic salts. In order, however, to have a perfect manure, all the inorganic salts should be included, unless it be clearly ascertained that those which may be omitted exist already in the soil.—F. Burke.

XI.—*Statement of the Comparative Quality of Milk from Alderney and Kerry (Irish) Cows upon the Farm of the Hon. Robert Clive, at Oakley Park,* 1840. By Richard White.

Priors Halton, 18*th November*, 1840.

Sir,—I beg leave to send you herewith particulars of the difference in cream from a given quantity of milk from your Alderney and Kerry cows. The test of cream was taken in the months of May, June, July, and August, from a lactometer holding one pint of milk, and the index showing 100 parts. The milk from eight Alderney cows was all put together after milking, and one pint taken from the whole and put into the lactometer, which stood forty-eight hours; the same course was adopted with the milk from eight Kerry cows, and the result is shown in the annexed Table. I have also added the quantity of butter obtained from three pints of cream. I attribute the falling off in the cream from the Alderney cows to their being old in milk, and having cast their calves. The Kerrys came into pasture fresh in milk after their first calf. I intend next summer to carry on the experiment, when I hope we shall be more fortunate with the Alderneys. Six Kerrys are now in calf, and I intend to turn them into the same pasture for the purpose of giving the experiment a full trial, which I shall be glad to report, together with one of the butter.

I have the honour to be, Sir,
Your faithful and very obedient, humble servant,
Richard White.

The Hon. R. H. Clive.

Statement of the Comparative Quality of Milk from Alderney and Kerry (Irish) Cows upon the Farm at Oakley Park, 1840. Tested from a Lactometer holding one Pint of Milk, and divided into 100 parts by Index.

Cows.	Portion of Cream in 100.	Difference.	Observations.
May—			
Alderneys . .	25		
Kerrys . . .	10		
		15	In favour of Alderney.
June—			
Alderneys . .	20		
Kerrys . . .	10		
		10	do. do.
July—			
Alderneys . .	23		
Kerrys . . .	10		
		13	do. do.
August—			
Alderneys . .	16		
Kerrys . . .	13		
		3	do. do.

Butter churned from 3 Pints of Cream from each:—

Alderneys . .	1 lb. 8½ oz.	16 oz. to the pound.
Kerrys . . .	1 lb. 4½ oz.	

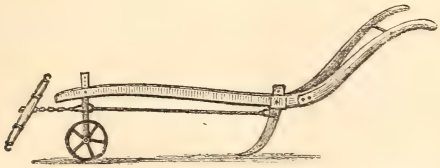
This was taken in August, when the Alderneys' produce of cream was at the lowest.

This experiment appears to me far from conclusive, for the comparison ought, according to my view of the matter, to have been made between cows of similar age, each having produced the same number of calves; and I shall be much deceived if the Kerrys be not found to yield more cream, from the same quantity of milk, after their second calves, than as here stated.

So far as to the *quality of the milk:* but, even were that decided in favour of the Alderneys, it would not, in my mind, be satisfactory regarding the *value of the animals;* to which alone a farmer has to look. Now, in order to make any experiment with that accuracy, from the result of which a just opinion can be formed, the comparative trials should be made under precisely similar circumstances; and, in this instance, I conceive, that can only be done in something like the following manner:—First, take two pairs of Kerrys and Alderneys, of equal age, and having had an equal number of calves, weigh them, and state their actual cost when put upon the farm. Then put them into the same paddock, divided equally, but placing both pairs separately into the two pieces, so as to show the probable quantity of pasture which each would require; and keep a strict account of the provender consumed by each, together with the exact quantity of milk and butter produced. Lastly, keep them until dry; then put them to fatten for the butcher; and, when that is done, sell them through the same salesman, at the same time and market. Were this duly performed, without favour to either the one breed or the other, and a debtor and creditor account brought forward, an accurate judgment may then—and not until then, I imagine—be made of their respective merits; and each should be of an unmixed pure breed.—J. French Burke.

XII.—*Description of a New Subsoil-Plough.* By Charles Gabell.

I had the pleasure of attending our Liverpool meeting, and looked with interest at the subsoil-ploughs; and not seeing anything like a simple instrument that I have made for my own use, I venture to lay it before the Council, and, if they think it may be useful, I shall feel gratified at its being made known.



The back of the coulter is about ¾ of an inch thick: the front is brought to an edge.

There are many farmers who cannot command six or even four horses, and who consequently cannot avail themselves of the Deanston plough. The tool, of which I enclose a sketch, I work with two stout carriage-horses; it goes, when required, 18 *inches deep.* It does not, of course, stir

the soil so much as those before invented, having no fin, nor will it move *very* large stones; but it easily breaks the crust formed by the sole of the plough, and makes it pervious to the air and water. Having only two horses, I used it last spring after the harrow, first with the furrow, and then across and diagonally. It completely loosened the soil, and appeared effectually to prepare it for Belgian carrots, which are a good crop. I have also used it as a subturf-plough, and think it still better calculated for that work. My crop appeared to be much increased; and I hope this season to subturf most of the grass-land on my little farm. Those farmers who have seen it think it a useful implement. I will not tire you with more; but if the little simple invention be thought of any importance, I shall feel happy in answering any inquiries.

Hollyfield, Crickhowell, August 25*th*, 1841.

*** *The Society is not responsible for opinions expressed in the communications of its Members.*

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END OF VOL. II.

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Royal Agricultural Society of England.

1840—1841.

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Royal Agricultural Society of England.

GENERAL MEETING,

5, Cavendish Square, Dec. 12, 1840.

REPORT OF THE COUNCIL.

The Council, in presenting to the General Meeting their Report on the present state and prospects of the Society, have the satisfaction of congratulating the Members on the spirit of improvement now pervading the agricultural community of this country.

During the last half-year no less than 1400 new Members have been proposed and elected into the Society; and this rapid increase of Members and extension of the Society, conjoined with the cordial good-will and co-operation of the Local Associations and Farmers' Clubs established and flourishing in every part of the kingdom, lead the Council to anticipate, with well-grounded confidence, the happiest results in the acquisition of sound practical knowledge, and in opportunities of extending the objects and permanent usefulness of the Society.

The success which attended the Society's Annual Meeting at Cambridge, in July, is too recent to require any comment on the part of the Council; but they beg on this occasion to report to the General Meeting, that at the first Council held after the Cambridge Meeting they had the pleasure of expressing, by their unanimous votes, the deep obligations of the Society to the Vice-Chancellor, the heads of the colleges, and the municipal authorities of the town, for their co-operation in promoting the successful issue of the Meeting; and in a more especial manner to the Master, Vice-Master, and Fellows of Trinity College, for the liberal use of their Hall for the ordinary on the Tuesday; to

the Master and Fellows of Downing College for permission to erect on their quadrangle the pavilion for the great dinner on the Wednesday; and to the Mayor and Corporation of Cambridge for their grant of the use of Parker's Piece for the Cattle Show, and for the admirable arrangements they effected for preserving the peace and good order of the town during the extraordinary influx of strangers on that occasion, which were so successful that not a single misdemeanor or breach of the peace was reported to the Watch Committee during the three principal days of the Show. They have also had the satisfaction of returning the best thanks of the Society to the Earl of Hardwicke and the Cambridge Committee for their zealous co-operation in carrying out the various details affecting the success of the Meeting, and to those gentlemen who so liberally came forward to offer every facility in the trial of implements, especially to Mr. Grain and Mr. Emson for the use of their land, and to Mr. Bryant, Mr. Witt, and also Mr. Emson, for the gratuitous supply of horses for working the machinery, as well as to Mr. Swan of Cambridge for the offer he made to the Committee of the use of his land for the trial of the subsoil-ploughs.

The Council have decided on selecting Liverpool as the place of the next Annual Meeting of the Society; and they anticipate, both from the position and importance of the town itself, and the ready modes of conveyance and access to that seaport, a meeting of an extensive and important character.

The Finance Committee have been actively engaged in simplifying the mode of keeping the accounts, and thus checking any casual errors which may from time to time arise from the insertion of so large an increase of new Members in the Register of the Society, and obviating the temporary confusion which has in some cases been occasioned by similarity of name, and error or imperfection in the address of their residences; and they have recommended that the financial year of the Society shall in future be established, not as formerly, by the irregular periods of the General Meetings, but in half-yearly divisions from January to June, and from July to December inclusively, and the auditors'

first balance-sheet will be presented to you under this half-yearly form.

The Journal Committee still feel a strong desire that the parts of the Journal, as published, should reach the hands of the Members in the securest and most expeditious manner; and your President, as their Chairman, has been anxiously occupied during the autumn recess in completing the classed list of those friends of the Society who have kindly consented to act as agents for the distribution of the copies in every county throughout the kingdom; this list will be inserted in the forthcoming part of the Journal, on the eve of publication.

The Council, taking into consideration the incalculable national importance of every circumstance affecting the growth and produce of Wheat, have requested the Members of the Society to transmit for the Museum such specimens as afford a fair average of their peculiar respective districts; and Professor Henslow, Colonel Le Couteur, and Mr. Morton, have kindly consented to act as a Committee of Curators in deciding on the plans to be adopted for the preservation and permanent exhibition of these specimens.

The Council would, in an especial manner, record their sense of Professor Henslow's services in promoting the objects of the Society, in having drawn up and presented to the Journal Committee a valuable Report on the Diseases of Wheat, and in delivering to the Members an illustrative Lecture on the same subject.

The Council have also been desirous of arriving, if possible, at some conclusions respecting the application of Nitrate of Soda as a manure; and although the communications already furnished lead to the presumption of highly interesting principles of organic action and laws of vegetable life, about to be developed from these inquiries, they regard the present state of our knowledge on this subject as very imperfect, and requiring much additional information.

The Council observe, with much satisfaction, that already men of the first scientific character have turned the powers of their minds to the investigation of these interesting but at present re-

condite laws of nature; and the celebrated Professor Liebig, of Giessen, has given to the world an important contribution to the Theory of Agriculture. But on this, and on every other occasion, the Council cannot too strongly express their conviction that, however splendid, as works of genius, such theoretical disquisitions and deductions may be, the solid advancement of practical agriculture can only be steadily and effectively promoted by sound induction from careful observation and repeated experiment under the most varied circumstances of locality, soil, and aspect; and they trust that the motto of the Society, "Practice with Science," will ever be the guiding rule of its members in their efforts to advance the cause of good husbandry.

The Council have watched with much anxiety the progress of the epidemic among cattle and other stock, now prevalent in so many districts of the United Kingdom; and while in the treatment of this disorder they have perceived in the remedies proposed the application of no new principle different from that assumed in the Society's original circular,—as to its nature, on the contrary, and its mode of action on the living economy, they require much further information to enable them to decide on many peculiar points of the disease; and they have, therefore, resolved to circulate among their members a list of such queries as they trust will obtain a mass of facts fully enabling them to derive just conclusions on the true nature of this troublesome and injurious complaint; for, although not very fatal in its consequences, its prevalence is the cause of much suffering to the animals, and disappointment and loss to the owners in the depreciation thus occasioned in the value of their stock.

By order of the Council,

JAMES HUDSON, Secretary.

The Society now consists of 4262 Members, viz., of 89 Life Governors, 205 Annual Governors, 184 Life Members, 3777 Annual Members, and 7 Honorary Members.

A STATEMENT OF THE RECEIPTS AND EXPENDITURE OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

From the 1st of JANUARY, to the 30th of JUNE, inclusively, 1840.

RECEIPTS.		£. s. d.
Balance, as per Banker's Book		787 14 11
Life Governors' Compositions	£400 0 0	
Life Members' Do.	419 0 0	
		819 0 0
Annual Subscriptions of Governors		728 0 0
Annual Subscriptions of Members		1194 0 0
Half-year's Dividend on £4000 Permanent Investment in the 3½ per Cent. Reduced Annuities		70 0 0
		£3598 14 11

EXPENDITURE.		£. s. d.
For Advertisements	£8 14 10	
Stationery	23 15 8	
Printing Journals and for Woodcuts and Lithography	296 16 3	
		329 6 9
Half-year's Salary to the Secretary and Editor	200 0 0	
Do. to Housekeeper, &c.	36 0 0	
		236 0 0
Half-year's Rent		175 0 0
Miscellaneous Payments, Coals, &c.		144 3 8
Mr. Symonds, Accountant		66 13 4
Mr. Plaskett, Fees for Charter		337 17 0
Grant to the Veterinary College; one Half-year to Lady-day, 1840		100 0 0
Captain Carr's Prize Essay		25 0 0
Premiums for Plans of Cambridge Dining-Room and Cattle-Yard		35 0 0
Balance in favour of the Society (to meet the exigencies of the Cambridge Meeting then immediately ensuing)		2149 14 2
		£3598 14 11

C. B. CHALLONER,
THOS. RAYMOND BARKER,
Auditors on the part of the Finance Committee.

Examined Dec. 11th, 1840,
THOMAS KNIGHT,
Auditor on the part of the Society.

Cambridge Meeting.

July 15, 1840.

AWARD OF PREMIUMS.

Class I. (Short-horns.)

To Mr. William Paul, of Pentney, near Downham, Norfolk: the Premium of Thirty Sovereigns, for his 4 years and 3 months-old Durham Bull; bred by Mr. Topham, of West Keal, Lincolnshire.

To Mr. R. M. Jaques, of St. Trinian's, near Richmond, Yorkshire: the Premium of Fifteen Sovereigns, for his 1 year and 10 months-old Short-horned Bull: bred by Mr. Parkinson, of Babworth, Nottinghamshire.

To Mr. Thomas Bates, of Kirkleavington, near Yarm, Yorkshire: the Premium of Fifteen Sovereigns, for his 6 years-old Short-horned Cow; bred by himself.

To The Right Honourable Charles Arbuthnot, of Woodford, near Kettering, Northamptonshire: the Premium of Fifteen Sovereigns, for his 2 years and 3 months-old Durham Heifer; bred by himself.

To Mr. R. M. Jaques, of St. Trinian's, near Richmond, Yorkshire: the Premium of Ten Sovereigns, for his 1 year and 10 months-old Short-horned Yearling Heifer; bred by the Earl of Carlisle.

To Mr. Thomas Bates, of Kirkleavington, near Yarm, Yorkshire: the Premium of Ten Sovereigns, for his 8 months-old Short-horned Bull-Calf; bred by himself.

Class II. (Herefords.)

To His Grace The Duke of Bedford, of Woburn Abbey, Bedfordshire: the Premium of Thirty Sovereigns, for His Grace's 2 years and 8 months-old Hereford Bull; bred by Mr. Yeld, of The Broome, near Pembridge, Herefordshire.

[No entry was made for the Premium of Fifteen Sovereigns, for the best Hereford Bull calved since the 1st of January, 1838, and more than one year old.]

To Sir Hungerford Hoskyns, Bart., of Harewood, near Ross, Herefordshire: the Premium of Fifteen Sovereigns, for his 6 years-old Hereford Cow; bred by himself.

To Sir Hungerford Hoskyns, Bart., of Harewood, near Ross, Herefordshire: the Premium of Fifteen Sovereigns, for his 2 years and 5 months-old Hereford Heifer; bred by himself.

To Mr. Francis Hewer, of Hereford: the Premium of Ten Sovereigns, for his 1 year and 11 months-old Hereford Yearling Heifer; bred by Mr. John Hewer, of Hampton Lodge, near Hereford.

[No entry for the Premium of Ten Sovereigns, for the best Hereford Bull-Calf.]

Class III. (Devons.)

To Mr. William Porter, of Hembury Fort, near Honiton, Devonshire: the Premium of Thirty Sovereigns, for his 3 years and 2 months-old Devon Bull; bred from Mr. Quartley's Bull.

To His Grace The Duke of Norfolk, of Fornham, near Bury St. Edmund's, Suffolk: the Premium of Fifteen Sovereigns, for His Grace's 1 year and 5 months-old Devon Bull; bred by himself.

To Mr. Thomas Umbers, of Wappenbury, near Leamington, Warwickshire: the Premium of Fifteen Sovereigns, for his 5 years-old North-Devon Cow; bred by the late Mr. Talbot, of Temple-Guiting, near Moreton-in-Marsh, Gloucestershire.

To Mr. George Turner, of Barton, near Exeter, Devonshire: the Premium of Fifteen Sovereigns, for his 2 years and 10 months-old North-Devon Heifer; bred by himself.

To Mr. George Turner, of Barton, near Exeter, Devonshire: the Premium of Ten Sovereigns, for his 1 year and 4 months-old North-Devon Yearling Heifer; bred by himself.

To Mr. Thomas Stephens, of Atherstone, near Ilminster, Somersetshire: the Premium of Ten Sovereigns, for his 5 months-old Devon Bull-Calf; bred by himself.

Class IV. (any Breed or Cross, not qualified for the foregoing Classes.)

To Mr. John Putland, of Firle-Place Farm, near Lewes, Sussex: the Premium of Thirty Sovereigns, for his 3 years and 2 months-old Pure-Sussex Bull; bred by himself.

To Lieutenant-General Sir Edward Kerrison, Bart., M.P., of Oakley Park, near Eye, Suffolk: the Premium of Fifteen Sovereigns, for his 1 year and 4 months-old Suffolk Bull; bred by Mr. Charles Etheridge, of Starston, Norfolk.

To Mr. John Putland, of Firle-Place Farm, near Lewes, Sussex: the Premium of Fifteen Sovereigns, for his 6 years and 2 months-old Pure-Sussex Cow; bred by Messrs. Freeman of Udimore, Sussex.

To Mr. John Putland, of Firle-Place Farm, near Lewes, Sussex: the Premium of Fifteen Sovereigns, for his 2 years and 3 months-old in-calf Heifer; bred by himself.

To Mr. John Putland, of Firle-Place Farm, near Lewes, Sussex: the Premium of Ten Sovereigns, for his 1 year and 3 months-old Pure-Sussex Yearling Heifer; bred by himself.

To Mr. John Putland, of Firle-Place, Farm, near Lewes, Sussex: the Premium of Ten Sovereigns, for his 5 months-old Bull-Calf of the Pure-Sussex breed; bred by himself.

Class V. (Horses.)

To Mr. John Bell, of Welton-le-Wold, near Louth, Lincolnshire: the Premium of Thirty Sovereigns, for his 12 years-old Cart-Stallion; bred by Mr. Adams, of Landbeach, Cambridgeshire.

To Mr. Thomas N. Catlin, of Chillesford Lodge, near Orford, Suffolk: the Premium of Fifteen Sovereigns, for his Cart-Mare and Foal; bred by Mr. Cooper, of Troston, Suffolk.

To Mr. John Reynolds, of Wisbeach, Cambridgeshire: the Premium of Thirty Sovereigns, for his 8 years-old Stallion; bred by Mr. T. O. Taylor, of Flixton, Suffolk.

Class VI. (Leicesters.)

To Mr. Samuel Bennett, of Bickering's Park, near Woburn, Bedfordshire: the Premium of Thirty Sovereigns, for his 16 months-old Pure-Leicester Shearling Ram; bred by himself.

To Mr. Samuel Bennett, of Bickering's Park, near Woburn, Bedfordshire: the Premium of Ten Sovereigns, for his 16 months-old Leicester Shearling Ram; bred by himself.

To Mr. T. E. Pawlett, of Tinwell, near Stamford, Lincolnshire: the Premium of Thirty Sovereigns, for his 2 years and 4 months-old Leicester Ram; bred by himself.

To Mr. Thomas Inskip, of Marston, near Ampthill, Bedfordshire: the Premium of Ten Sovereigns, for his Pen of Five Leicester Ewes (with their Lambs); bred by himself.

To Mr. William Pawlett, of Barnack, near Wansford, Northamptonshire: the Premium of Ten Sovereigns, for his Pen of 16 months-old New-Leicester Shearling Ewes; bred by himself.

Class VII. (South-Downs, and other Short-woolled Sheep.)

To His Grace The Duke of Richmond, of Goodwood Park, near Chichester, Sussex: the Premium of Thirty Sovereigns, for His Grace's 16 months-old South-Down Shearling Ram; bred by himself.

To Mr. Thomas Crisp, of Gedgrave Hall, near Orford, Suffolk: the Premium of Ten Sovereigns, for his 16 months-old South-Down Shearling Ram; bred by himself.

To Mr. Thomas Crisp, of Gedgrave Hall, near Orford, Suffolk: the Premium of Thirty Sovereigns, for his 3 years-old South-Down Ram; bred by himself.

To Mr. Jonas Webb, of Church Farm, near Babraham, Cambridgeshire: the Premium of Ten Sovereigns, for his Pen of South-Down Ewes (and their Lambs); bred by himself.

To Mr. Jonas Webb, of Church Farm, near Babraham, Cambridgeshire: the Premium of Ten Sovereigns, for his Pen of South-Down Shearling Ewes; bred by himself.

Class VIII. (Long-woolled Sheep, *not qualified to compete for Class VI.*)

To Mr. Charles Large, of Broadwell, near Burford, Oxfordshire: the Premium of Thirty Sovereigns, for his 16 months-old New-Oxfordshire Long-woolled Shearling Ram; bred by himself.

To Mr. John T. Harradine, of Needingworth, near St. Ives, Huntingdonshire: the Premium of Ten Sovereigns, for his 16 months-old Long-woolled Shearling Ram; bred by himself.

To Mr. Charles Large, of Broadwell, near Burford, Oxfordshire: the Premium of Thirty Sovereigns, for his 3 years and 4 months-old New-Oxfordshire Long-woolled Ram; bred by himself.

To the Rev. James Linton, of Hemingford, near St. Ives, Huntingdonshire: the Premium of Ten Sovereigns, for his Lincoln and Leicester Ewes (with their Lambs); bred by Mr. Richard Daintree, of Hemingford-Abbotts, Huntingdonshire.

To Mr. Edward Smith, of Charlbury, near Enstone, Oxfordshire: the Premium of Ten Sovereigns, for his Pen of 15 months-old Improved-Oxfordshire Shearling Ewes; bred by himself.

Class IX. (Pigs.)

To Mr. Edward George Barnard, M.P., of Gosfield Hall, near Halstead, Essex: the Premium of Ten Sovereigns, for his 1 year and 4 months-old Boar, of the Improved-Essex Breed; bred by himself.

To Mr. William Fisher Hobbs, of Mark's Hall, near Coggeshall, Essex: the Premium of Five Sovereigns, for his 3 years-old Sow; bred by Mr. Francis, of White Colne, Essex.

To Mr. George Williams Kirkby, of Epping-Bury, Essex: the Premium of Ten Sovereigns, for his Three Pigs, 36 weeks old; bred by himself.

Class X. (Extra Stock, &c.)

To His Grace The Duke of Norfolk, of Fornham, near Bury St. Edmund's, Suffolk: the sum of Five Pounds, for His Grace's fat Devon Heifer; bred by himself.

To Mr. Charles Large, of Broadwell, near Burford, Oxfordshire: the sum of Five Pounds, for his fat Long-woolled Ewe; bred by himself.

To Mr. Richard Daintree, of Hemingford-Abbotts, near St. Ives, Huntingdonshire: the sum of Five Pounds, for his 5 years-old Cart-Mare; bred by himself.

To Mr. Henry Crosse, of Boyton Hall, near Stowmarket, Suffolk: the Sum of Five Pounds, for his Suffolk Mare, 5½ years-old; bred by Mr. Wilden, of Stownpland, near Stowmarket.

SELECTION OF SEED-WHEAT.

Colonel John Le Couteur, of Bell-Vue, in the Island of Jersey: the *Belle-Vue Talavera* White Wheat; grown by himself, at Belle-Vue, Jersey.

Mr. John Elliss, of Send, near Ripley, Surrey: the *Drewitt's Improved Chidham* White Wheat; grown at Send, in Surrey.

These two wheats were selected by the Judges as the best samples of White Wheat exhibited at the Cambridge Meeting. Neither of the samples of Red Wheat were adopted for trial, in consequence of their want of purity, from the slight intermixture of White Wheat which each of them was found to contain.

COMMENDATIONS.

Mr. H. Hammond's 11 years-old Stallion; bred by himself.

Mr. E. Pell's 20 years-old Stallion; bred by Mr. Humphreys, of Woodford Bridge.

The Duke of Richmond's Pen of Shearling South-Down Ewes; bred by himself.

Mr. Samuel Webb's Pen of Shearling South-Down Ewes; bred by Mr. Jonas Webb, of Babraham.

The Judges commended the whole of Class VII. (South-Downs and other Short-woolled Sheep) generally.

Mr. William Bryant's 5 years-old Short-horned Bullock, in Extra Stock; breeder unknown.

The Duke of Norfolk's Pen of South-Down Wether Sheep, in Extra Stock; bred by himself.

Mr. Samuel Webb's three Shearling Wethers, in Extra Stock; bred by himself.

Mr. Henry John Adeane's three South-Down Wethers, in Extra Stock; bred by himself.

The Judges commended the Pigs generally in Extra Stock.

Cambridge Meeting.

REPORT

ON THE

EXHIBITION OF IMPLEMENTS.

THE Judges of Implements, after having carefully examined such as were exhibited in the Show-yard, Cambridge, July 14th, unanimously agreed to a Report, which they delivered to the Council on the following morning, recommending to the notice of the Society such implements as appeared to them, from novelty and general utility, to deserve the Society's honorary rewards; and these were as follows: viz.—

To Mr. BEART, of Godmanchester, for his Tile and Sole Making Machine.*

To Mr. GROUNSELL, of Louth, for an improvement in his Dropping-Drill.*

To Messrs. GARRETT, of Saxmundham, for their Corn and Turnip Drill, with Moveable Axle and Swing Steerage.

To Mr. WOOD, of Stowmarket, for his Barley Roller.

To Mr. CROSKILL, of Beverley, for his Clod-crushing Roller and Liquid-Manure Cart.

To Mr. WEDLAKE, for his Corn and Stubble Rake, with Balance-Weight.

To Mr. HANNAM, of Dorchester, Oxfordshire, for his Skeleton Harvest-Cart.*

In justice, however, to the several exhibitors, who, at considerable cost to themselves, had responded to the Society's invita-

* For accounts of these implements see the Oxford Report of Implements in the Appendix of Part III. and pages 73 and 93 of the present Part of the Journal.

tion, and had sent from various quarters of the country such a selection of implements as, beyond controversy, were never before collected in one show-yard, the judges desire to particularise others also, which, although on this occasion they were unrewarded, yet are not the less entitled to notice.

At the conclusion of last year's Report a hope is expressed that upon a future occasion a still better exhibition may be made than on that their first attempt. That this hope has been realised no one who has had an opportunity of comparing the two can doubt: thus proving that one great object of the Society is in the progress of fulfilment—namely, the producing competition among machinists, and the consequent improvement of agricultural implements.

Before proceeding to comment upon the variety of implements which passed under their inspection, the judges beg leave to notice the very great difference that was observable in their workmanship; nor can they forbear expressing an opinion that in general the attention of implement-makers has been more directed to novelty and ingenuity of design than to skill in execution. Messrs. Ransome, of Ipswich, however, appeared to them to merit the commendation of the Society, as well for their unrivalled collection of machinery of all descriptions as for the superiority which these machines exhibited in the above-noticed particular. A bank of their ploughs (86 varieties) were arranged and elevated on planks to the height of at least 20 feet, and struck the eye of the beholder as he entered the yard; nor did a nearer inspection of them diminish his admiration.

There were three Gorse-Crushers, but none of them seemed to come within the conditions of the Society's premium of 20 sovereigns, and therefore it was not awarded. Messrs. White and Leith, of Worksop, showed one which might be efficient; but its price would put it beyond the reach of the small farmer. Mr. Dell, of Dudswell, Hertfordshire, exhibited one which seemed to possess the merit of simplicity, being worked by the power of an ass, and the gorse bruised by means of a heavy cast-iron grooved roller, passing, in a rotatory direction, over a grooved cast-iron

floor. The construction, however, of the machine was extremely incomplete; and the bruised matter produced too insufficient to entitle the machine to reward in its present state. There was one other, manufactured by Messrs. Hurwood and Co., of Ipswich, and to be worked by two men; by this machine the gorse was well bruised, but the labour of the two men was too great to be long sustained, and the quantity produced less by much than that of Dell's.

Of the Drills there was a great variety. The judges especially commended two: one, made by Messrs. Garrett and Sons, calculated for sowing either corn or turnips. The improvement effected in this drill seemed to consist in having a moveable axle, whereby, when used for sowing turnips on ridges, the wheels may be extended at pleasure, and thus adjusted to the exact width of the ridges. The other drill was made by Mr. Grounsell, of Louth; and, although rewarded last year by the Society's medal, was considered to be entitled to a similar distinction again, on account of an improvement recently introduced into it; viz., the being made capable of delivering manure, especially when in a damp state, with greater facility and less liability to clog than heretofore. In this respect—and no practical farmer will under-rate its importance—the various other drills which came under the judges' notice were deemed to be deficient. Upon the dropping principle they do not think it necessary to pronounce an opinion farther than to state that it does not yet seem to have arrived at that degree of precision by which alone the principle can be brought into advantageous practice.

The Straw-Cutting machines were very numerous: the principal implement-makers contributing each their several varieties, from the large one, cutting straw from 1·16 to 2 inches in length, and worked by two horses, to the small one, cutting one length only, and worked by one man. The judges, however, did not discover any one of a novel principle; regretting very much that Ransomes' patent chaff-engine, marked A in their catalogue, and for which a patent has recently been taken out, did not fall under their inspection.

Of Turnip-Cutters there was not much variety; public attention being now apparently confined, in these machines, to two rival principles,—viz., that involved in Gardner's patent cutter, in which the movement is cylindrical; and that of Hart's, in which the cutting part is attached to a cast-iron plate, and the movement vertical. It would be well if, on some future occasion, the respective merits of these exceedingly valuable implements were fairly brought to the test.

Of Iron Rollers there were several: the judges distinguished one, made by Mr. Wood, of Stowmarket, intended for rolling barley or other spring corn, in which there appeared novelty. The roller was in two parts; the one part placed a little in advance of the other, so that in turning the movement of each part is reversed, and thereby an actual saving of power is obtained, and a considerable evil obviated incident to rollers in general, which in turning are apt forcibly to displace the soil and disturb the new-sown seed. A Clod-Crushing Roller, made by Mr. Croskill, of Beverley, was also exhibited, which in particular cases has been proved to be a most valuable implement; land the most tough and stubborn, and clots of earth the most unmalleable, being by it reduced to powder. That considerable notice has been attracted to this implement is evident from various causes, especially from the fact of another being exhibited on this occasion professing to work on the same principle, but in reality being divested of the essential quality of Mr. Crosskill's; his clod-crusher consisting of a series of cast-iron rings having a dentated surface, and hung rather loosely upon an iron axle; and thus in working (and it can only work on a dry soil) an irregular shaking movement occurs, preventing thereby the possibility of any clogging; a fault into which that of the imitator seemed liable to fall. Mr. Croskill showed also a Liquid-Manure Cart, which was thought to merit the Society's reward.

There were Cake-Crushers of various descriptions; one, of the manufactory of Messrs. Bond, Turner, and Co., of Ipswich, was very much noticed: it was made for the purpose of crushing cake, by one movement, for beasts, sheep, and tillage; and this

was done by the introduction of two sieves of different dimensions: the linseed-cake, by the action of opposing teeth, is crushed into pieces of an irregular size; the largest pieces are caught by sieve No. 1, and thrown out by a spout for cattle; that which is next intercepted by sieve No. 2 is of a size suited for sheep; and the remainder, which has passed through both sieves, may be applied either for tillage or as a mixture with other food.

The machine, however, which perhaps attracted more observation than any other in the yard was a Tile and Sole making Machine, invented by Mr. Beart, of Godmanchester, and was by the judges recommended for the Society's reward: it was stated to be an improvement upon one for which Mr. Beart had recently received a medal from a local society in the county of Huntingdon, and was of an ingenious and simple construction, and its price such as to render it within the compass of any one possessed of capital enough to set up a tile-yard; sufficiently portable also to be moved with ease, and without risk of disarrangement.

Messrs. Drummond and Son, of Stirling, showed a variety of implements, chiefly of iron, and well executed. Amongst them was a Turnip-Scuffler, made with a pair of moveable cast-iron mould-boards; which was perhaps one of the most efficient articles of the many that were shown of a similar description.

In conclusion, the Judges can but reiterate the hope of last year, that, under such encouragement as that afforded by the Royal Agricultural Society of England, the advancement of knowledge in Agricultural Machinery may not be of a temporary nature, but progressive, and be not more characterised by novelty of design than by skill in execution.

Signed by

George Legard,
R. S. Graburn,
Rd. Fleetwood Shawe.

Liverpool Meeting.

Thursday, July 22, 1841.

Prizes for Improving the Breed of Cattle.—1841.

Class I.—Short-Horns.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.
To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . . Ten Sovereigns.

Class II.—Herefords.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.
To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . . Ten Sovereigns.

Class III.—Devons.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.
To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . Ten Sovereigns.

Class IV.—Cattle of any Breed, or Cross:

Not qualified for the foregoing Classes.

To the owner of the best Bull calved previously to the 1st of January, 1839	Thirty Sovereigns.
To the owner of the second-best ditto	Twenty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old .	Twenty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Cow in milk	Fifteen Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old	Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . .	Ten Sovereigns.
To the owner or the best Bull Calf	Ten Sovereigns.

Class V.—Horses.

To the owner of the best Cart-Stallion for agricultural purposes	Thirty Sovereigns.
To the owner of the second-best ditto	Twenty Sovereigns.
To the owner of the best Cart-Mare and Foal for agricultural purposes	Fifteen Sovereigns.
To the owner of the second-best ditto	Ten Sovereigns.

SHEEP.

Prizes for Improving the Breed of Sheep.—1841.

Class VI.—Leicesters.

To the owner of the best Shearling Ram . . .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Ram of any other age .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best pen of Five Ewes suckling their Lambs at the time of showing	Ten Sovereigns.
To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.

Class VII.—South Downs, or other Short-woolled Sheep.

To the owner of the best Shearling Ram . . .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Ram of any other age .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.

To the owner of the best pen of Five Ewes suckling their Lambs at the time of showing . . . Ten Sovereigns.
To the owner of the best pen of Five Shearling Ewes . . . . . Ten Sovereigns.

Class VIII.—Long-woolled Sheep:

Not qualified to compete in Class VI.

To the owner of the best Shearling Ram . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . . Fifteen Sovereigns.
To the owner of the best Ram of any other age . Thirty Sovereigns.
To the owner of the second-best ditto . . . . Fifteen Sovereigns.
To the owner of the best pen of Five Ewes suckling their Lambs at the time of showing . . . . Ten Sovereigns.
To the owner of the best pen of Five Shearling Ewes . . . . . Ten Sovereigns.

Class IX.—Pigs.

To the owner of the best Boar . . . . . Ten Sovereigns.
To the owner of the second-best ditto . . . . Five Sovereigns.
To the owner of the best breeding Sow . . . Five Sovereigns.
To the owner of the best pen of three breeding Sow Pigs of the same litter, above four and under nine months old . . . . . Ten Sovereigns.

N.B.—It is to be stated in the certificate of the Sow, how many pigs she produced in her last litter, and reared to the time of weaning.

Class X.—Extra Stock, Roots, and Seeds.

For Extra Stock of any kind, not shown for any of the above Prizes, and for Roots, Seeds, &c. Prizes may be awarded and apportioned, by the Committee and Judges, not exceeding in the whole . . . . . Fifty Sovereigns.

Machinery.

A sum not exceeding Two Hundred Pounds, to be at the disposal of the Council, to be by them apportioned for rewarding the Exhibition and trial of Implements, if they shall think fit.

Any Implement.

For the Invention of any new Agricultural Implement, such sum as the Society may think proper to award.

Seed-Wheat.

I. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor at the Liverpool Meeting of the best 14 bushels of White Wheat, of the harvest of 1840, and grown by himself.

II. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor at the Liverpool Meeting of the best 14 bushels of Red Wheat, of the harvest of 1840, and grown by himself.

[12 bushels of the wheat will be sealed up by the judges, and one of the remaining bushels of each variety will be exhibited as a sample to the public. At the public Meeting in December, 1842, the prizes will be awarded.]

The three best samples of both red and white wheat, without distinguishing between the three, will be selected by judges appointed at the Liverpool Meeting, and will be sown, under the direction of the Society, in the autumn of 1841, by three farmers, who will make their report, upon which the prize will be awarded. Ten sovereigns will be given at the Liverpool Meeting to the Exhibitor of each of these three samples.

Gorse-crushing Machine.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the cheapest and most effective Gorse-crushing Machine.

1. The machine produced must be on a working scale, and at a cost that will be attainable by the occupiers of the smallest farms.
2. It must be capable of reducing the material to a pulpy state for the mastication of ruminating animals, as cows and sheep.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

I.—Premiums for 1841.

PRIZE ESSAYS.

1. Varieties of Wheat.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Comparative Merits of different Varieties of Wheat.

Competitors will be required to state—

1. Preparation and quantity of the seed; time and method of sowing; relation to preceding and following crops; nature of the soil.
2. Power to withstand severe winters.
3. Time of flowering and of maturity.
4. Tendency to degenerate, and liability to disease.

5. Amount of produce in grain and straw, and the relative quantities of flour and offal.
6. Quantity of bread produced from 18 lbs. of flour, according to the process described by Colonel Le Couteur, in the Second Part of the Journal, Vol. I., page 115.

Not less than a quarter of an acre to be planted with each variety.—It would be desirable that competitors should consult Colonel Le Couteur's Work upon Wheat.

2. Varieties of Barley.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Comparative Merits of different Varieties of Barley.

Competitors will be required to state—

1. Preparation and quantity of the seed; time and method of sowing; relation to preceding and following crops; nature of the soil.
2. Power to withstand drought or extreme wet.
3. Tendency to degenerate, and liability to disease.
4. Time of flowering and of maturity.
5. Amount of produce in grain and straw.
6. Malting qualities.

3. Varieties of Turnips.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Report on the Comparative Merits of different Varieties of Turnips.

Competitors will be required to state—

1. The comparative produce per acre of each variety treated of.
2. The nutritive qualities as compared with weight; distinguishing—
   (*a*) The varieties possessing early maturity appropriate for autumn stocking;
   (*b*) The more productive and nutritive kinds for general feeding; and,
   (*c*) The more hardy varieties for spring and late consumption.

4. Effects of certain Crops on subsequent Crops of Wheat.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Comparative Effects of Crops of Beans, Clover, Vetches, Potatoes, Rye-grass, or any other crop, upon a subsequent crop of Wheat.

Competitors must state—

1. The soil on which the experiment was tried.
2. The crops preceding the wheat, and the manner of cultivating it.
3. The quantity of manure applied.
4. Whether fed or mown, and the quantity of produce if mown.
5. The species of wheat sown.
6. The manner in which the wheat was cultivated; and if manured, the quantity applied.
7. The produce in bushels of the crop of wheat.
8. Any other particulars that may seem important.

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5. Food for Labourers.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Directions to enable Labourers to prepare wholesome, nutritious, and palatable Food, in the most economical and easy manner.

As the object of the Society in offering this prize is to procure such instructions for agricultural labourers as may enable them to supply themselves with the greatest quantity of nutriment which the means at their command will produce, and to prepare a warm, comfortable, and nutritious meal for themselves and their families when they return home from their day's work ;—the Competitors for it are requested to observe:

1. That the receipts must be given in such a plain manner as may render them available to a labourer, or his wife, who are unaccustomed to cookery.
2. That the receipts must be such as may be used without requiring any apparatus which an agricultural labourer does not usually possess.
3. That they shall not require the use of any ingredients which he may not easily procure, either from his garden or in agricultural villages. This condition is not intended to preclude the recommendation of fish as a part of any dish.
4. The cost of the different dishes for which receipts are given must be accurately stated.

On Manures and Soils.

6. Application of Lime.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Experiments on the application of Lime as a manure.

The Competitors will be required to state—

1. How many years they have used lime as a manure.
2. How many acres they have limed each year.
3. What quantity they have put on per acre.
4. On what sort of soil.
5. At what time of the year.
6. For what crop.
7. Whether with or without manure.
8. In what manner applied.
9. What effect on the crop.
10. What effect on the succeeding crop.
11. The price of the lime.
12. Whether they continue to use it
13. The chemical description of lime they use.
14. Any particulars generally with respect to lime.

7. Nitre and Cubic Nitre.

Twenty Sovereigns, or a Piece of Plate of that value, will be given

for the best Account of Experiments on the application of Nitres as Manures, including Saltpetre (the nitrate of potash) and Cubic Nitre (the nitrate of soda).

Competitors will be required to state—

1. The quantity and mode of these applications, whether used before sowing, along with the seed, or after the blade is up.
2. Every particular of each experiment; and a comparison made with the same quantity of ground sown both without manure and also with common yard-dung; stating the value of the manure in every case.
3. The result at different periods of the growth.
4. The conclusion come to from the experiments.
5. Not less than a quarter of an acre to be taken for each experiment; and to be varied as much as possible.

8. Improvement of Peat-Soils.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay or Report on the most successful means by which the Improvement of Peat Soils may be effected.

Competitors will be required to state the following particulars:—

1. Description of the mode, so far as it can be ascertained, in which the peat has been formed, whether by rain-water lodging on the surface, the oozing of springs, or under a body of stagnant water.
2. Description of the plants, from the decay of which the peat appears to be formed, and of the state of decomposition in which they are found.
3. Chemical account of any acid or bitter principle injurious to vegetation which may be found in the peat.
4. Account of any substances applied to the peat, either for correcting its chemical defects or improving its consistence.
5. Level of the water in the neighbouring ditches in winter and summer.
6. General treatment and mode of cropping.

On Agricultural Operations and Implements.

9. Subsoil and Trench Ploughing.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the most satisfactory Experiment on the Comparative Merits of the two processes of Subsoil and Trench Ploughing.

The Society will require from Competitors—

1. An accurate description of the ploughs used.
2. Of the quality and state of soil and subsoil, with an estimate of its annual value before the commencement of the operation.
3. An account of the drains cut (if any), their depth and distance from each other.
4. A detailed statement of the subsoil and other ploughings to which the grounds have been subjected.

5. An account of any manure expended.
6. Of the bulk of produce of each crop.
7. Of the total expence of the operation, so far as it has proceeded; and,
8. An authentic estimate of the improved value of the land resulting therefrom.

As the object of the Society is to ascertain, as far as possible, the advantages of subsoil ploughing (in which the subsoil is divided by the plough, but left in its original situation), and of trench ploughing (in which the subsoil is not only divided, but is also brought to the surface), they strongly recommend to competitors that the two processes should be conducted on a piece of ground fairly divided into two lots of equal quality, and that the drains cut in each lot, as well as any assistance afforded by manure, should be similar on each of the lots.

10. Single-horse Carts.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the most satisfactory account of any experiments to compare the relative advantages of the single-horse carts which are generally used in Scotland with any mode of conveying agricultural produce which is practised in any part of England, or in any foreign country; having regard to economy of labour both of men and animals, quickness of work, and facility in loading and conducting the carriage.

11. Agricultural Mechanics.

Fifty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Present State of Agricultural Mechanics, and on the Improvement of which the various Implements now in use may be susceptible.

These Essays must be sent in to the Secretary on or before March 1st, 1841.

N.B.—General Conditions for all Experiments on Soils or Manures.

1. The nature and depth of the soil.
2. The proportions of clay, sand, lime, or other substances, of which the soils are composed: or, otherwise, to send specimens of the soils (in quantities of a pound or pint of each variety) to the Secretary, on his application for them.
3. The nature of the subsoil.
4. When the ground is not level, the degree in which it slopes, and the direction (north, east, &c.) of its inclination, as found by the compass.
5. The two or three preceding crops; the manure put on for them, and the produce of these crops.

II.—Premiums for 1842.

PRIZE ESSAYS.

1. Drill Husbandry of Turnips.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report of Experiments on the Drill Husbandry of Turnips.

Competitors will be required to state—

1. The time of sowing the different varieties, on different soils, and at different elevations and latitudes.
2. The mode of preparing the land, and of drilling the seed; with a description of the implements used.
3. The kind and quantity of manure employed.
4. The distance between the rows.
5. The manner of performing the hoeing.

N.B.—It will be desirable that the mode of cultivation employed by practical farmers in some considerable district should be described, as well as any variations in the practice, arising from difference in the quality of the soil.

2. Wireworm.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Natural History, Anatomy, Habits, and Economy of the Wireworm, and the best means of protection against its ravages.

Competitors will be required to attend to the following points—

1. The length of time during which the wireworm exists in that state.
2. The vegetable productions on which its depredations are chiefly committed, and the mode by which it effects their injury or destruction.
3. The places in which the perfect insect deposits its eggs; and what seasons aid or retard the development of the gnat or mark its changes.
4. Whether peculiar soils or aspects are more particularly infested by the insect; and whether preceding crops influence it in its selection.

3. Mechanical Properties of the Plough.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Mechanical Properties of the Plough.

Competitors will be required to define—

1. The form of the cutting and moving parts of the plough, as affecting the work to be performed on various soils.

2. The form of the same, as affecting the draught.
3. The true line of draught, as derived from the shape of the plough, and from the structure of animals employed in drawing.

4. Prognostics of Weather.

The Gold Medal will be given for the best Account or Record of the Prognostics, or Natural Signs, of Changes in the Weather.

Conditions:—

1. Competitors for this prize will be required to draw the rules which they give from such appearances as may be observed, by men living in the country, with ordinary attention to the state of the atmosphere, the habits of animals, and the thermometer and barometer.
2. They will be required to state, whether they intend the Rules which they give to apply to a hilly or flat country, to the neighbourhood of the sea, or to inland situations.
3. The merit of the different sets of Rules sent in will be decided upon by practical experience in different parts of the country: and the prize awarded to the person whose Rules, after twelve months' trial, shall be reported by the gentlemen selected as judges to have proved most generally correct.

5. Making of Cheese.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Making Cheese.

Competitors will be required to give—

1. A description in detail of the mode employed in preparing the cheese in some district of established reputation for the production of cheese.
2. An inquiry, how far the excellence of the best cheeses arises from peculiarity of pasture, soil, and situation; or, how far from superior management.
3. It is also desirable to investigate the effects of the colouring matters which are employed in making some kinds of cheese.

6. Rotations of Crops on Light Lands.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Rotation of Crops suited for Light Lands.

Competitors will be required to keep in view—

1. The succession of crops which combines the greatest number and productiveness of crops with the largest profit and most improving condition of the soil.
2. The greatest consumption of the produce by the Stock profitably kept on the land.

7. Rotations of Crops on Heavy Lands.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Rotation of Crops suited for Heavy Lands.

N.B.—The same conditions will apply to this prize as to the last; but particular stress is to be laid on bringing heavy lands more nearly on an equality with light lands, than they at present are, in the Maintenance of Stock.

8. Curing of Butter.

Ten Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Mode of Curing Butter for future consumption, and for Preservation in foreign countries.

Competitors will be required to attend to the following Conditions—

1. The butter to be made from grass-fed cows, milked between the 20th of May and the 20th of June; stating the exact period at which it was manufactured; and whether made from cream alone, or from the whole milk and cream churned together.
2. That two samples of the butter—of not less than 12 lbs. each—be packed in jars, and sent up to the Society on or before the 1st day of July: stating the exact quantity of any salt, honey, or other substance used in the curing: with a minute description of the mode employed in effecting it.
3. That each sample be cured with a different sort of salt—if any different kinds can be procured—and not less than 6 lbs. of each be sent up, separately, to the Society: distinguishing the particular kinds which have been used.
4. That the samples of salt will be duly analysed; but those of the butter will be retained in the Society's rooms until the month of December, when they will be opened and valued by two eminent dairymen: the valuation of which to be paid to the makers.
5. That the judgment of those dairymen, in regard to the prize, will be directed not so much to the quality of the butter as to its sweetness, and the probability of its preservation at home and in warm climates.

9. Varieties of Wheat suited to Different Soils.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Varieties of Wheat suited to Different Soils.

N.B.—As it is well known that many soils will not bring forth in perfection the best varieties of wheat—particularly of white wheat—it is desirable to know what is the best wheat which each soil is capable of producing.

10. On the Food of Plants.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Food of Plants.

Competitors will be required to state—

1. The sources from which plants derive the elements of which they are composed.
2. The mode in which farm-yard dung strengthens the growth of agricultural crops.
3. The mode in which other manures, whether singly or combined, act upon vegetation.

These Essays must be sent in to the Secretary on or before March 1st, 1842.

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Bosanquet, Rev. R. Wm.		Bolingbroke, Lincolnshire
Boswell, Alexander		The Grange, Aylesbury, Bucks.
Bosworth, T. W.		Spratton, Northampton
Boulnois, William	12, Abbey-rd, St JW	
Bowker, Thomas		Whittlesey, Cambridgeshire
Bowyer, Geo.		Diddington, Buckden
Bowyer, Thomas		Buckden, Huntingdonshire
Bowyer, William		Southoe, St. Neot's, Huntingdonshire
Boyce, Charles		Whittlesey, Cambridgeshire
Brackenbury, William		Shouldham-Thorpe, Downham, Norfolk
Bradfield, J. S.		Stoke Ferry, Norfolk
Bradley, John		Blyth, East Retford, Notts.
Brady, Charles Robert		Lime Park, near Disley, Cheshire
*Brambridge, C. H.		Lumly Park, Durham
Brandreth, Henry	Oxford-st., Camb.cl	Houghton House, Dunstable, Be ls.
Branfield, William Williams		Dunchurch, Warwickshire
Brettell, John		Northampton
Brewitt, John		Wickford, Ballericay, Essex
Brewster, Joseph		Breewood, Staffordshire
Brickwell, John		Leckamstead, Buckingham

Members.	Town Residence.	Country Residence.
Bridgeward, J.		Sudbury, Suffolk
Briggs, David		Oxcombe, Louth, Lincolnshire
Bright, John		Skeffington Hall, Leicester
Brigstocke, William Owen		Blaenpont, near Cardigan, South Wales
Brigstocke, Rev. Augustus		Gllynill
Brimby, A. G.		Cambridge
Brimby, W.		Willington, Bedfordshire
Blofeld, Rev. Thomas John		Rectory, Drayton, near Norwich, Norfolk
Bolden, S. Edward		Lancaster
Bromley, Augustus Frederick		Meopham, Gravesend, Kent
Brokenbrow, William Perrins		Beenham, Reading, Berkshire
Bromley, John		Derby
Brooke, John		Great Walsingham, Norfolk
Brooke, Willaim De Capell		The Elms, Market Harbro', Leicestershire
Brown, J.		Lea Castle, Worcestershire
Brown, John		Pear-Tree Ho., Elm, Ely, Cambridgeshire
Brown, J. B.		Colne Engain, Essex
Brown, Rev. L. B.		Kesdale
Brown, Samuel		Stanley, St. Leonard's, Stroud, Glouc.
Brown, Thomas		Packington, Lichfield, Staffs.
Brown, William		Winterbourne Stoke, Salisbury, Wilts.
Brown, Edward		Silsoe, Bedfordshire
Browne, E. M.		Dereham, Norfolk
Browne, John		Little Hallingbury, Sawbridgeworth, Herts
Browne, Thomas		Thrigby Hall, Yarmouth, Norfolk
Browne, William		Winterbourne Stoke, Ambrosbury, Wilts.
Browne, William		South Rainham, Rougham, Norfolk
Bruce, Chas. Cumming, M.P.		Dunphail, Forres, N.B.
Bruges, William		Haxton, Amesbury, Wilts.
Bryan, Reginald		Trinity College, Cambridge
Bucke, Lewis, M.P.		Moreton House, Bideford, Devonshire
Bull, George		Trinity College, Cambridge
Bull, George		Great Oakley, Bedfordshire
Bull, Rev. George		Aylesbury, Buckinghamshire.
Bullen, John		Biggin Grange, Oundle, Northamptonsh.
Buller, Frederick		Cherry Hinton, near Cambridge
Bullimore, W.		Witham, near Colsterworth, Lincolnshire
Bulling, John		Holkham, Wells, Norfolk
Burdakin, Rev. James, M.A.		Clare Hall, Cambridge
Burder, John		Codham Hall, Braintree, Essex
Burder, Joseph Davey		Braintree, Essex
Burnham, George		Wellingborough, Northamptonshire
Burdon, George		Felton Park, Felton, Northumberland
Burroughes, Rev. Jeremiah		Lingwood Lodge, Norwich, Norfolk
Burroughes, Rev. Thomas		Rickinghall, Botesdale, Suffolk
Burroughes, William		Hoveton Hall, Norwich, Norfolk
Buston, Rev. Roger		Emmanuel College, Cambridge
Butler, Thomas		Ivychurch, New Romney, Kent
Caldecott, Barnes		Ormsby House, Norwich, Norfolk
Caldicott, C. M.		Myton House, near Warwick
Callis, John		Mears Ashber, Northampton
Calthrop, Rev. Henry		Archdeacon of Derby
Calvert, William		Hunsdon, Ware, Hertfordshire
Cambridge, William		South Runcton, King's Lynn, Norfolk
Cambridge, William, Sen.		South Runcton, King's Lynn, Norfolk
Camden, Marquis	19, Belgrave-square	Wilderness Park, Sevenoaks, Kent
*Campbell, Alexander Francis		Great Plumstead, near Norwich, Norfolk
Campion, Rev. Job		Overston Rectory, Northampton

Members.	Town Residence.	Country Residence.
Cana, Robert	. .	Marlesford, Wickham Market, Suffolk
Cane, Rev. H.	. .	Southwell, Nottinghamshire
Canham, R. G.	. .	Hilgay, Norfolk
Cantrell, Charles S.	. .	Manor Farm
Cantrell, Henry	. .	Bayliss, Stoke, Buckinghamshire
Caparn, Daniel	. .	Horncastle, Lincolnshire
Carey, John	. .	Pylle House, Shepton Mallet
Carne, Rev. T. C.	. .	Breckinghurst, Southwell, Notts.
Carns, Rev. William	. .	Trinity College, Cambridge
Carr, T.	. .	Wheeting, Norfolk
Carter, James	. .	Barton, Hopwas, Tamworth, Staffordshire
Carter, John	. .	Pinchbeck, Spalding, Lincolnshire
Carter, John R.	. .	Westleton, Yoxford, Suffolk
Carter, Thomas S.	. .	Ballards, near Croydon, Surrey
Carter, T.	. .	
Carter, William	. .	Boughton, Faversham, Kent
Cartwright, Moses	. .	Stanton, Burton-on-Trent
Cartwright, R. N.	. .	Ixworth Abbey, Suffolk
Cartwright, J. T.	. .	Tathwell, Louth, Lincolnshire
Carver, Rev. William James	. .	Sprowston Hall, Norwich, Norfolk
Castellain, Charles	3, Copthall-court	Upper Clapton, Middlesex
Castellain, Hermenegild	3, Copthall-court	Belgian Consul
Castellain, Alfred	20, Bedford-st. So.	
Casborne, Rev. J. W. Spring	. .	New House, Pakenham, Ixworth, Suffolk
Catt, William	. .	Bishopstone, Sussex
Catlin, Thomas	. .	Bintley Abbey, Woodbridge, Suffolk
Cattle, William	. .	Burleigh, Stamford
Cavendish, William George	Burlington Ho. Pic.	
Chafy, Westwood	. .	Conington House, St. Ives, Huntingd.
Chalk, Rev. William Shore	. .	Wilden Rectory, near Bedford
Chamberlin, William	. .	Westby, Lincolnshire
Chambers, William	. .	Derby
Champion, William	. .	Bridge House, Worksop, Notts.
Chaplin, A. T.	. .	Fulbourne, Cambridgeshire
Chaplin, J. H.	. .	Fulbourne, Cambridgeshire
Charnock, Charles	. .	Holmesfield House, Ferrybridge, Yorks.
Chatterton, Richard	. .	Allington, Louth, Lincolnshire
Chew, L.	. .	Clipston, Market Harborough
Cheere, Rev. George	. .	Papworth Hall, Caxton, Cambridge
Cheere, William H.	. .	Papworth Hall, Caxton, Cambridge
Cheetham, Samuel	. .	Hambleton, near Oakham, Rutland
Child, John	. .	Merton Mills, Surrey
Cholmondely, Rev. Humphrey	. .	Troston, near Bury, Suffolk
Church, Rev. William	. .	Woolsthorpe, Grantham, Lincolnshire
Churchyard, J.	. .	Pettishee, Suffolk
Clark, E.	. .	Canwick, Lincolnshire
Clark, W. James	. .	Burley, Oakham, Rutlandshire
Clark, George	. .	Barnby Moor, East Retford, Notts.
Clark, Rev. William	. .	Prof. of Anat., University of Cambridge
Clark, William John	. .	Buckland-T-Saints, Kingsbridge, Devon.
Clarke, Charles	. .	Nettleham, Lincolnshire
Clarke, Sir C. Mansfield, Bt. FRS	. .	Dunham, Norfolk
Clarke, Robert	. .	Reymerston, Attleborough, Norfolk
Clarkson, Rev. T. L.	. .	Bayton, Suffolk
Claydon, Carter	. .	Barham, Linton, Cambridgeshire
Claydon, Charles	. .	Cambridge
Claydon, Henry	. .	Hadleigh, Suffolk
Clemenson, Joseph	. .	Welney, Norfolk
Clemenson, Thomas	. .	Upwell, Norfolk
Clifford, Henry Clifford	. .	Frampton-on-Severn, Gloucestershire

Members.	Town Residence.	Country Residence.
Clift, Samuel		Lawleigh Hall, Latchingdon, Essex
Clover, John		Kirtling Place, Newmarket, Cambridges.
Clowes, Francis		Hemsby, Norfolk
Cobbold, I. C. M.		Ipswich
Codrington, Bethel		
Coker, John		Hale Shipdham, Watton, Norfolk
Colborne, Lord	19, Hill-st, Berk-sq.	West Harling, Norfolk
Cole, Charles		Gorse Hall, near Kidderminster
Cole, William		Oakington
Collin, Rev. John, Jun.		Quendon Rectory, Rickling, Essex
Collis, William Blow		Iverley Lodge, Stourbridge, Worcesters.
Collison, Brown	37, Fleet-street	New England, Hitchin, Herts.
Colvile, Rev. A. A.		Linconmeer Rectory, Bury St. Edmund's
*Colvile, Charles R.		Lullington, Burton-on-Trent
Colvile, Lieut.-Colonel		Duffield, near Derby
Combermere, Viscount	22, Portman-square	Combermere Abbey, Nantwich, Cheshire
Compton, John		Fordham, Downham Market, Norfolk
Conolly, Colonel, M.P	Up. Grosvenor-st.	Castletown, Ireland
Cook, Henry		Willesborough, Ashford, Kent
†Cook, Rev. James		Semes, near Hadleigh, Suffolk
Cooke, George	University Club	
Coombe, Rev. Thomas		Waterbeach, Cambridgeshire
Cooper, J. Rous		Red House, Werlleton, Suffolk
Cooper, J. R.		Westleton, Suffolk
Cooper, Mark		Great Oakley, Essex
Cooper, Robert		Pebworth, Chipping-Camden, Glouc.
Cornele, Joseph		Wethersfield, Braintree, Essex
Corrie, Professor		Catherine Hall, Cambridge
Cory, Rev. Robert		Emmanuel College, Cambridge
Cotes, Rev. Chas. Grey		Stanton, St. Quintin, Chippenham, Wilts.
Cotton, Alexander		Hildersham Hall, Linton, Cambridgesh.
Cotton, Rev. Alexander		Girton, Cambridge
Courtier, John		Moretonhampstead, Exeter, Devonshire
Courthope, G. C.		Whyly, Lamberhurst, Sussex
Cox, Henry		Trevereux, Lympsfield, Surrey
Coxwell, Captain		Bracknell, Berkshire
Craig, Gibson, M.P.		Edinburgh
Cribb, John Jennings		Cambridge
Cripps, J. M.		Novington, Lewes, Sussex
Crofton, Lord		Mote Park, Athlone, Ireland
Croker, Rt.Hon.J.Wilson, FRS.		Kensington Palace
Croote, William		Lassford, Chumleigh, Devonshire
Cropley, James		Ely, Cambridgeshire
Cropper, William		Munting, Horncastle, Lincolnshire
Crouch, James		Cainhoe, Silsoe, Bedfordshire
Crowe, W.		Gonel House, Cambridge
Croy, John Du		Manor Ho., E. Stanningfield, Chelmsford
Croydon, Thomas		Drayton, Penkridge, Staffordshire
Cull, Thomas		Farleigh, Maidstone, Kent
Cullack, John		Littleport, Isle of Ely, Cambridgeshire
Cullum, John		Ipswich, Suffolk
Currie, Edmund		Erlwood, Bagshot, Middlesex
Curtis, John		West Rudham, Norfolk
Curtis, John, jun.		West Rudham, Norfolk
Curtois, Rev. Peregrine		Longhills, Lincoln
Dare, R. W. Hall		Abridge, Rumford, Essex
Dalton, James		Bury, Suffolk
Davies, John		The Abbey, Much Wenlock, Salop.

Members.	Town Residence.	Country Residence.
Davies, Henry	. .	Blakebrook, Kidderminster
Davis, Thomas	. .	Little Wenlock, Wellington, Salop.
Davis, Thomas Henry	. .	Orleton, near Worcester
Davy, W.	. .	Thornway Vale, Caistor, Lincolnsh.
Dawes, Henry J.	. .	Gillingham, Chatham, Kent
Dawson, Richard	. .	Withcall House, Louth, Lincolnsh.
Dawson, Henry	. .	Launde Abbey, Uppingham, Rutland.
Dawson, William	. .	Binthorp, Folkingham, Lincolnshire
Day, John	. .	Burghill, Chiddingley, Sussex
Deck, Isaiah	. .	Cambridge
Dell, Thomas	. .	Broadway Farm, Hemel Hempstead
Denton, Rev. R. A.	. .	King's College, Cambridge
Derry, John	. .	Writtle, Essex
Derry, Thomas, jun.	. .	Gedney, Wisbeach, Cambridgeshire
Dewing, Wm. Edward	. .	Leiston Hall, Suffolk
Dexter, Joseph	. .	Bramcote, Tamworth, Staffordshire
Dickin, John	. .	Waters Upton, Wellington, Salop.
Dickenson, Thomas	. .	Great Pontow, Lincolnshire
Dickins, Francis	. .	Adisham, Wingham, Kent
Dickinson, John	22, Bedford-row	Abbott's Hill, Watford, Hertfordshire
Dickrows, W.	. .	Magdalen College, Cambridge
Dix, R.	. .	Stroston Hall, Walton
Dixon, John	. .	Waddington Heath, Lincoln
Dixon, J. G.	. .	Caistor, Lincolnshire
Dobede, John	. .	Soham, Cambridgeshire
Dod, John Whitehall	. .	Cloverley, Whitchurch, Salop.
Dodd, Thomas	. .	Rainham, Sittingbourne, Kent
Dodson, John	. .	Swavesey, Cambridgeshire
Dollond, George, F.R.S.	St. Paul's Ch.-yd.	North Terrace, Camberwell, Surrey
*Donnell, Mac, Edmund	Mivart's-hotel	Glenarm Castle, Glenarm, Ireland
Dowall, Mac, J. C. S.	. .	Water End, Sandridge, St. Alban's
Downs, Thomas	. .	Patton, Much Wenlock, Salop.
Downes, William	. .	Dedham, Essex
Downing, John	. .	Casthorpe, Grantham, Lincolnshire
Downward, Rev. George Rich.	. .	Whitchurch, Shropshire
Douro, Marquis of	3, Belgr.-st. Belg.sq	
Dover, Henry	. .	Caston, Watton, Norfolk
Drake, Frederick Tyrwhitt	. .	St. Paul's Walden, Welwyn, Herts.
Drake, Sir Trayton Elliott, Bt.	. .	Nutwell Court, Devonshire
Drew, Rev. John	. .	Tregunnon, Newtown, Montgomeryshire
Drummond, Rev. Arthur	. .	Charlton Rectory, Kent
Dudding, R.	. .	Ponton, Wragby, Lincolnshire
Dudding, J. W.	. .	Saxley, near Lincoln
Eaden, Francis	. .	Cambridge
Eastnor, Viscount, M.P.	. .	Eastnor Castle, Tewkesbury, Gloucestersh.
Eaton, Richard	. .	Stetchworth Park, Newmarket, Cambs.
Eaton, Capt. Richard J., M.P.	. .	Stetchworth Park, Newmarket, Cambs.
Edgar, Rev. Mileson	. .	Red House, Ipswich, Suffolk
Edmeads, J.	. .	Hazells, Northfleet
Edwards, O. H.	. .	Chesterford, Essex
Eland, Stephen Eaton	. .	Manor Ho, Stanwich, Higham Ferrers, Nor.
Elliott, A. S.	. .	Hartford, Huntingdon
Ellis, D.	. .	Creshall Grange, Essex
Ellis, Gifford Ingle	. .	Skepreth, Cambridgeshire
Ellis, Robert Ridge	. .	Yalding, Kent
Ellis, John	. .	Beaumont Leys, Leicestershire
Ellis, Joseph	. .	Threplow, Cambridgeshire
Elsum, Thomas	. .	Whittlesey, Cambridgeshire

Members.	Town Residence.	Country Residence.
Etheridge, Charles		Starston, Norfolk
Ely, Lord Bishop of		Ely Palace, Cambridgeshire
England, Richard		Binham, Wells, Norfolk
Evans, Charles Henry		Henblas, Anglesey, N. W.
Evans, H. R., Jun.		Ely, Cambridgeshire
Evans, John		Hadley Park, Wellington, Shropshire
Evans, Thomas Brown		Deane House, Enstone, Oxon.
Everard, Edward		Middleton, Lynn, Norfolk
Everard, Rev. Edward Browne		Bilney Lodge, Lynn, Norfolk
Everitt, Isaac		Capel, Suffolk
Everitt, James		North Creake, Fakenham, Norfolk
Exall, William		Reading, Berkshire
Fair, James		Lytham, Preston, Lancashire
Faldor, Robert		Lidlington, Bedfordshire
Fardell, Rev. Richard		Wisbeach, Cambridgeshire
Farmer, Richard		Sheldon, Birmingham
Farmer, Thomas		Stonidelph, Fazeley, Staffordshire
Farrer, Edmund		Sporle, Swaffham, Norfolk
Fairman, Joseph		Bishopstortford, Hertfordshire
Fawcett, Thomas		Gate House, Dent
Fawcett, J. M. R.		Cambridge
Fawdon, James		Tughale, near Alnwick, Northumberland
*Fawkes, T. Hawkesworth		Farnley Hall, Ottley, Yorkshire
Faulkes, Robert		Beckingham, Newark, Nottinghamshire
Fellowes, Henry Arthur		Eggesford, Chumleigh, Devonshire
Fellowes, Hon. Newton		Eggesford, Chumleigh, Devonshire
Ficklin, T. J.		Cambridge
Field, William		Rumboldswhyke, near Chichester
Firmin, James B.		Walter Belcham, Halstead, Essex
Fisher, John		Cambridge
Fisher, Thomas Hall		Cambridge
Fisher, W. W.		Downing College, Cambridge
Fiske, E. F.		Cambridge
Fitzroy, Captain William		Weasenham, Rougham, Norfolk
Fitzroy, Capt. H. (Gren. Guards)	3, Chesham-place	
Flack, William		Water's Place, Ware, Hertfordshire
Floyer, John Wadham		Ketsby House, Louth, Lincolnshire
Foley, Rev. Richard		Worcester
Foley, Rev. Richard		Kingswinford House, Dudley, Worc.
Folkestone, Viscount		Longford Castle, Salisbury
Ford, Richard S.		Clifford's Wood, Stone, Staffordshire
Fordham, Edward King		Royston, Hertfordshire
Forster, Captain H.		Southend, Sydenham, Kent
Forster, Samuel	6, Lincoln's-inn	Southend, Middlesex
Forte, Nathaniel		Trinity College, Cambridge
Foster, Robert Carr	John-st. Bedford-rw	
*Foster, William Carr	John-st. Bedford-rw	
Fothergill, Mark	40, Up. Thames-st.	
Fowler, William		Hemingford Grey, St. Ives, Huntingdons.
Fowles, William		Market Lavington, Devizes, Wiltshire
Fountain, J.		Eaton Lodge, Norfolk
Frampton, Henry		Moreton, Dorchester, Dorsetshire
France, F.		St. John's College, Cambridge
Francis, Benjamin		High House, Litchams, Norfolk
Francis, Philip		Moore, Crediton, Devonshire
Francis, Samuel		Stifford-place, Romford, Essex
Francis, S. R. G.		Mucking Hall, Thorndon-on-Hill, Essex.
Frederick, Sir Richard, Bart.		Burwood Park, Walton-on-Thames, Surrey

Members.	Town Residence.	Country Residence.
French, Thomas	. .	Eye, Suffolk
French, Rev. W., D.D.	. .	Master of Jesus College, Cambridge
Frere, Philip Howard	. .	Bursar of Downing College, Cambridge
Frewen, C.	. .	Brickwall House, Northiam, Rye, Sussex
Frost, Henry	. .	West Wratting, Cambridgeshire
Fryer, John	. .	Chatteris, Cambridgeshire
Fuller, John	. .	Beechamwell, Swaffham, Norfolk
Fuller, J.	. .	Dinelnaw
Frumon, Charles	. .	Beckford Hall, Tewkesbury, Gloucestersh.
Fyson, William	. .	Horningsey, near Cambridge
Fyson, Robert Dillaymore	. .	Fordham, Cambridgeshire
Gale, William	. .	Farnbridge Hall, Maldon, Essex
Gameau, John Edwin	. .	Stilton, Huntingdonshire
Gardner, William	. .	Ewell Court, Epsom, Surrey
Garnons, Rev. C. W. L. P.	. .	Sydney College, Cambridge
Gardner, Edward	. .	Sapon Hall, Newmarket, Cambridgeshire
Garrod, Robert	. .	Ipswich
Garth, Captain, R.N.	. .	Haines Hill, Maidenhead, Berkshire
Garth, Rev. Richard	. .	Farnham, Surrey
Gattaker, George	. .	Mildenhall, Suffolk
Gaussen, George Robert	. .	Brookmans Park, Hatfield, Herts.
Gedge, Johnson	. .	Bury St. Edmund's, Suffolk
Gent, G. W.	. .	Halstead, Essex
Gerrish, Thomas	. .	Upton, near Andover, Hampshire
Gibbons, Henry	. .	Wolverhampton, Staffordshire
Gibson, Richard	. .	Belvoir Inn, Leicestershire
Gibson, Thomas	. .	Basingthorpe, Lincolnshire
Gibson, Thomas	. .	Middleton, Fazeley, Staffordshire
Gilbert, Rev. Alexander	. .	Cantley, Norfolk
Gilbert, Thomas	. .	Westley, Cambridgeshire
Gilbert, T. W.	. .	Westley Lodge, Newmarket, Cambridges.
Gilbert, Mrs. Davies	. .	East Bourn, Sussex
Giles, J.	. .	Hargrave, Bury St. Edmund's, Suffolk
Gilstrap, J.	. .	Hawton, Newark, Notts.
Girdlestone, Steed	. .	Stibbington Hall, Wansford, Northampts.
Glasspoole, Captain	. .	Ormsby, Great Yarmouth, Norfolk
Glegg, John Baskeroyle	. .	Withington Hall, Congleton, Cheshire
Gobbitt, John	. .	Iken Hall, Saxmundham
Godrich, Wm.	. .	Durley, Bottley, Hampshire
Godson, Richard	. .	Heckington, Sleaford, Lincolnshire
Godwin, Shadrach	. .	Hemel Hempstead, Hertfordshire
Golborne, William	. .	Witham, Ely, Cambridgeshire
Goldsmith, John	. .	Ixworth, Suffolk
Goldsmith, W.	31, Parliament-st.	
Golpin, John	. .	Dorchester, Dorsetshire
Goodall, Rev. James	. .	Bromham, Bedfordshire
Goodwin, Samuel C.	. .	Huntingfield Hall, Yoxford, Suffolk
Goodwin, Samuel	. .	Huntingfield, Suffolk
Gordy, J.	. .	Wickham Market, Suffolk
*Gore, Wm. Ormsby, M.P.	66, Portland-place	Porkington Hall, Oswestry, Salop.
Gosling, F.	. .	Bocking, Essex
Gostling, Henry	. .	Oakley, Bedfordshire
Gossip, Randall	. .	Thorpe Arch Hall, Wetherby, Yorkshire
Gough, Edward	. .	Gravel Hill, Shrewsbury
Granger, John	. .	Stretham, Cambridgeshire
Granger, Joseph	. .	Stretham, Cambridgeshire
Grain, Peter	. .	Shelford, Cambridgeshire
Grain, Henry	. .	Shelford, Cambridgeshire

Members.	Town Residence.	Country Residence.
Green, Hugh		Newton, Sudbury
Green, Francis		Court Henry, near Landilo, Carmarthen.
Green, George		Depden Hall, Newmarket, Cambridgesh.
Green, George		Milbrook, Bedfordshire
Green, John		Badger Heath, Shiffnal, Shropshire
Green, John		Grantham, Lincolnshire
Green, Richard		Depden, Newmarket, Cambridgeshire
Green, Thomas Abbott		Pavenham, Bedfordshire
Greenall, John		The Bank, Warrington, Lancashire
*Greenaway, Charles, M.P.		Barrington Grove, Burford, Oxon.
Greene, Benj. Aislabie		St. Ives, Huntingdonshire
Greenham, James		Blankney, Sleaford, Lincolnshire
Greetham, Thomas		Stainsfield, Wragby, Lincolnshire
Grenville, Hon. & Rev. G. Nev.		Master of Magdalen College, Cambridge
Grice, Rev. F. Le		Great Gransden, Huntingdonshire
Griffin, John		Borough Fen, Peterborough, Northampt.
Griffin, W. E.		Werrington, Peterborough, Northampt.
Griffinhoofe, Rev. T. S.		Arkesden, near Bishopstortford, Herts.
Griffith, John		Llwynduris, Newcastle-Emlyn, S. Wales
Grimmer, H.		Haddiscoe, Norfolk
Groom, Richard	3, Henrietta-st. C.G.	
Grosvenor, General		Hare Park
Grove, T.		Baddon, Essex
Groom, Rev. John Hindes, Jun.		Earl Soham, Suffolk
Grimwade, William		Hadleigh, Suffolk
Grundy, James		Heave's Lodge, near Kendal
Gunniss, Jackson		Spilsby, Lincolnshire
Gurdon, Brampton	89, Glouc-p. Port.-s.	
Gurney, John		Earlham, Norwich
Gurney, John		Towcester, Northamptonshire
Gurney, Richard Hanbury	Berners-hotel	
Hagger, Thomas		Northampton
Hague, John		Cranbrook, Kent
Hailstone, Rev. J., MA., FRS.		Vicarage, Bottisham, Cambridgeshire
*Hale, William		Kingsmalden Park, Welwyn, Herts.
Halford, Rev. Thomas	42, Montague-st.	Downing College, Cambridge
Hall, J. O.	1, Brunsw.-row	
Hall, Lieut.-Col.	1st Life Guards	
Hall, John		Landbeach, Cambridgeshire
Hall, John		Kiveton Park, Sheffield, Yorkshire
Hall, John Hancock		Risley Hall, Derby
Hall, Thomas		Cottenham, Cambridgeshire
Hall, William		Saucethorpe, Spilsby, Lincolnshire
Hall, William		Landbeach, Cambridgeshire
Hall, Wilson		Landbeach, Cambridgeshire
Halleth, Job		Martock, Somersetshire
Halley, Francis		Shiffnal, Shropshire
Hamel, Dr.		Imp. Acad. of St. Petersburgh & Moscow
Hammond, James W.		Wistaston Hall, Nantwich, Cheshire
Hanbury, Osgood, Jun.	Lombard-street	
Hand, Robert		Woolsthorpe, Lincolnshire
Hannell, James		Lynn Regis, Norfolk
Harbin, George		Newton House, Yeovil, Somersetshire
Harcourt, George Granv., M.P.		Nuneham Park, Oxfordshire
Harding, William		Acton, near Stafford
Hardy, Thomas		Crowland, Lincolnshire
Harland, W.		Ely, Cambridgeshire
Harlock, W.		Ely, Cambridgeshire

Members.	Town Residence.	Country Residence.
Harradine, John		Needingworth, Huntingdonshire
Harradine, Samuel		Hawnes, Ampthill, Bedfordshire
Harris, John		Springwell Cottage, Clapham Common
Harris, William		Somerby, Lincolnshire
Hart, John George		Stowmarket, Suffolk
Hart, William		Woodham Mortimer Hall, Maldon, Essex
Hankin, Daniel		Stanstead, Ware, Herts.
Hatch, Rev. Charles		King's College, Cambridge.
Hawes, Robert		Colterhall, Norfolk
Hawkins, Henry		The Priory, Royston, Herts.
Hayden, James		Arrington, Cambridgeshire
Hayes, Henry		Whittlesey, Cambridgeshire
Haylock, John		Balsham, Cambridgeshire
Haynes, Henry		Whittlesey, Cambridgeshire
Hayward, William		Wilsford, Devizes, Wiltshire
Hayward, W. P.		Wilsford, Devizes, Wiltshire
Hazard, Henry		Cambridge
Hazard, John		Brentford, Middlesex
Headly, James		Cambridge
Headly, Richard		Hapleford, near Cambridge
Heath, William		Salford, Bidford, Warwickshire
Heath, W.		Norwich
Heelis, Thomas		Skipton Castle, Yorkshire
Hemming, William		Fox Lydiate House, Bromsgrove, Worc.
Hemming, Rev. George		Great Parndon, Essex
Hersee, Dennett		Burpham, near Arundel
Hetley, Henry		Long Sutton, Wisbeach, Cambridgeshire
Hibbert, John, Jun.	47, Gt. Ormond-st.	
†Hickman, Rev. Henry		Walton-on-Thames, Surrey
Hicks, J.		Walton Hall, Thorp, Essex
Hickman, Harvey		Colnbrook, Bucks.
Higgins, Thomas Charles		Turvey House, Olney, Bucks.
Hilder, Thomas		Mays, Lewes, Sussex
Hildred, William		March, Cambridgeshire
Hildyard, Rev. H., M.A.		Peter House, Cambridge
Hill, Charles		Winceby, Horncastle, Lincolnshire
Hilton, Henry		Sole-street House, Faversham, Kent
Hinde, George T.		Lincoln
Hine, George		Knotting, Bedfordshire
Hitchman, W.		Chipping Norton, Oxfordshire
Hoare, Henry Charles	23, Bruton-st, Bk-sq	
Hoare, Sir H. Hugh, Bart.	St. James's-square	Stourhead, Wilts., and Wavenden, Bucks.
Hobson, John		Eaton Socon, St. Neots, Hunts.
Hodgkinson, Richard		Osberton Grange, Retford, Notts.
Hodson, John		Upwell, Cambridgeshire
Hodgson, Joseph		Holme Hall, Bakewell, Derbyshire
Hodson, W.		West Bletchington, Brighton, Sussex
Hogg, Frederick		Girtford, Bedfordshire
Hoff, William		Halston, Spilsby, Lincolnshire
Holmes, Rev. John		Brooke Hall, Norwich
Holland, William		Rodbaston Hall, Penkridge, Staffordshire
Holley, Joseph		Burgh, Norfolk
Hooper, William		West Lavington, Devizes, Wilts.
Hopkins, Francis		Cambridge
Hopkins, Rev. J.		Hartford, near Huntingdon
Hopkins, W.		Peterhouse, Cambridge
Hopkinson, Luke	10, Bedford-row	
Hopkinson, Dr.		Stamford, Lincolnshire
Horner, Rev. John		Wells Rectory, Frome, Somerset.
Horner, Colonel		Wells Park, Frome

Members.	Town Residence.	Country Residence.
Horton, Richard	. .	Audley End, Saffron Walden, Essex
*Hoskyns, Sir Hungerford, Bart.	. .	Harewood, Ross, Herefordshire
Hoste, Derick	. .	Berwick House, Docking, Norfolk
Howard, Hon. Colonel Greville		
Hukman, Harvey	. .	Colnbrook, Buckinghamshire
Humfrey, Charles	. .	Cambridge
Humphries, James	. .	Cawley, Cheltenham, Glouc.
Hunt, John	. .	Thornington, near Wooler, Northumberld.
Hunt, Rev. George . . .	. .	Barmingham Rectory, Botesdale, Suffolk
Hunt, W.	. .	Stamford, Lincolnshire
Hurst, Robert, Jun. . . .	. .	Horsham, Sussex
Hurwood, George	. .	Ipswich, Suffolk
Hutley, Jonathan	. .	Earls Colne, Halstead, Essex
Hutten, Francis	. .	North Runcton, near Lynn, Norfolk
Hutton, F.	. .	Lynn, Norfolk
Hutton, George	. .	Hattesfield, Suffolk
Hutton, Timothy	. .	Clifton Castle, Bedale, Yorkshire
Ibbetson, L. L. Boscawen . .	. .	North Kynce, Lincolnshire
Ingall, C.	. .	Swineshead, Boston, Lincolnshire
Ireland, J. Ireland Clayfield .	. .	Binlington, near Bristol
Isaacson, William Parr . .	. .	Newmarket, Cambridgeshire
Ivett, William	. .	Barnby Moor, East Retford, Notts.
Iviatt, James	. .	Cottenham, Cambridgeshire
Iviatt, Robert	. .	Cottenham, Cambridgeshire
Jackson, Thomas	. .	Redwane, Rugeley, Staffordshire
Jackson, Thomas	. .	Hill Bedware, Staffordshire
James, Rev. Joseph . . .	. .	Goodall, Bromham, Bedfordshire
Jebb, George	. .	Brynkenalt, Chick, N. W.
Jeffes, Thomas	. .	Sapiston
Jeffrys, Edward	. .	Much Wenlock, Shropshire
Jenkins, Thomas	. .	Spetchley, Worcester
Jenner, Thomas	. .	Cowdray Park, Easebourne, Midh., Sussex
Jennings, W.	. .	Duffield, near Derby
Jenyns, George	. .	Bottisham, Newmarket, Cambridgeshire
Jermyn, Rev. Dr. Bitten, LL.D.	. .	Long Stanton House, Cambridge
Jervoise, S. Clarke	. .	Porters, Shenley, Barnet, Hertfordshire
Johnson, Henry	. .	Burwell, Cambridgeshire
Johnson, John	. .	Holbeach, Lincolnshire
Johnson, Oliver	. .	Earls Colne, Halstead, Essex
Johnson, Robert	. .	Burwell, Cambridgeshire
Johnson, Sturton	. .	
Johnson, William	29, Gordon-street	Chesterton, Cambridge
Johnson, Rev. Henry Luttman .	. .	Binderton House, Chichester
Johnston, John Alexander . .	. .	Crondall, Farnham, Surrey
Jones, H. J.	. .	Brockworth, Gloucester
Jones, A. G.	. .	Gloucester
Jones, Thomas	. .	Buildwas Abbey, Much Wenlock, Salop.
Jones, William	. .	Harrington, Shiffnal, Salop.
Jorden, William Hill . . .	. .	Bearley, Stratford-on-Avon, Warwicks.
Jordan, William	. .	Phenice Farm, Leatherhead, Surrey
Josselyn, John, jun. . . .	. .	Belstead, Ipswich, Suffolk
Julian, John	. .	Bury, Ramsey, Huntingdonshire
Julian, John, jun.	. .	Bury, Ramsey, Huntingdonshire
Keeling, Chas.	. .	Congreve, Penkridge, Staffordshire
Kegworth, T. M.	. .	Lincoln
Kellow, John	. .	Woodhouse, Andover, Hampshire

Members.	Town Residence.	Country Residence.
Kemp, Jesse	. .	Utterby Grove, Louth, Lincolnshire
Kennington, T.	. .	Stinton Vale, Binbrook, Lincolnshire
Kent, John	. .	Stratford, Essex
Ketly, Henry	. .	Long Orton, Peterborough, Northamp.
Killingbeck, Robert	. .	Swaffham Prior, Cambridgeshire
Kilpin, W. W.	. .	Bedford
Kingdon, Rev. C. S.	. .	Sydney College, Cambridge
King, Captain George, R.N.	19Chpl-st S.Aud-st	
King, George	. .	Saffron Walden, Essex
King, John	. .	Kelby, Sleaford, Lincolnshire
King, Rev. John	. .	Cutcombe, Dunster, Somersetshire
King, John	. .	Berwick, Lewes, Sussex
King, J. M.		Cutcombe Vicarage, Dunster, Som.
King, Hon. P. J. Locke	38, Dover-street	Woburn Park, Chertsey, Surrey
King, Sir Richard, Bart.	19Chap-stS.Aud-st	
Kington, Sir Hill, Bart.	. .	Blendworth House, Horndean, Sussex
Kington, Thos.	. .	Charlton House, Bristol
Kirkham, John	. .	Hagnaby, Bolingbroke, Lincolnshire
Knight, Charles Allanson	. .	Simonsbath, South Molton, Devonshire
Knight, George	. .	Cliffe, Rochester, Kent
Knight, Richard	. .	Dunton Hall, Brentwood, Essex
Knight, R.	. .	Dunton House, Brentwood, Essex
Knight, Richard	. .	Stamford
Knight, Thomas	. .	Edmonton, Middlesex
Knight, Jno.	. .	Stamford
Knowles, John	. .	Easton, Newbury, Berkshire
Lacon, Sir Edmund H. K., Bt.	. .	Ormesby, Great Yarmouth, Norfolk
Ladbroke, Felix	. .	Hedley, Epsom, Surrey
Lambert, Rev. Burges	. .	Misterton, Crewkerne, Somersetshire
Lambert, John James	. .	Dorchester, Dorsetshire
Langley, Thomas	. .	Upton, near Shiffnal, Salop.
Langton, Robert Martin	. .	Thorney Abbey, Peterborough
Langwith, Joseph Silvester	. .	Grantham, Lincolnshire
Largeat, J. H.	. .	Wickham Market, Suffolk
Lavington, Samuel	. .	Poulshot, Devizes, Wiltshire
Law, Rev. H.	. .	Standon
Lawrance, Munton	. .	Dunsby Hall, Folkingham, Lincolnshire
Lawrance, Joseph	. .	Tilty Grange, Dunmow, Essex
Lawrence, Henry, Jun.	. .	Ely, Cambridgeshire
Layton, William	. .	Woodhouse, Ely, Cambridgeshire
Lee, Joseph, Jun.	. .	Red Brook, Whitchurch, Salop.
Lee, Thomas	. .	Barkstone, Lincolnshire
Leedham, William	. .	Brixton Villa, Surrey
Leeds, Henry	. .	Stibbington, Huntingdonshire
Leeds, R.	. .	Addiscombe, Devonshire
Leete, Henry	. .	Thrapstone, Northamptonshire
Leigh, James Heath	. .	Belmont, Northwich, Cheshire
Leighton, Sir Baldwin, Bart.	. .	Loton, Shropshire
Leith, Alexander	. .	Freefield and Glentindie, Aberdeenshire
Lempriere, Capt.	. .	Alton, Hampshire
Leonard, Thomas	. .	Broxtead Hall, Dunmow, Essex
Lethgoe, George	. .	Stanway, Colchester, Essex
Leslie, Charles	3, Upper Harley-st.	Glasslough, Ireland
Lewis, David	4,Chesham-pl, B-sq	
Ley, William	. .	Woodlands, Exeter, Devonshire
Lilley, Frederick W.	. .	Grantchester, Cambridgeshire
Linton, William	. .	Westwich, Cambridgeshire
Lisburne, Earl of	. .	Cross Wood, Aberystwith

Members.	Town Residence.	Country Residence.
Little, Harry	. .	Whittlesey, Peterborough, Northamp.
Little, John	. .	Eldernell
Little, John	. .	Whittlesey, Peterborough
Livett, John	. .	Eaton Socon, St. Neot's, Huntingdonshire
Lloyd, Charles	. .	Court Calman, Montgomeryshire
Lock, Samuel	. .	Barton, Stoke Ferry, Norfolk
Long, William	. .	Melbourne, Cambridgeshire
Longstaff, W.	. .	Fiskerton Hall, Lincoln
Loud, Henry	. .	Herne, Kent
Love, P.	. .	Mesley
Love, Samuel	. .	Park Farm, Shoreham, Sussex
Lowry, Thomas	. .	Syston, Grantham, Lincolnshire
Lucas, Rev. W.	. .	Burgh Acre
Lucy, Rev. John	. .	Hampton Lucy, Stratford-on-Avon
Lungley, Brooke	. .	Boxford, Suffolk
Lungley, Smyth	. .	Kelvedon, Essex
Lushington, Rt. Hn. S. R., M.P.	. .	Merry Hill, Watford, Herts.
Lynedoch, Lord, G.C.B.	12, Stratton-street	
Lynn, Robert	. .	Stroxton, Lincolnshire
Lyon, Edmund H.	. .	Horstead House, Norwich
Lys, Stephen	. .	Harlow, Essex
Lyttelton, Hon. W. H.	. .	Trinity College, Cambridge
Machin, Henry	. .	Gateford Hill, Worksop, Nottinghamshire
Mahir, J. H.	. .	Lynn, Norfolk
Maine, Rev. T.	. .	St. Neots, Huntingdonshire
Maitland, Rev. John Gorham	. .	Surrey Villa, Lambeth, Surrey
Majoribanks, E.	77, Harley-street	
*Malcolm, Neil	. .	Kilmarton, Lochgilphead, Argyleshire
Manners, Lord Charles, M.P.	. .	Belvoir Castle, near Grantham, Lincolns.
Manning, Henry	. .	Redbourne, Brigg, Lincolnshire
Manning, William	. .	Elstow
Mann, John	. .	Shropham, Norfolk
Maples, Thomas	. .	Spalding, Lincolnshire
Marshall, Henry	. .	Pen's Hill, Cambridge
Marshall, Joseph	. .	Waldersea House, Wisbeach, Cambridges.
Marshall, Joseph	. .	Hilgay, Norfolk
Marshall, John	. .	Rixholme Lodge, near Lincoln
Marshall, J.	. .	Hitchin, Hertfordshire
Marsom, F. C.	Cumb-ter. Reg-pk.	
Martin, David	. .	Wainfleet, Lincolnshire
Martin, Henry	. .	Littleport, Ely, Cambridgeshire
Martin, James	. .	Nonsuch Farm, Epsom, Surrey
Martin, John	. .	Bury, Huntingdonshire
Martin, P. S. F.	. .	Halstead, Essex
Martin, W.	. .	Downham, Ely, Cambridgeshire
Mason, Edward	. .	Hall Farm, Waterbeach, Cambridgeshire
Mason, John	. .	Wrest Park, Silsoe, Bedfordshire
Massen, James	. .	Coltsterworth, Lincolnshire
Matson, Henry	. .	Wingham, Kent
Maxwell, William James	49, Weymouth-st	
May, Charles Hughes	. .	Sneyd Farm, Burslem, Staffordshire
Mayd, Rev. W.	. .	Wethersfield, Haverhill, Suffolk
Mayer, Thomas Walton	. .	Newcastle-under-Lyne, Staffs.
Mayer, Thomas	. .	Newcastle-under-Lyne, Staffs.
Meeson, John	. .	Grays, Essex
Meredith, Rev. Edward	. .	Newport, Shropshire
Merrington, D. W.	. .	Fulbourn, near Cambridge
Meyer, James	. .	Forty Hall, Enfield, Middlesex

Members.	Town Residence.	Country Residence.
Micklethwait, N.	. .	Faversham, Norwich, Norfolk
Micklethwait, Sir Peckham, Bt.	. .	Tridge Place, Hurst Green, Lewes, Sussex
Middleton, Henry	. .	Killington, near Oxford
Middleton, Lord	Thomas's Hotel	
Mill, Sir John Barker, Bart.	. .	Downing College, Cambridge
Mills, Rev. J.	. .	Pembroke College, Cambridge
Mills, S.	. .	Elston, Devizes, Wiltshire
Mills, William	. .	Saxham Park, Bury St. Edmund's, Suff.
Milward, R.	. .	Hexgreave Park, Southwell, Nottinghams.
Milward, Thomas	. .	Thengarton Hill, Southwell, Nottinghams.
Minnitt, Joshua Robert	. .	Annabeg, Nenagh, Ireland
Mitchell, John	. .	Wymondham, Norfolk
Monins, John	. .	Ringwould, near Dover, Kent
Monteagle, Lord	. .	Mount Trenchard, Limerick
Moore, Henry	. .	Redbourn, Brigg, Lincolnshire
Moore, John Kirby	. .	Badley, Stowmarket, Suffolk
Moore, Thomas, Jun.	. .	Shalford, Braintree, Essex
Moore, W.	. .	Guneshill
Moore, William	. .	Elm, Cambridgeshire
Moore, William	. .	Eagle Hall, Lincoln
Morgan, Caleb, Jun.	. .	Hom Lodge, Ross, Herefordshire
Morgan, Francis	51, Bedford-square	Oakfield, Reading, Berkshire
Morgan, Philip	. .	Defynnock, Brecknockshire, S. Wales
Morriss, Charles Campbell	. .	Loddington Hall, Uppingham, Rutland
Morris, Rev. Francis Orpen	.	Ordsal, near Retford, Nottinghamshire
Morris, T.	. .	Walcot, Bishop's Castle, Shropshire
Morris, W. Clark	. .	Oakham Grange, Rutlandshire
Mosley, Sir Oswald, Bart.	. .	Rolleston Hall, Burton-on-Trent, Staffsh.
Mortlock, Henry	. .	Caxton, Cambridgeshire
Mortlock, Thomas	. .	Coombe Grove, Cambridge
*Mortlock, Thomas	. .	Abington Park, Cambridge
Mott, William	. .	Wall, Lichfield, Staffordshire
Mott, John Thomas	. .	Blickling Lodge, Aylsham, Norfolk
Mullens, Dunnett	. .	
Murton, John	. .	Cooling Castle, Rochester, Kent
*Murray, Charles Robert Scott	11, Cavendish-sqre	Danesfield, Marlow
Mostyn, C.	. .	West Rasen, Lincolnshire
Munn, Wm. Augustus	. .	Gore Hill, Sittingbourne, Kent
Mussen, James	. .	Colsterworth, Lincolnshire
Myton, Thomas	. .	Shipton Hall
Nairn, Philip	. .	Waren House, Belford, Northumberland
Napper, John	. .	Malham, Petworth, Sussex
Nash, Charles	. .	Biggleswade, Bedfordshire
Nash, Frederick J.	. .	Bishop-Stortford, Hertfordshire
Nash, Peter	. .	Cambridge
Neale, Charles	. .	Mansfield Woodhouse, Nottinghamshire
Neave, Francis	. .	Downham Grove, Wymondham, Norfolk
Neems, John	. .	Frocester, Stroud
Nevile, Henry	. .	Walcot Hall, Stamford
Newland, Robert	. .	Kemston, Bedford
Newbett, Edward	. .	Knipton, Leicestershire
Newburgh, Earl of	. .	Hassop Hall, Bakewell, Derbyshire
Newby, Richard	. .	Cambridge
Newstead, Thomas, jun.	. .	Dunham, Newton, Nottinghamshire
Newton, William	39, Dover-street	Elvedon Hall, Thetford, Suffolk
Nicholls, L.	. .	Bryncamisha, Newtown, Montgomeryshire
Nicholls, Samuel	. .	Offord D'Arcy, near Huntingdon
Nicholson, G. T.	. .	Waverley Abbey, Farnham, Surrey

Members.	Town Residence.	Country Residence.
Nicholson, Thomas	. .	Grayingham, Kirton-in-Lindsey, Lincoln
Nock, John	. .	Kinver, Stourbridge, Worcestershire
Nockold, Martin	. .	Saffron Walden, Essex
Nodder, Rev. Joseph	. .	Ashover Rectory, Chesterfield, Derbyshire
Norgate, Rev. Burroughes	. .	Ashfield House, Bury St. Edmund's, Suff.
Northgate, H. S.	. .	Pynes
Norman, John Manship	. .	Slaugham Park, Crawley, Sussex
Norton, John	. .	Little Donn, near Stafford
Norton, Richard	. .	Audley End, Saffron Walden
Nott, John	. .	Bydown House, Barnstaple, Devonshire
*Nugent, Hon. M. W. Bellew	. .	Effingham House, Leamington, Warw.
Nunn, Carrington	. .	Little Bromley Hall, Colchester
Nutter, James, Jun.	. .	Grandchester Mills, Cambridge
Nutter, Thomas	. .	Cambridge
O'Brien, Stafford Augustus	. .	Blatherwycke Park, Wansford, Northamp.
Okes, John	. .	Cambridge
*Oldham, F. O.	. .	Belle-amour Hall, Rudgeley, Staffordshire
Oliver, Francis	. .	Dorchester, Dorset.
Orde, Rev. John	. .	Winsley, Bedale, Yorkshire
Osborn, George, jun.	. .	Pattishall Manor House, Northamptonshire
Oslar, Thomas	. .	Fulbourn, Cambridgeshire
Otter, Rev. William	. .	Rectory, Cowfold, Horsham, Sussex
Owen, Edward Smyth	. .	Condover Park
Owen, John	. .	Lynn, near Shenston, Staffordshire
Packe, Rev. Augustus	. .	Walton Rectory, Loughborough, Leic.
Packe, James	. .	Vice-Provost of King's College, Cambr.
Page, Thomas	. .	Ely, Cambridgeshire
Pain, Joseph	. .	Felmersham, Bedfordshire
Palmer, E.	. .	Caston
Palmer, Henry Norton	. .	Old Buckenham, Norfolk
Palmer, Sir John, Bart.	. .	Carleton, Northamptonshire
Palmer, Rev. Philip H.	. .	Granby, Bingham, Nottinghamshire
Paris, Archibald	. .	West Lodge, Barnet, Hertfordshire
Paris, John	. .	Farnham, Essex
Parker, Charles G.	. .	Springfield Place, Chelmsford, Essex
Parker, Charles Staurt	. .	Annesley, Liverpool, Lancashire
Parker, Rev. Richard, M.A.	. .	Corpus Christi College, Cambridge
Parkins, Abraham	. .	Arnsby, Leicestershire
Parkinson, John Law	. .	26, Cloudesley Terrace, Islington
Parkinson, Richard	. .	Babworth, Retford, Nottinghamshire
Parry, Nicholas	. .	Little Hadham, Ware, Hertfordshire
Partridge, Rev. John Anthony	. .	Bacon's Thorpe, Aylsham, Norfolk
Patterton, Thomas Benjamin	. .	Clipston, near Market Harbro', Leicesters.
Pattisson, F. A.	. .	Coggeshall, Essex
Parlbey, Joshua	. .	West Wratting, Linton, Cambridgeshire
Pawlett, Thomas Edward	. .	Tinwell, Stamford, Lincolnshire
Pawlett, William	. .	Barnack, Stamford, Lincolnshire
Paxton, T.	. .	Potsgrove, Woburn, Bedfordshire
Payne, John	. .	Hargrave, Bury St. Edmund's, Suffolk
Payne, William	. .	Mildenhall, Suffolk
Peakes, R.	. .	Stag's Hall, March, Ely, Cambridgeshire
Peake, T. C.	. .	Sidney College, Cambridge
Peck, Rev. Edward M.	. .	Wyton, near Huntingdon
Peck, Rev. Edward A.	. .	Wyton, Huntingdon
Peck, Walter	. .	Wyton, Huntingdon
Peck, Rev. William	. .	Hilton, St. Ives, Huntingdonshire

Members.	Town Residence.	Country Residence.
Pedder, Edward	. .	Clifton Hall, Preston, Lancashire
Peed, Anthony	. .	Cambridge
Peed, John	. .	Whittlesey, Isle of Ely, Cambridgeshire
Peel, Henry	. .	Aylesmore House, near Chepstow, Monm.
Pells, Edward	. .	Culpho, Suffolk
Pemberton, Christopher Robert	Eaton-pl., Belg.-sq.	
Pemberton, Francis Charles J.	. .	Trumpington, Cambridge
Penn, J.	. .	Hewell, Bromsgrove, Worcestershire
Penrice, Rev. C.	. .	Plumstead
Penrice, John	. .	Witton House, Blofield, Norwich, Norfolk
*Perkins, Henry	. .	Hanworth Park, Middlesex
Perkins, John	. .	Gedney Hill
Perry, John	. .	Writtle, Essex
Perry, Richard	. .	Debden, Essex
Perry, Robert	. .	Debden, Essex
Petley, C. C.	. .	Sevenoaks, Kent
Petre, Hon. Charles	. .	Bury St. Edmund's, Suffolk
Phelips, Charles	. .	Briggins Park, Ware, Hertfordshire
Pherson, Mac, J.	. .	King's Lynn, Norfolk
Phillips, C.	. .	Margaret Roothing, Essex
Phillips, Charles	. .	Newmarket, Cambridgeshire
Phillips, John	. .	Royston, Hertfordshire
Phillips, Joseph Taylor	. .	New Lodge, Shiffnal, Shropshire
Phillips, John	. .	Brockton Leasows, Shiffnal, Shropshire
Phillips, Richard, Jun.	. .	Brockton, near Shiffnal, Shropshire
Pickernell, John	. .	Little Witley, Worcestershire
Piggott, Z.	. .	Southfleet, Kent
Piggott, William	. .	Alting, Witham, Essex
Pigott, William	. .	Dullingham Hall, Newmarket, Cambridg.
Pilcher, William Wood	. .	Town's End Farm, St. Margaret's, Dover
Pinkey, Joseph	. .	Rowley, Much Wenlock, Shropshire
Pinkus, Henry	Slaughtern.-hotel	
Pinneger, Broom	. .	Newbury, Berkshire
Piper, R. D.	. .	Great Abington, Berkshire
Pitter, John Robert		
Platten, John	. .	King's Lynn, Norfolk
Plough, Rev. Richard, D.D.	. .	Clayden Rectory, Ipswich, Suffolk
Pochin, Samuel	. .	Sherborne, Wallington, Oxon.
Podmore Charles	. .	West Rudham, Norfolk
Pollett, Thomas	. .	Latton Harlow, Essex
Pollett, T.	. .	Great Banfield, Essex
Poltimore, Lord	. .	Poltimore, near Exeter, Devonshire
Poole, Domville	. .	Marbury, Whitchurch, Salop.
Pooly, T.	. .	North Wold, Norfolk
Pope, Richard E.	. .	March, Isle of Ely, Cambridgeshire
Poppy, Charles	. .	Witnesham
Porcher, Charles	. .	Cliffe House, Blandford, Dorsetshire
Porter, William	. .	Frieston, near Boston, Lincolnshire
Postle, John	. .	Smallburgh, Worstead, Norfolk
Postle, William	. .	Smallburgh, Worstead, Norfolk
Pottinger, J.	. .	Sonning, near Reading, Berkshire
Poundley, J. W.	. .	Brook Cottage, Newtown, Montgomerysh.
Powis, Earl of	. .	Powis Castle, Shropshire
Powlett, Lord William	19, Curzon-st.	
Pownall, Rev. C. C. B.	. .	Milton Ernest, Bedfordshire
Praed, W. T., M.P.	35, St. James's-pl.	
Prake, Robert	. .	Stagshott Farm, Wisbeach, Cambrigesh.
Pratt, Robert	. .	Spelsbury, Enstone, Oxon.
Price, Charles	2, Great Queen-st.	
Price, Rev. T.	. .	King's College, Oxford

Members.	Town Residence.	Country Residence.
Prichard, Charles Arthur	. .	Tyllwydd, near Cardigan, South Wales
Prichard, Evan	. .	Collenna, Cardiff, Glamorganshire
Pritchard, George	. .	Broseley, Shropshire
Pritchard, John	. .	Broseley, Shropshire
Pryor, John	. .	Clay Hall, Bedfordshire
Pryor, John	. .	Baldock, Hertfordshire
Pryor, Maurice	. .	Baldock, Hertfordshire
Pryor, Vickriss	. .	Baldock, Hertfordshire
Pryse, Pryse, M.P.	. .	Gryerddan, Aberystwith, South Wales
Pulver, R.	. .	Stone Farm, Aylesbury, Buckinghamshire
Purkis, William	. .	Withinfield, Essex
Purkis, William	. .	Balsham, Linton, Cambridgeshire
Purser, William	. .	Cople, Bedfordshire
Pyatt, Abraham	. .	Wilford, near Nottingham
	. .	
Questin, George		Ash, Wingham, Kent
Quihampton, Henry	. .	Little Totham, Maldon, Essex
Quintin, Thomas St.	. .	Hatley Park, Biggleswade, Bedfordshire
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Royal Agricultural Society of England.

1840—1841.

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Royal Agricultural Society of England.

ANNIVERSARY MEETING,

5, Cavendish Square, May 22, 1841.

REPORT OF THE COUNCIL.

The Society has now been established for three years, and the Council having had the satisfaction of reporting at every General Meeting during that period the steady increase in the number of Members, who have enrolled their names in its list, from every district in the kingdom, and of recording the progressive interest with which its labours have been regarded, have, on the present occasion, the further satisfaction of seeing that its example, and that of the Highland and Agricultural Society of Scotland, have led to the establishment of a similar Society in Ireland. The Finance Committee have been applying their attention to the completion of that system of arrangement in the accounts which they have adopted as the most simple in its details, and to which reference was made at the last General Meeting. They have also prepared for the inspection of the Auditors a Balance-sheet of the accounts for the whole of last year, showing the receipts and payments of the Society from the 1st of January to the 31st of December, and followed by a general account of the state of the funds of the Society at the end of that year; and have reported to the Council the further permanent investment they

have already made this year in the purchase of 1000*l.* stock. They have the satisfaction of reporting that the probable annual receipts of the Society for the year 1841 exceed any probable expenditure to be incurred during the year, sufficiently to secure the prosperity of the Society; but they feel themselves called upon to state, that the amount of arrears due from Members is becoming so large, that it will be necessary for them to apply their attention seriously, not only to recovering what is now due, but to prevent a similar accumulation in future.

The arrears, as will appear by the accounts now presented, amount—

For 1838	to	£ 42
1839	to	274
1840	to	1382
		£ 1698

No less than 2026 new Members have been elected into the Society during the past year, and the Society now consists, at the present Anniversary, of 4595 Members: namely, of 91 Life Governors, 219 Annual Governors, 231 Life Members, 4047 Annual Members, and 7 Honorary Members.

The Council having received from Mr. Wyon, Her Majesty's Chief Medallist at the Mint, the dies for the Medal of the Society, they have directed the proper number of gold and silver medals to be struck, and these will be presented by your President to the individuals who have successfully obtained these Honorary Rewards of the Society.

The Council having at the last General Meeting had the pleasure of announcing the services of Professor Henslow of Cambridge in promoting the objects of the Society, they have on this occasion not only to state the continued interest of that gentleman, in making known his researches through our Journal, and

undertaking the arrangement of the specimens of wheat, but to announce the liberality of Dr. Daubeny, the new Professor of Agriculture in the University of Oxford, in placing his Lectures at the disposal of the Journal Committee.

The Journal Committee have reported that the new part of the Journal will be published immediately, and the Council have decided to renew the conditions of the model experiment proposed last year on the growth of Swedish turnips.

The Council having selected Liverpool as the place of the Annual Country Meeting to be held this year, have decided on additional prizes to the amount of 100*l.* to be given at that Meeting for agricultural horses, and have also agreed to the mode in which the 200*l.* to be awarded this year for implements shall be distributed into classes. The Liverpool Prize Sheet, containing the details of these arrangements, as well as the general regulations for exhibition, has been printed, and a copy sent by post to each Member of the Society.

Mr. Earle having consented to act as the Society's representative in directing the progress of the arrangements on the spot, a deputation was sent by the Council to the authorities of the town, and was received by the present, and the late Mayor, with every mark of interest and respect. This deputation reported to the Council the result of their personal inspection, when it was resolved, that the piece of ground termed the Old Infirmary Yard, which had been offered by the Mayor and Corporation, should be accepted as the site for the Dining Hall; that Falkner's Fields, offered by Mr. Falkner and Mr. Lace, should be selected for that of the Cattle Yard; that the rooms of the Mechanics' Institute should be accepted for the use of the Finance and Dinner Committees, and Mr. Lucas's Repository for the purpose of the Wednesday's Dinner,

Having ascertained from Mr. Manning, the contractor for the Cambridge Works, that his present engagements would preclude his undertaking the works this year at Liverpool, the Council decided to appoint a Surveyor of Works, who should inspect the progress of their erection, and Mr. Wild having been elected to that office, he has proceeded to Liverpool for the purpose of making arrangements with the contractors to be employed.

The Council having decided that there should this year be two days for the exhibition of the stock instead of one, as formerly, the exhibition of the implements will open on Wednesday the 21st of July, and that of the cattle on Thursday the 22nd, the Show remaining open till 2 o'clock on the Friday; and the Dinner of the Society will take place on the Thursday. They have also directed that catalogues containing a list of all the subjects of the exhibition shall be prepared for sale before the time of the meeting—that only the printed forms shall be allowed for the certificates of exhibitions—and that the awards for implements shall be announced at the same time as those for cattle. They have decided that the sale of Dinner Tickets shall only take place at Liverpool, commencing on Tuesday, and continuing open to the Members in general on the two following days; each day, however, a certain number of tickets being reserved for old Members, namely, for such as were elected by the 24th of March last; and that after the first Wednesday in July no further election of Members shall take place until after the Meeting.

The Council having maturely considered all the comparative advantages offered by various places for the next year's Meeting, have decided in selecting the City of Bristol as the most suitable locality for the Annual Country Meeting of 1842; and agreeably with the new by-law, regulating the announcement of the list of prizes for the Country Meetings, the Bristol Prize-Sheet has been

provisionally agreed to, and will be laid before you for suggestions and revisions at the present Anniversary Meeting.

The Veterinary Committee, having had referred to them the numerous answers sent in reply to the circular containing Queries respecting the epidemic, have directed these Reports to be reduced into a classed form for the purpose of comparison and investigation; Mr. Handley as Chairman of the Veterinary Committee, and Professor Sewell as the representative of the Royal Veterinary College, having been requested by the Council to lay before the Journal Committee, for publication, their general Report on this important subject, for the full information of the Members of the Society.

By order of the Council,

JAMES HUDSON, Secretary.

Journal.

Mr. J. Curtis having engaged to furnish various Reports for this Journal, relating to the Insects injurious to the Agriculturist, any communications, with specimens, bearing upon this subject, will be very acceptable, if addressed to him,

No. 11, Robert Street, Hampstead Road.

Members who may have made trial of the Nitrate of Soda this year are requested to forward accounts of its success or failure, at their earliest convenience after the harvest, addressed to the Secretary.

DETAIL BALANCE-SHEET OF THE RECEIPTS AND DISBURSEMENTS OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND

For the Year 1840.

RECEIPTS.		£.	s.	d.
Balance in the Bankers' hands on January 1st, 1840		787	14	11
Compositions of 10 Governors	£499 0 0			
Compositions of 88 Members	851 0 0			
		1350	0	0
Annual Subscriptions of 191 Governors	912 10 0			
Annual Subscriptions of 2501 Members	2501 10 0			
		3414	0	0
One Year's Dividends on Stock		140	0	0
Mr. Murray's Balance on Sale of Journal	26 16 1			
Miscellaneous Receipts	1 19 0			
		28	15	1
Outstanding Cheques		36	16	0
Repaid by Mr. Pym on account of Cambridge Meeting		24	2	1
Sum not accounted for		7	8	2
		£5788	16	3

(Signed)

C. B. CHALLONER,

Chairman of the Finance Committee.

THOS. RAYMOND BARKER.

EXPENDITURE.		£.	s.	d.
Secretary's Salary, one year	£400 0 0			
Clerk's Salary	40 0 0			
Housekeeper's Wages, one year	52 0 0			
Rent of Apartments, one year	350 0 0			
Veterinary College	200 0 0			
		1042	0	0
Occasional Clerks	97 19 7			
Expenses of Journals	316 0 5			
Fees on Charter	337 17 0			
Cambridge Plans	39 4 0			
		791	1	0
Cambridge Prizes		765	0	0
Prize Essays		85	0	0
Mr. Manning, extra work at Cambridge		52	18	0
Investment (in purchase of 700*l.* Stock in New 3½ per Cent. Reduced Annuities, at 100)		700	17	6
Office Furniture	38 0 6			
Miscellaneous Payments	23 5 0			
Stationery, Advertisements, &c.	124 13 0			
General Printing	21 3 6			
Postage of Epidemic Circulars	10 9 0			
Incidental Expenses (as per Petty Cash Book)	176 16 9			
Household Expenses	26 0 0			
Repayment to Colonel Seymour	10 0 0			
		430	7	9
Balance of Expenses at the Cambridge Meeting		173	5	2
Balance in the hands of the Bankers, Dec. 31, 1840		1725	3	7
Balance in the hands of the Secretary		23	3	3
		£5788	16	3

Audited by us, 21st May, 1841, on the part of the Society,

(Signed) C. HAMPDEN TURNER,
THOMAS KNIGHT.

GENERAL ACCOUNT OF THE STATE OF THE FUNDS OF THE SOCIETY

Between the 1st of January and the 31st of December, 1840.

		£.	s.	d.
In the hands of Messrs. Drummond January 1st, 1840		787	14	11
Subscriptions received of Members during the year 1840		4764	0	0
Dividends on Stock		140	0	0
Miscellaneous Receipts		28	15	1
Repayment by Mr. Pym		24	2	1
Outstanding drafts		36	16	0
Receipts at the Cambridge Meeting		3415	17	0
Not accounted for		7	8	2
Arrears of Subscriptions for 1838	£42 0 0			
Ditto ditto, 1839	274 0 0			
Ditto ditto, 1840	1382 0 0			
		1698	0	0
		£10,902	13	3

4700*l.* invested in the $3\frac{1}{2}$ per Cent. Reduced Annuities.

C. B. CHALLONER,
Chairman of the Finance Committee.

THOS. RAYMOND BARKER.

				£.	s.	d.
Purchase of 700*l.* Stock in the New $3\frac{1}{2}$ per Cent. Reduced Annuities				700	17	6
Expenses of the Society as detailed in the preceding Balance-sheet	£1042	0	0			
	791	1	0			
	52	18	0			
	430	7	9			
				2316	6	9
Balance in the hands of Messrs. Drummond				1725	3	7
Balance in the hands of the Secretary				23	3	3
Expenses at the Cambridge Meeting				3589	2	2
Prizes at Cambridge				765	0	0
Prizes for Essays				85	0	0
Amount of Arrears of Subscriptions				1698	0	0
				£10,902	13	3

Audited by us, 21st May, 1841, on the part of the Society,

C. HAMPDEN TURNER,
THOMAS KNIGHT.

Liverpool Meeting.

THE SHOW WILL BE OPEN

On WEDNESDAY, July 21st, 1841, for the Implements only: on THURSDAY, July 22nd, and until 2 o'clock on FRIDAY, JULY 23rd, for the Entire Show.

The Society's Dinner will take place on Thursday, July 22nd, at 4 o'clock.

THE PRIZES ARE OPEN TO GENERAL COMPETITION.

Prizes for Improving the Breed of Cattle.—1841.

CLASS I.—SHORT-HORNS.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.
To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . . Ten Sovereigns.

CLASS II.—HEREFORDS.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.
To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . . Ten Sovereigns.

CLASS III.—DEVONS.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.

To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . Ten Sovereigns.

Class IV.—Cattle of any Breed, or Cross:

Not qualified for the foregoing Classes.

To the owner of the best Bull calved previously to the 1st of January, 1839 . . . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . . Twenty Sovereigns.
To the owner of the best Bull calved since the 1st of January, 1839, and more than one year old . Twenty Sovereigns.
To the owner of the second-best ditto . . . . Fifteen Sovereigns.
To the owner of the best Cow in milk . . . . Fifteen Sovereigns.
To the owner of the second-best ditto . . . . Ten Sovereigns.
To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
To the owner of the best Yearling Heifer . . . Ten Sovereigns.
To the owner of the best Bull Calf . . . . Ten Sovereigns.

Class V.—Horses for Agricultural Purposes.

Division 1.

To the owner of the best Cart-Stallion of 4 years old and upwards . . . . . Thirty Sovereigns.
To the owner of the second-best ditto . . . . Twenty Sovereigns.
To the owner of the best three years old ditto . . Twenty Sovereigns.
To the owner of the best two years old ditto foaled since the 1st of January, 1839 . . . . . Fifteen Sovereigns.
To the owner of the best Cart-Mare and Foal . Twenty Sovereigns.
To the owner of the second-best ditto . . . . Ten Sovereigns.
To the owner of the best two years old Filly . . Ten Sovereigns.

Division 2.

To the owner of the best pair of Horses or Mares at plough on the ground . . . . . Twenty Sovereigns.
To the owner of the second-best pair of Horses or Mares at plough on the ground . . . . . Ten Sovereigns.
To the owner of the third-best ditto . . . . Five Sovereigns.
To the owner of the best Horse or Mare at plough on the ground, not competing for any prize in the yard . . . . . Ten Sovereigns.
To the owner of the second-best ditto . . . . Five Sovereigns.

*** The Prizes for the working horses will be awarded after a trial at plough; and no horse can compete for these Prizes which competes for the Prizes for horses in the Yard.

SHEEP.

Prizes for Improving the Breed of Sheep.—1841.

Class VI.—Leicesters.

To the owner of the best Shearling Ram . . .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Ram of any other age .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best pen of Five Ewes suckling their Lambs at the time of showing . . .	Ten Sovereigns.
To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.

Class VII.—South Downs, or other Short-woolled Sheep.

To the owner of the best Shearling Ram . . .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Ram of any other age .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best pen of Five Ewes suckling their Lambs at the time of showing . . .	Ten Sovereigns.
To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.

Class VIII.—Long-woolled Sheep:

Not qualified to compete in Class VI.

To the owner of the best Shearling Ram . . .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best Ram of any other age .	Thirty Sovereigns.
To the owner of the second-best ditto	Fifteen Sovereigns.
To the owner of the best pen of Five Ewes suckling their Lambs at the time of showing	Ten Sovereigns.
To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.

Class IX.—Pigs.

To the owner of the best Boar	Ten Sovereigns.
To the owner of the second-best ditto	Five Sovereigns.
To the owner of the best breeding Sow . . .	Five Sovereigns.
To the owner of the best pen of three breeding Sow Pigs of the same litter, above four and under nine months old	Ten Sovereigns.

N.B.—It is to be stated in the certificate of the Sow, how many pigs she produced in her last litter, and reared to the time of weaning.

CLASS X.—Implements.

Division 1.

To the owner of the best Plough for general purposes	Twenty Sovereigns.
To the owner of the second-best ditto . . .	Ten Sovereigns.
To the owner of the best double-furrow Plough .	Ten Sovereigns.
To the owner of the best Plough drawn by one horse	Five Sovereigns.
To the owner of the best Subsoil-Plough . . .	Ten Sovereigns.

N.B.—Lightness of draught will be considered, as well as quality of work performed. Quantity of land to be ploughed, and all regulations as to the depth of the furrow, and time allowed, to be fixed by the stewards of the ground set apart for the ploughing-match.

To the owner of the best Scarifier or other implement for stirring or cleansing the soil . . .	Fifteen Sovereigns.
To the owner of the second-best ditto . . .	Ten Sovereigns.

Division 2.

To the owner of the best Drill for corn and general purposes	Twenty-five Sovs.
To the owner of the best Turnip and Manure Drill	Fifteen Sovereigns.
To the owner of the best Horse Hoe	Five Sovereigns.
To the owner of the best Chaff Cutter . . .	Ten Sovereigns.
To the owner of the best Crusher of Corn, Cake, &c.	Five Sovereigns.
To the owner of the best Machine for Cleaning Corn and Seeds	Ten Sovereigns.

Division 3.

Fifty Sovereigns will be apportioned among such implements exhibited as the Judges shall consider to have sufficient merit.

N.B.—In the case of more notices than one for exhibiting the same description of implement for trial being received, the inventors and manufacturers of such implements will be considered as entitled to the preference of trial. Otherwise, the notices will be taken according to priority. Parties will be furnished with horses and ploughmen at a moderate rate, if notified in the certificate.

Class XI.—Extra Stock, Roots, and Seeds.

For Extra Stock of any kind, not shown for any of the above Prizes, and for Roots, Seeds, &c., Prizes may be awarded and apportioned, by the Committee and Judges, not exceeding in the whole	Fifty Sovereigns.

Any New Implement.

For the Invention of any new Agricultural Implement, such sum as the Society may think proper to award.

Seed-Wheat.

I. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor at the Liverpool Meeting of the best 14 bushels of White Wheat, of the harvest of 1840, and grown by himself.

II. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor at the Liverpool Meeting of the best 14 bushels of Red Wheat, of the harvest of 1840, and grown by himself.

[12 bushels of the wheat will be sealed up by the judges, and one of the remaining bushels of each variety will be exhibited as a sample to the public. At the General Meeting in December, 1842, the prizes will be awarded.]

The three best samples of both red and white wheat, without distinguishing between the three, will be selected by judges appointed at the Liverpool Meeting, and will be sown, under the direction of the Society, in the autumn of 1841, by three farmers, who will make their report, upon which the prizes will be awarded. Ten sovereigns will be given at the Liverpool Meeting to the Exhibitor of each of these three samples.

Gorse-crushing Machine.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the cheapest and most effective Gorse-crushing Machine.

1. The machine produced must be on a working scale, and at a cost that will be attainable by the occupiers of the smallest farms.
2. It must be capable of reducing the material to a pulpy state for the mastication of ruminating animals, as cows and sheep.

GENERAL REGULATIONS FOR EXHIBITION.

I. No stock can be admitted for exhibition unless the necessary certificates, on the printed form prescribed, and signed by the exhibitor in the manner directed, be delivered to the Secretary, or sent (post-paid) so as to reach the Society's rooms, No. 5, Cavendish Square, on or before the 1st of July next.

II. The name and residence of the breeder of all animals exhibited, when known, should be stated.

III. Non-members will be required to pay five shillings for every head or lot of live stock before obtaining a ticket of permission to bring their stock into the show-yard.

IV. The same animal cannot be entered for two classes; and in all cases the age of animals is to be computed from the day of birth, except in the case of horses, when the year only will be required.

V. No animal which won a first prize in any class at the previous meetings of the Society will be allowed to compete for a similar prize at Liverpool.

VI. The sheep exhibited for any of the prizes must have been really and fairly shorn between the 1st of May and the 1st of July, 1841, both days inclusive.

VII. Persons intending to exhibit extra stock must give notice to the Secretary on or before the 1st of July next.

VIII. Any person who shall have been proved, to the satisfaction of the Council, to have been excluded from showing for prizes at the exhibition of any society in consequence of having been convicted of an attempt to obtain a prize by giving a false certificate, shall not be allowed to compete for any of the prizes offered by the Royal Agricultural Society of England.

IX. In case any gentleman, or number of gentlemen, wish to offer a prize for any class of stock not distinctly specified among the prizes offered by the Society, he or they will be allowed to offer such prize at the Liverpool Meeting; and the stock which shall compete for such prize shall be exhibited, subject to such conditions as shall be decided upon by the Council; and the prize awarded by such of the judges as the Council shall select. Animals exhibited for such prizes shall not be prevented from competing for any of the prizes offered by the Society for which they are qualified.

X. Stock of every description can only be admitted between the hours of eight in the morning and eight at night, on Tuesday the 20th of July; and must remain in the show-yard until after two o'clock in the afternoon of Friday the 23d of July: and no animal can be removed from its place, or taken out of the show-yard, without leave in writing from the Stewards.

N.B.—Stallions only may be removed for the night.

XI. Whenever reference is made to weights and measures, it is to be considered that the imperial weights and measures only are referred to.

XII. Persons intending to exhibit seed-wheat, implements, seeds, roots, &c., must give notice to the Secretary of the Society, in Cavendish Square, on or before the 1st of July, and furnish him with a description of the articles intended to be shown, and the probable space which would be required for them, in order that the Council may be enabled properly to apportion the space allotted for the exhibition of such articles among the various parties making application: and the articles to be exhibited must be brought to the show-yard either on Friday, the 16th, or Saturday, the 17th of July, between the hours of eight in the morning and six in the evening; as none will be admitted after those days.

XIII. The judges of stock are to have the whole of Wednesday, the 21st of July, for making their adjudication, and signing their award, without the admission of members, strangers, or candidates into any part of the yard.

XIV. No prize will be given when the judges shall be of opinion that there is not sufficient merit in the stock, implements, &c., to justify their award, especially in cases where there is no competition.

XV. All exhibitors for sweepstakes or extra prizes to be subject to the regulations of the Council.

*** Further information respecting regulations of detail may be obtained from the Secretary in due time previously to the show. The conditions for the trial of implements will be published before the Meeting.

No certificate will be allowed unless the printed forms (to be obtained of the Secretary) be employed, and filled in by the exhibitor, or by his agent in his name.

INSTRUCTIONS TO THE JUDGES.

As the object of the Society in giving the prizes for neat cattle, sheep, and pigs, is to promote improvement in breeding stock, the judges, in making their award, are requested not to take into their consideration the present value to the butcher of animals exhibited, but to decide according to their relative merits for the purpose of breeding.

In Class V., the prizes being offered for horses adapted to farming purposes, the judges are therefore requested, in addition to symmetry, to take activity and strength into their consideration, in awarding those prizes.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

Prizes for 1842.

PRIZE ESSAYS.

1. Drill Husbandry of Turnips.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report of Experiments on the Drill Husbandry of Turnips.

Competitors will be required to state—

1. The time of sowing the different varieties, on different soils, and at different elevations and latitudes.
2. The mode of preparing the land, and of drilling the seed; with a description of the implements used.
3. The kind and quantity of manure employed.
4. The distance between the rows.
5. The manner of performing the hoeing.

N.B.—It will be desirable that the mode of cultivation employed by practical farmers in some considerable district should be described, as well as any variations in the practice, arising from difference in the quality of the soil.

2. Wireworm.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Natural History, Anatomy, Habits, and Economy of the Wireworm, and the best means of protection against its ravages.

Competitors will be required to attend to the following points—

1. The length of time during which the wireworm exists in that state.
2. The vegetable productions on which its depredations are chiefly committed, and the mode by which it effects their injury or destruction.
3. The places in which the perfect insect deposits its eggs; and what seasons aid or retard the development of the gnat or mark its changes.
4. Whether peculiar soils or aspects are more particularly infested by the insect; and whether preceding crops influence it in its selection.

3. Mechanical Properties of the Plough.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Mechanical Properties of the Plough.

Competitors will be required to define—

1. The form of the cutting and moving parts of the plough, as affecting the work to be performed on various soils.
2. The form of the same, as affecting the draught.
3. The true line of draught, as derived from the shape of the plough, and from the structure of animals employed in drawing.

4. Prognostics of Weather.

The Gold Medal will be given for the best Account or Record of the Prognostics, or Natural Signs, of Changes in the Weather.

Conditions:—

1. Competitors for this prize will be required to draw the rules which they give from such appearances as may be observed, by men living in the country, with ordinary attention to the state of the atmosphere, the habits of animals, and the thermometer and barometer.
2. They will be required to state whether they intend the rules which they give to apply to a hilly or flat country, to the neighbourhood of the sea, or to inland situations.
3. The merit of the different sets of rules sent in will be decided upon by practical experience in different parts of the country; and the prize awarded to the person whose rules, after twelve months' trial, shall be reported by the gentlemen selected as judges to have proved most generally correct.

5. Making of Cheese.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Making Cheese.

Competitors will be required to give—

1. A description in detail of the mode employed in preparing the cheese in some district of established reputation for the production of cheese.
2. An inquiry, how far the excellence of the best cheeses arises from peculiarity of pasture, soil, and situation; or, how far from superior management.
3. It is also desirable to investigate the effects of the colouring matters which are employed in making some kinds of cheese.

6. Rotations of Crops on Light Lands.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Rotation of Crops suited for Light Lands.

Competitors will be required to keep in view—

1. The succession of crops which combines the greatest number and productiveness of crops with the largest profit and most improving condition of the soil.
2. The greatest consumption of the produce by the Stock profitably kept on the land.

7. Rotations of Crops on Heavy Lands.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Rotation of Crops suited for Heavy Lands.

N.B.—The same conditions will apply to this prize as to the last; but particular stress is to be laid on bringing heavy lands more nearly on an equality with light lands, than they at present are, in the Maintenance of Stock.

8. Curing of Butter.

Ten Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Mode of Curing Butter for future consumption, and for Preservation in foreign countries.

Competitors will be required to attend to the following Conditions—

1. The butter to be made from grass-fed cows, milked between the 20th of May and the 20th of June; stating the exact period at which it was manufactured; and whether made from cream alone, or from the whole milk and cream churned together.
2. That two samples of the butter—of not less than 12 lbs. each—be packed in jars, and sent up to the Society on or before the 1st day of July: stating the exact quantity of any salt, honey, or other substance used in the curing: with a minute description of the mode employed in effecting it.
3. That each sample be cured with a different sort of salt—if any different kinds can be procured—and not less than 6 lbs. of each be sent up, separately, to the Society: distinguishing the particular kinds which have been used.
4. That the samples of salt will be duly analysed; but those of the butter will be retained in the Society's rooms until the month of December, when they will be opened and valued by two eminent dairymen: the valuation of which to be paid to the makers.

5. That the judgment of those dairymen, in regard to the prize, will be directed not so much to the quality of the butter as to its sweetness, and the probability of its preservation at home and in warm climates.

9. Varieties of Wheat suited to Different Soils.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Varieties of Wheat suited to Different Soils.

N.B.—As it is well known that many soils will not bring forth in perfection the best varieties of wheat—particularly of white wheat—it is desirable to know what is the best wheat which each soil is capable of producing.

10. On the Food of Plants.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Food of Plants.

Competitors will be required to state—

1. The sources from which plants derive the elements of which they are composed.
2. The mode in which farm-yard dung strengthens the growth of agricultural crops.
3. The mode in which other manures, whether singly or combined, act upon vegetation.

These Essays must be sent in to the Secretary on or before March 1st, 1842.

N.B.—General Conditions for all Experiments on Soils or Manures.

1. The nature and depth of the soil.
2. The proportions of clay, sand, lime, or other substances, of which the soils are composed: or, otherwise, to send specimens of the soils (in quantities of a pound or pint of each variety) to the Secretary, on his application for them.
3. The nature of the subsoil.
4. When the ground is not level, the degree in which it slopes, and the direction (north, east, &c.) of its inclination, as found by the compass.
5. The two or three preceding crops; the manure put on for them, and the produce of these crops.

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1841—1842.

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Royal Agricultural Society of England.

GENERAL MEETING,

5, Cavendish Square, Saturday, Dec. 11, 1841.

REPORT OF THE COUNCIL.

The Council, in reporting to the Society, at its present half-yearly meeting, the progress of its labours, and the successful prosecution of those objects for the attainment of which it has been founded, have now, in the middle of the fourth year of its existence, the satisfaction of congratulating the Members not only on its own permanent establishment, but on the vigorous activity and increase of every kindred association throughout the empire; and, in recording the continued addition to a list of Members already exceeding 5000, they have the pleasure of reporting to the Society, on this occasion, the gratifying fact that the Illustrious Consort of your Royal Patroness The Queen, His Royal Highness The Prince Albert, has allowed his name to be enrolled in the list of your Governors, thus evincing his cordial approbation of the Royal Agricultural Society of England and its objects.

The Council regard with peculiar interest the establishment and successful operation of the various Farmers' Clubs throughout the kingdom; and continue to experience the greatest interest in perfecting the communication they wish to see existing between those associations and the Royal Agricultural Society of England. They feel fully assured that they can only advance the sound practice of farming by the right application of correct scientific

principles to incontrovertible and well-observed facts; and that such facts are elicited in the discussions of Farmers themselves, and are those to which scientific principles can be most usefully applied, they being peculiarly valuable from the genuine character of their observation by practical men. The Council are fully sensible that the value of the Society will mainly, if not altogether, depend on the practical bearings of its labours, "in bringing home to men's business and bosoms" those principles of science which are intended to advance them in their knowledge of improved modes of cultivation and husbandry; and that their Journal, as the great vehicle of dissemination among their Members of recommendations and suggestions on agricultural subjects, can only be maintained in its career of usefulness, and preserved from becoming the mere organ of a discussion of opinions and statement of theories, by being supplied with the rich store of absolute facts, well observed, carefully noted in all their circumstances, and important in their bearing and practical application.

The Council have to report the cordial co-operation not only of many of the Farmers' Clubs and Local Agricultural Associations established in various parts of the kingdom, but of a direct communication having been established with the Central Board of Agriculture of Nova Scotia, the Western Australian Agricultural Society, and other similar colonial establishments in other parts of the empire; all of which are becoming daily more sensible of the mutual importance resulting from a more intimate and direct alliance with the farmers of the United Kingdom. In foreign countries the value of this interchange of opinion on the science and practice of agriculture is becoming more fully estimated; and your President is preparing to lay before the Society, in the pages of the Journal, his personal report of the great meeting of German agriculturists held last autumn at Doberan, and which he attended as your representative; and the Hon. Andrew Stevenson, the first elected of your Honorary Members, has returned, from his diplomatic engagements in this country, to America, with the ardent desire of devoting his attention to the

pursuit of agriculture and the establishment of the most friendly relations and communication between the Royal Agricultural Society of England and the numerous native Agricultural Societies already established in the United States.

The Council have had the pleasure of adding to the list of your Honorary Members the distinguished names of Dr. Sprengel, residing in the kingdom of Prussia, not only one of the most active cultivators of agricultural science in that part of the Continent, but the editor of a monthly Journal of Agriculture, and author of numerous important works on Agricultural Chemistry, the Doctrine of Soils, and a Treatise on Manures—from the latter of which a chapter on Animal Manures has already been translated by your Secretary, and printed in the Fourth Part of the Journal; of Dr. Daubeny, the Sibthorpian Professor of Rural Economy in the University of Oxford, who has liberally placed his Lectures at the disposal of the Journal Committee; and of Professor Johnston, of the University of Durham.

The Finance Committee have been applying their best attention to two most important points: first, the reduction of the amount of arrears of subscription standing on the register of the Society on the 1st of January last; and, second, the recommendation of measures to obviate a similar accumulation for the future. In their attention to the first of these subjects, they have issued to each member in arrear a printed circular, informing him of the circumstance and amount of his unpaid subscription, suggesting a direct post-office order, payable to the Secretary, as the simplest means of discharging the liability, and reminding him of the by-law which prohibits the transmission of the Journal to all members in arrear; at the same time stating the fact of many members having paid their subscriptions through country bankers under names which at present could not be deciphered in the manuscript of the banker's book, or consequently carried to their credit in the Society's Register. In reply to this circular, the Committee have reported a favourable result, both in the payment of arrears and the explanations given in reference to their occurrence. With scarcely a single exception these expla-

nations have proved satisfactory, both to the Committee and the parties themselves, who have evinced the greatest willingness to comply with the rules of the Society, the chief cause of these arrears having had its origin from the misconception of many members as to the fact of the subscriptions being due in advance, and taking date from the 1st of January in the year of their election; and, having paid up their subscriptions to the present time, a great number of members who had been thus in arrear, being anxious to obviate a similar omission for the future, have either compounded for life or given permanent orders on their bankers for due and regular payment year by year. The result of the consideration of the Finance Committee on the second point, of preventing the occurrence or accumulation of similar arrears in future has been communicated to the Council by Colonel Challoner, their chairman, who has stated at length the decided views of the Committee on this subject, which is now under the serious and deliberate consideration of the Council. The Committee have also reported that since the anniversary meeting in May last, the amount of 407*l.* has been paid and accounted for in the discharge of the arrears then announced as existing; and they have, at the same time, laid before the Council their numerical summary of the Society, which now consists of a total of 5382 members, namely, 90 Life Governors; 216 Annual Governors; 290 Life Members; 4776 Annual Members; and 10 Honorary Members.

Your President has reported to the Council, that, agreeably with their resolutions, he took an immediate opportunity, after the Liverpool Meeting, to address letters containing the Society's votes of thanks to the Mayor and Corporation, the Directors of the Mechanics' Institution, Messrs. Falkner and Lace, Messrs. Lucas, and every other institution or individual in Liverpool or its neighbourhood who had been instrumental in promoting the objects of the Meeting. The value attached to the excellent display of Agricultural Implements at that Meeting has been greatly enhanced by the admirable Report which the Judges of the Implements on that occasion have since drawn carefully up

and presented to the Council, who have directed it to be read to you at the present General Meeting, as a document of much inquiry and interest.

The Duke of Richmond, as Chairman of the General Bristol Committee, has presented to the Council two Reports of the proceedings of the Committee to the present time, including an account of the favourable manner in which the Chairman and Committee, as a deputation of the Society, were received at Bristol; and the Council are much gratified to learn that the announcement made to Robert Phippen, Esq., the late, and to George Woodroffe Franklyn, Esq., the present, Mayor of Bristol, has been received by those gentlemen in so cordial and courteous a manner; and that the facilities offered by these Chief Magistrates of the city, and the kind and active intervention of Mr. William Miles, M.P., and Mr. Marmont, Secretary of the Bristol Agricultural Society, have enabled the Committee to institute those inquiries respecting suitable localities and sites for the Council and Pavilion Dinners, and for the Implement and Cattle-yard, which have led to so favourable a result, that a considerable amount of preparation has already been made in advance for the Bristol Meeting. The Council have directed the Bristol Prize Sheet to be made known as widely as possible by advertisement in the London Agricultural and the Bristol Papers, and in its transmission by post to every Member of the Society. They have also adopted the recommendations of the General Bristol Committee: that in due time before the Meeting, a programme of every requisite information respecting the Meeting should be sent to each Member; that this year the show of cattle should be open for one day only, the sale of Stock taking place the next morning; that the number to dine in the great Pavilion be limited to 2400; and that Thursday the 14th of July should be the principal day of the Show. The Committee have also decided that the plan of the Pavilion erected at the Cambridge Meeting is the one best adapted for the purposes of the Society; and that advertisements should be issued for builders and others to send in tenders for its erection at Bristol. They have further

recommended that a Ladies' gallery to contain 300 persons should be included in the plan of the Pavilion as at Cambridge; that each Member of the Council and each Governor should have the privilege of a ticket for the Council Dinner; and that a Local Committee should be appointed by the Council to carry out the various details connected with the business of the Meeting, consisting of Mr. William Miles, M.P., Mr. G. Webb Hall, and three other Members of the Society residing in the neighbourhood of Bristol, whom they shall select, Mr. Miles being requested by the Council to act as the Chairman, and Mr. Marmont as the Secretary, of such Local Committee.

The Journal Committee have reported that the new Part of the Journal will make its appearance on Monday, the 20th of December; and that the second and third parts of the First Volume, so long out of print, having been now reprinted, those Members who were elected previously to the Cambridge Meeting, but who had not been supplied with those Parts, should now receive them on application to the Secretary.

One of the great objects of the Council in reference to the convenience and accommodation of the Members of the Society, has long consisted in their possession of such an establishment in London as would possess within itself the combined advantages of a Museum, Model Room, Library, and Reading Room; and your President has already transmitted to Her Majesty's Chief Commissioner of Woods and Forests a memorial on behalf of the Society applying for a suitable space of crown-land to form a site for the Society's House, to be erected with a view to these special objects.

The District Committee have presented to the Council their final Report recommending the division of England and Wales into nine districts, from each of which in a certain succession, as from time to time agreed upon, a place shall be selected for holding the annual Country Meeting of every year, and the Council have unanimously adopted the districts proposed to their consideration for this purpose. The following tabular statement gives a connected view of the districts themselves, as well as the

succession in which they follow each other for supplying, in the rotation decided by the votes of the Council, the particular place of meeting in each year:—

1839.	Town, *Oxford.*	**B.**—Midland District: Oxfordshire, Berkshire, Wiltshire, Gloucestershire, Warwickshire, South Division of Northamptonshire, Bedfordshire, and Buckinghamshire.
1840.	Town, *Cambridge.*	**I.**—Eastern District: Norfolk, Suffolk, Cambridgeshire, Essex, Huntingdonshire, and Hertfordshire.
1841.	Town, *Liverpool.*	**G.**—Yorkshire District: Yorkshire and Lancashire, including the Isle of Man.
1842.	Town, *Bristol.*	**C.**—Western District: Cornwall, Devonshire, Somersetshire, and Dorsetshire.
1843.	Town (*undecided*).	**F.**—North-Eastern District: Derbyshire, Nottinghamshire, Leicestershire, Lincolnshire, Rutlandshire, and the North Division of Northamptonshire.
1844.	Town (*undecided*).	**A.**—Middlesex District: Middlesex, Surrey, Kent, Sussex, and Hampshire, including the Isle of Wight and the Channel Islands of Jersey, Guernsey, &c.
1845.	Town (*undecided*).	**E.**—North Wales District: Anglesey, Carnarvonshire, Merionethshire, Montgomeryshire, Denbighshire, Flintshire, Cheshire, Shropshire, and Staffordshire.
1846.	Town (*undecided*).	**H.**—Northern District: Westmoreland, Cumberland, Durham, and Northumberland, including Berwick-upon-Tweed.
1847.	Town (*undecided*).	**D.**—South Wales District: Pembrokeshire, Cardiganshire, Carmarthenshire, Brecknockshire, Glamorganshire, Monmouthshire, Radnorshire, Herefordshire, and Worcestershire.

The Council entertain a well-grounded hope that this arrangement, in concentrating the attention of the Society to the consideration of each particular district of the series as it comes under their notice for the purpose of selecting from it a place of meeting for the year, and in preparing the friends of agriculture who are resident within its boundaries to receive the

Society and compete for its premiums, will lead to important practical results in the well-working of the Society and the prosecution of its objects. The deep interest especially which the Society feels on the subject of improving the condition of the agricultural labourer, as one of the chartered objects of their incorporation, is one which daily increases with the difficulty of knowing how to decide on the steps to be taken as tending most securely to attain their great object; and they eagerly embrace the adoption of any plan having this object in view, on the desirableness of which no doubt can be entertained. An instance of this desire on the part of the Council has just occurred in their unanimous adoption of Mr. Burke's proposal, that a very cheap publication, giving plain directions for the preparation of economical and nutritious food for labourers, should be compiled, with the consent of the writers, from the numerous essays sent in to compete for the prize offered by the Society on that subject, and that Mr. Burke should also be requested to append to it such a digest of Mr. Main's article on Cottage Gardening in the Journal as may best adapt it for the use intended.

Earl Spencer, Mr. Graburn, and Mr. Druce having reported to the Society the results of their cultivation of the samples of wheat selected for trial at the Cambridge Meeting, the Council have unanimously resolved, that it is not expedient to adjudge the prize to either of the samples in question, as it appears from these reports that other wheats usually grown in the respective neighbourhoods in which the trials took place have proved more productive.

The Council have decided on proposing the following subjects for the Prize Essays of 1843, the conditions of which will be appended on their publication in the Prize Sheet of the Society:—

1. On Artificial Food for Cattle.
2. On Natural Food for Cattle.
3. On the Comparative Advantages of Horse and Ox Teams.
4. On the Construction of Cottages.
5. On the Drainage of Land.

6. On Liquid Manure.
7. On the Management of Farm-yard Manure.
8. On the Detection of Adulteration in Artificial Manures.
9. On Relative Value of Meadow and Upland Hay.
10. On the Physiological Causes affecting the Production of Anima Fat or Muscle.

The Council have the pleasure of recording their sense of the kindness of Professor Henslow and Dr. Daubeny, in having each consented, at a very short notice, to deliver a lecture before the members of the Society during the present week of their December meeting.

By order of the Council,

JAMES HUDSON, Secretary.

General Meetings of 1842.

The Anniversary Meeting, in London, on Monday, May 23.

The Annual Country Meeting, at Bristol; the principal Day of the Show being Thursday, July 14.

The General December Meeting, in London, on the Saturday of the Week of the Smithfield Club-Show.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Statement of Account from the 1st of January to the 30th of June, 1841.

Receipts.	£.	s.	d.
Balance in the hands of the Bankers on the 1st of January, 1841	1725	3	7
Ditto in the hands of the Secretary on the 1st of January, 1841	23	3	3
Dividends on 4700*l.* New 3½ per Cent. Reduced Annuities	82	5	0
Subscriptions received during the Half Year . . .	2953	9	0
Prize Cheque on Account of Cambridge Meeting . .	10	0	0
	£4794	0	10

C. B. CHALLONER,
Chairman of the Finance Committee.

THOMAS RAYMOND BARKER,
THOMAS AUSTEN.

Expenditure.	£.	s.	d.
Permanent Charges	275	0	0
Establishment	628	16	4
Expenses of Journals	1124	12	4
Postage and Carriage	82	19	0
Miscellaneous	99	18	5
Sundry Items of petty Cash not included in Ledger . .	0	17	6
Purchase of 1000*l.* Stock	986	5	0
Power of Attorney for receiving Dividends on Stock .	1	1	6
Payments made on account of Cambridge Meeting . .	69	0	0
Cash in the hands of the Bankers on the 30th of June, 1841	1500	16	10
Cash in the hands of the Secretary on the 30th of June, 1841	24	13	11
	£4794	0	10

C. H. TURNER,
THOMAS KNIGHT,
JOHN ROLFE,
} Auditors on the part of the Society.

Liverpool Meeting.

PRINCIPAL DAY OF THE SHOW, JULY 22, 1841.

AWARD OF PRIZES.

Class I. (Short Horns.)

To Thomas Bates, of Kirkleavington, Yorkshire: the Premium of Thirty Sovereigns, for his 4 years and 7 months-old Short-Horned Bull; bred by himself.

To Thomas Forrest, of Stretton, Cheshire: the Premium of Twenty Sovereigns for his 2 years and 5 months-old Short-Horned Bull; bred by himself.

To John Booth, of Killerby, near Catterick, Yorkshire: the Premium of Fifteen Sovereigns, for his 4 years and 6 months-old Short-Horned Cow in Milk; bred by himself.

To John Booth, of Killerby, near Catterick, Yorkshire: the Premium of Fifteen Sovereigns, for his 2 years and 5 months-old Short-Horned in-calf Heifer; bred by himself.

To John Forrest, of Stretton, Cheshire: the Premium of Ten Sovereigns, for his 1 year and 2 months-old Short-Horned Yearling Heifer; bred by himself.

To John Clifford Etches, of Tutbury, Burton-on-Trent, Staffordshire: the Premium of Ten Sovereigns, for his 9 months-old Short-Horned Bull-Calf; bred by himself.

Class II. (Herefords.)

To Philip Morris, of Newbury, Herefordshire: the Premium of Thirty Sovereigns, for his 3 years and 7 months-old Hereford Bull; bred by himself.

To John Walker, of Burton, Worcestershire: the Premium of Twenty Sovereigns, for his 1 year and 4 months-old Hereford Bull; bred by himself.

To The Earl Talbot, of Ingestre, Staffordshire: the Premium of Fifteen Sovereigns, for his 6 years and 3 months-old Hereford Cow in milk; bred by himself.

To Sir Hungerford Hoskyns, Bart., of Harewood, Herefordshire: the Premium of Fifteen Sovereigns, for his 2 years and 11 months-old Hereford in-calf Heifer; bred by himself.

To John Walker, of Burton, near Worcester: the Premium of Ten Sovereigns, for his 1 year and 6 months-old Hereford Yearling Heifer; bred by himself.

To Sir Hungerford Hoskyns, Bart., of Harewood, Herefordshire: the Premium of Ten Sovereigns, for his 8 months-old Hereford Bull-Calf; bred by himself.

Class III. (Devons.)

To Charles Gibbs, of Bishops-Lydeard, Somersetshire: the Premium of Thirty Sovereigns, for his 3 years and 4 months-old Devon Bull; bred by himself.

To Thomas Umbers, of Wappingbury, Warwickshire: the Premium of Fifteen Sovereigns, for his 5 years and 3 months-old Devon Cow in Milk; bred by the late George Talbot, of Temple-Guyting, Gloucestershire.

To George Turner, of Barton, near Exeter: the Premium of Ten Sovereigns, for his 1 year and 7 months-old Devon Yearling Heifer; bred by himself.

To George Turner, of Barton, near Exeter: the Premium of Ten Sovereigns, for his 6 months-old Devon Bull-Calf; bred by himself.

Class IV. (Cattle of any Breed or Cross, not qualified to compete in any of the foregoing Classes.)

To John King, of Berwick, Sussex: the Premium of Thirty Sovereigns, for his 5 years and 6 months-old Sussex Bull; bred by Thomas Noaks, of Jevington, Sussex.

To William Daniel, of Burton-upon-Trent, Staffordshire: the Premium of Twenty Sovereigns, for his 6 years and 2 months-old Long-Horned Bull; bred by Edward Green, Odstone Hill, Leicestershire.

To Thomas Ellman, of Beddingham, Sussex: the Premium of Twenty Sovereigns, for his 1 year and 10 months-old Sussex Bull; bred by the late John Putland, of Firle.

To William Stace, of Berwick, near Lewes, Sussex: the Premium of Fifteen Sovereigns, for his 1 year and 7 months-old Sussex Bull; bred by himself.

To William Ellison, of Sizergh Castle, near Kendal, Westmoreland: the Premium of Fifteen Sovereigns, for his 5 years-old Wyersdale Cow in milk.

To John King, of Berwick, Sussex: the Premium of Ten Sovereigns, for his 3 years and 6 months-old Sussex Cow in-milk; bred by himself.

To John King, of Berwick, Sussex: the Premium of Fifteen Sovereigns, for his 2 years and 6 months-old In-Calf Sussex Heifer; bred by himself.

To Joseph Woolf, of Haslington, Cheshire: the Premium of Ten Sovereigns, for his 1 year and 6 months-old Short-Horned (with a Cross) Yearling Heifer; bred by himself.

To William Hayward, of Weston-Turville, Buckinghamshire: the Premium of Ten Sovereigns, for his 11 months-old Hereford and Short-Horned Bull-Calf; bred by himself.

Class V. (Horses.)

To Thomas Crisp, Gedgrave, Suffolk: the Premium of Thirty Sovereigns, for his 6 years-old Cart Stallion; bred by F. Keer, of Raydon, Suffolk.

To The Earl Talbot, of Ingestre, Staffordshire: the Premium of Twenty Sovereigns, for his 6 years-old Cart Stallion; bred by himself.

To Thomas Crisp, Gedgrave, Suffolk: the Premium of Twenty Sovereigns, for his 3 years-old Cart Stallion; bred by himself.

To The Earl of Derby, of Knowsley, Lancashire: the Premium of Fifteen Sovereigns, for his 2 years-old Cart Stallion; bred by himself.

To The Earl of Derby: the Premium of Twenty Sovereigns, for his Cart Mare and Foal.

To Richard Almond, of Standish, near Wigan, Lancashire: the Premium of Twenty Sovereigns, for the best Pair of Horses at Plough.

To Richard Podmore, of Shotton, Flintshire, North Wales: the Premium of Ten Sovereigns, for the Second-best Pair of Horses at Plough.

To The Hon. Edward M. L. Mostyn, of Mostyn, Flintshire, North Wales: the Premium of Five Sovereigns, for the Third-best Pair of Horses at Plough.

To William Ellison, of Sizergh Castle, Westmoreland: the Premium of Ten Sovereigns, for the best Single Horse at Plough.

To Richard Almond, of Standish, Lancashire: the Premium of Five Sovereigns, for the Second-best Single Horse at Plough.

Class VI. (Leicesters.)

To The Earl Talbot, of Ingestre, Staffordshire: the Premium of Thirty Sovereigns, for his 16 months-old Leicester Shearling Ram; bred by himself.

To Joseph Bennett, of Tempsford, Bedfordshire: the Premium of Fifteen Sovereigns, for his 16 months-old Leicester Shearling Ram; bred by himself.

To The Earl Talbot: the Premium of Thirty Sovereigns, for his 52 months-old Leicester Ram; bred by himself.

To Samuel Bennett, of Bickering's Park, near Woburn, Bedfordshire: the Premium of Fifteen Sovereigns, for his 2 year and 4 months-old Leicester Ram; bred by himself.

To Thomas Inskip, of Marston-Mountaine, Bedfordshire: the Premium of Ten Sovereigns, for his Pen of 5 Leicester Ewes with their Lambs; bred by himself.

To Thomas Inskip, of Marston-Mountaine, Bedfordshire: the Premium of Ten Sovereigns, for his Pen of Five 16 months-old Leicester Shearling Ewes; bred by himself.

Class VII. (Southdowns, or other Short-Woolled Sheep.)

To Jonas Webb, of Babraham, Cambridgeshire: the Premium of Thirty Sovereigns, for his 16 months-old Southdown Shearling Ram; bred by himself.

To Jonas Webb, of Babraham, Cambridgeshire: the Premium of Fifteen Sovereigns, for his 16 months-old Southdown Shearling Ram; bred by himself.

To Jonas Webb, of Babraham, Cambridgeshire: the Premium of Thirty Sovereigns, for his 28 months-old Southdown Ram; bred by himself.

To Stephen Grantham, of Stoneham, Lewes, Sussex: the Premium of Fifteen Sovereigns, for his 52 months-old Southdown Ram; bred by himself.

To Samuel Webb, of Babraham, Cambridgeshire: the Premium of Ten Sovereigns, for his Pen of five 16 months-old South Down Shearling Ewes; bred by Jonas Webb.

Class VIII. (Long-Woolled Sheep, not qualified to compete as Leicesters.)

To Charles Large, of Broadwell, Oxfordshire: the Premium of Thirty Sovereigns, for his 16 months-old New-Oxfordshire Long-woolled Shearling Ram; bred by himself.

To Joseph Hewer, of Eastington, near Northleach, Gloucestershire: the Premium of Fifteen Soverigns for his 1 year and 5 months-old Cotswold Shearling Ram; bred by himself.

To Edward Smith, of Charlbury, Oxfordshire: the Premium of Thirty Sovereigns, for his 40½ months-old Oxfordshire Ram; bred by himself.

To Thomas Wells, of Hampnett, Gloucestershire: the Premium of Fifteen Sovereigns, for his 28 months-old improved Cotswold Ram; bred by himself.

To Charles Large, of Broadwell: the Premium of Ten Sovereigns, for his Pen of 5 New-Oxfordshire Long-woolled Ewes with their Lambs; bred by himself.

To Edward Smith, of Charlbury: the Premium of Ten Sovereigns, for his Pen of five 16½ months-old Shearling Oxfordshire Ewes; bred by himself.

Class IX. (Pigs.)

To Samuel Umbers, of Dunton Hall, near Coleshill, Warwickshire: the Premium of Ten Sovereigns, for his 4 years and 2 months-old Normanton-hill Boar; bred by himself.

To Edward George Barnard, M.P., of Gosfield Hall, Halstead, Essex: the Premium of Five Sovereigns, for his 1 year 1 month and 12 days-old improved Essex Boar; bred by himself.

To John Dawson, of Gronant, Flintshire: the Premium of Five Sovereigns, for his 2 years and 4 months-old Leicester Sow; bred by himself.

To The Rev. John Higginson, of Thormanby, Yorkshire: the Premium of Ten Sovereigns, for his Pen of three 26 weeks-old Leicestershire Sow Pigs; bred by Mr. Whitey, Blansby, Yorkshire.

Extra Stock.

To John Forrest, of Stretton, Cheshire: the Premium of Five Sovereigns, for his 1 year and 11 months-old Short-horned Bull; bred by himself.

To Sir Charles R. Tempest, Bart., of Broughton Hall, near Skipton, Yorkshire: the Premium of Five Sovereigns, for his 5 years and 3 months-old Short-horned Heifer; bred by himself.

Commendations.

*John Grantham, of Hatcliffe, near Grimsby, Lincolnshire: a 4 years and 4 months-old Short-horned Bull; bred by Mr. Codd, of Holton-le-Clay, near Grimsby.

Henry Lister Maw, of Tetley, near Crowle, Lincolnshire: a 7 years and 1 month-old Short-horned Bull; bred by Earl Spencer, at Wiseton.

Seymour Deighton, of Winston, near Darlington, Durham: a 2 years and 8 months-old Pure Short-horned Bull; bred by Mr. Armitage, of Gelling.

Thomas Bates, of Kirkleavington, near Yarm, Yorkshire: a 1 year and 9 months-old Short-horned Bull; bred by himself.

John Forrest, of Stretton, near Warrington: a 5 years and 2 months-old Short-horned Cow; bred by himself.

John Dawson, of Gronant, Flintshire: a 10 years and 3 months-old Short-horned Cow; bred by Mr. Dudding, in Lincolnshire.

Sir Charles R. Tempest, Bart., of Broughton Hall, near Skipton, Yorkshire: a 2 years and 5 months-old Short-horned Heifer; bred by himself.

Sir Charles R. Tempest, Bart.: a yearling Short-horned Heifer; bred by himself.

*Edward Price, of The Courthouse, near Pembridge, Herefordshire: a 4 years and 8 months-old Hereford Bull; bred by himself.

*The Earl Talbot, of Ingestre, near Stafford: a 2 years and 9 months-old Herefordshire Bull; bred by himself.

Edward Gough, of Gravel Hill, near Shrewsbury: a 5 years and 4 months-old Hereford Bull; bred by himself.

John Muscott, of Westonbury, Herefordshire: a 3 years and 10 months-old Hereford Bull; bred by the late Mrs. Jeffries, of the Sherrifs, Herefordshire.

William Perry, of Monkland, near Leominster: a 7 years and 3 months-old pure Hereford Bull; bred by John Turner, of Noke, Herefordshire.

William Williams, of Corrance Court, Herefordshire: a 7 years and 3 months-old Hereford Bull; bought of John Hewer, of Hampton Lodge, Herefordshire.

John Walker, of Burton, near Worcester: a 4 years and 4 months-old Hereford Bull; bred by himself.

Thomas Jeffries, of The Grove, near Pembridge, Herefordshire: a 1 year and 8 months-old Hereford Bull; bred by himself.

*The Rev. John Robert Smythies, of Lynch Court, near Leominster: a 2 years and 9 months-old In-calf Hereford Heifer; bred by himself.

*John Price, of Poole House, near Hanley Castle, Worcestershire: an 11 months-old Hereford Bull-Calf; bred by himself.

Thomas Jeffries, of The Grove, near Pembridge, Herefordshire: an 8½ months-old Hereford Bull-Calf; bred by himself.

James Heaps, of Street-Gate, Little Hulton, Lancashire: a 7 years-old Cart-Stallion; breeder unknown.

*Edward George Barnard, M.P., of Gosfield Hall, near Halstead, Essex: a 1 year, 1 month, and 12 days-old Improved Essex Boar; bred by himself.

*Richard Almond, of Standish, Lancashire: an 11 months-old Sow.

The Earl Talbot: two 15 months-old Shearling Leicester Rams; two 40 months and one 52 months-old Leicester Rams; all bred by himself.

William Allen, of Malton: a 3 years-old Leicester Ewe; bred by himself.

Joseph Allison, of Bilby, near Retford, Nottinghamshire: a pen of 16 months-old Shearling Leicester Wethers; bred by himself.

*Thomas Carpenter, of Hull Farm, near Chipping-Norton, Oxfordshire; a 28½ months-old Oxfordshire Wethers; bred by himself.

Charles Large, of Broadwell, Oxfordshire: a three 28 months-old New Oxfordshire Long-woolled Wethers; bred by himself.

John Harris, of Hinton, Berkshire: a 28 months-old South-Down Wether; bred by himself.

Stephen Grantham, of Stoneham, near Lewes, Sussex: a 28 months-old South-Down Wether; bred by himself.

William Fisher Hobbs, of Marks Hall, near Coggeshall, Essex; a 20 months-old Improved Essex fat Pig; bred by himself.

Richard Almond, of Standish: a Pen of three 44 months-old Breeding Sow Pigs.

[Those marked (*) were "highly commended," all the others "commended."]

SELECTION OF SEED-WHEAT.

Colonel John Le Couteur's *Belle-Vue Talavera* White Wheat.

Daniel Maydwell's *Chidham* White Wheat.

Joseph Pain's *Burwell* Red Wheat.

William Lake Wakeley's *Champion-Red* Wheat.

[The result of the cultivation of these Wheats, and the comparison of their productiveness with that of other varieties commonly grown in the respective neighbourhoods where the trials are made, will be reported to the General December Meeting in 1842.]

Liverpool Meeting,

1841.

REPORT

ON THE

EXHIBITION OF IMPLEMENTS.

The Judges of Implements, in presenting to the Council their award of prizes, cannot refrain from expressing the gratification they felt at the splendid exhibition of implements and machines submitted to their inspection; nor can they omit offering their congratulations to the Society on the good effects which have already resulted from the public exhibitions of implements at the Society's Meetings, in stimulating the talent of the mechanic and the zeal of the husbandman. At Oxford the show-yard may be said to have presented an epitome of the state of agricultural mechanism existing in 1839, the era of the formation of the Royal Agricultural Society of England. No spectator of that show can have failed to be struck with surprise and admiration at the Liverpool exhibition. At Oxford there were some examples of good machinery and workmanship, but many more of rude, cumbrous, and ill-executed implements. At Liverpool many machines were exhibited not only of surpassing skill in contrivance and execution, but also having for their object the effecting of processes in tillage-husbandry of the most refined nature and acknowledged importance, but hitherto considered of very difficult practical attainment. Some of these may already be considered as forming part of the necessary apparatus of every well-managed farm, and to be essential to its economy and profit. This vast stride in the mechanics of agriculture, made within so short a period, has doubtless arisen from the congregating together of agriculturists and mechanicians from all parts of the empire; and a still higher perfection in machinery may be confidently anticipated from the opportunity offered, under the auspices of the Society, of periodically contrasting and estimating the merits of varied implements used for similar purposes in different localities and soils. It is apparent that the manufacture of even the commoner instruments has already, to a great extent, passed out of the hands of the village-ploughwright and hedge-carpenter, and been transferred to makers possessed of greater intelligence, skill, and capital. The improved style of finish, the greater lightness and elegance of construction, and the generally superior adaptation of the means to the end, in every class of implements, were sufficient manifestations of the beneficial results arising from the encouragement given by the Society to these objects. Neither were examples wanting in the higher classes of machines to show that the fourth important object for which the Society

was incorporated is, to some extent, fulfilled:—viz. "to encourage men of science in their attention to the improvement of agricultural implements."

Agriculture, as an art and a practical science, is still in its infancy; and it is to be ardently desired that the mechanical constructor should be seconded in his efforts to produce new or more perfect implements, by receiving the co-operation and instructions of those whose leisure, affluence, or greater knowledge of the wants and capabilities of agriculture enable them to supply the ideas on which the mechanic would work.

The exhibition at Liverpool contained productions, by several humble mechanics, not inferior in point of genius to the more finished performances of old-established firms; and with the pleasing fact before them of the advance already made in the improvement of old and in the invention of new implements, the members of the Society would perceive how profitable a mine still remains to be worked by the aid of its fostering care. It was also a gratifying feature of this large assemblage of rival mechanicians, that but little jealousy of success was manifested by unsuccessful candidates; and it was agreeable to the Judges to learn that several of the more important or best-executed implements, to which prizes were awarded, were afterwards purchased by competing makers.

In the distribution of the sums left to the discretion of the Judges, they have endeavoured to reward merit in most of the varied forms in which it attracted their notice, hoping to encourage the agricultural machine-maker in the application of sound scientific principles and good workmanship to every species of implement, whether for improving the preparation of the soil, for lessening animal and human labour either in field or farm-yard, or for alleviating the toil of the domestic in the dairy.

Having carefully examined the implements and machines exhibited in the show-yard, Liverpool, July 20th, and upon trial, on the race-course at Aintree, the following day, the Judges present the award of prizes as follows: viz.—

1. Ploughs.

To James Wilkie, of Uddington, near Glasgow, for the best Subsoil-Plough, 10 sovs.

To Messrs. Ransome, of Ipswich, for their Two-wheeled Plough, marked N.L., 5 sovs.

To James Wilkie, of Uddington, near Glasgow, for his Swing-Plough, 5 sovs.

To the Hon. Edward M. L. Mostyn, of Mostyn, Flintshire, North Wales, for the Swing-Plough exhibited by him, 5 sovs.

To John Howard, of Bedford, for his Patent Scotch Two-wheeled Plough, 5 sovs.

To Edward Deane Falkner, of Fairfield, near Liverpool, for his Swing-Plough, made by E. Brayton, of Dykesfield, near Carlisle, 5 sovs.

To Messrs. Sandars, Williams, and Taylor, of Bedford, for their Two-wheeled Plough, 5 sovs.

To Messrs. Perry, Barrett, and Exall, of Reading, for their One-horse Plough, 5 sovs.

To C. Hart, of Wantage, Berkshire, for the Double-furrow Plough made by him, 10 sovs.

To Thomas Glover, of Thrussington, Leicestershire, for the Turf and Stubble Paring Plough invented by him, and exhibited by the Hon. H. W. Wilson, 4 sovs.

To James Smith, of Deanston, near Stirling, for his Turn-wrest Plough, with Drill attached, 3 sovs.

2. Cultivating Implements.

To the Earl of Ducie, Woodchester Park, near Stroud, Gloucestershire, for the Uley Cultivator, invented by John Morton, of Chester Hill, near Stroud, 15 sovs.

To Messrs. Ransome, of Ipswich, for Biddell's Extirpating Harrow, made and exhibited by them, 10 sovs.

3. Drills.

To Richard Hornsby, of Spittlegate, near Grantham, for his Drill for general purposes, 25 sovs.

To Richard Hornsby, of Spittlegate, near Grantham, for his Turnip and Manure Ridge-Drill, 10 sovs.

To Messrs. Garrett and Son, of Leiston Works, Saxmundham, for their Drill for general purposes, 10 sovs.

To James Smyth, of Peasenhall, near Yoxford, Suffolk, for his Drill for general purposes, 10 sovs.

To Messrs. Drummond and Sons, of Stirling, for their Turnip and Manure Single-rowed Drop-Drill, 3 sovs.

4. Horse-Hoes.

To Messrs. Garrett and Son, of Leiston Works, Saxmundham, for their Improved Horse-Hoe, 5 sovs.

To John Hamilton, of Torthorwald, near Dumfries, for his Improved Horse-Hoe, 2 sovs.

To Thomas Huckvale, of Over-Norton, near Chipping-Norton, Oxfordshire, for his Horse-Hoe with revolving blades for thinning turnips, 3 sovs.

To the Earl of Ducie, of Woodchester Park, near Stroud, Gloucestershire, for a Parallel Expanding Horse-Hoe, invented by John Morton, of Chester Hill, near Stroud, 3 sovs.

5. Chaff-Cutter.

To the Earl of Ducie, of Woodchester Park, near Stroud, Gloucestershire, for the Uley Chaff-Cutter, 10 sovs.

6. Corn and Cake Crushers.

To T. Cartmel, of Liverpool, for his Corn-Crusher, 3 sovs.

To Messrs. Garrett and Son, of Leiston Works, Saxmundham, for their Cake-Breaker, 2 sovs.

7. Corn-Dressing Machine.

To Joshua Cooch, of Harlestone, near Northampton, for his Winnowing Machine, invented by the late John Cooch, 10 sovs.

8. Gorse-Crusher.

To Messrs. White and Leith, of Worksop, Nottinghamshire, for their Gorse-Crusher, invented by Joseph White, 20 sovs.

9. Roots, Seeds, &c.

To William Skirving, of Liverpool, for his exhibition of Roots and Seeds, 5 sovs.

To Messrs. Thomas Gibbs and Co., Half-moon Street, Piccadilly, London, for their exhibition of Roots and Seeds, 5 sovs.*

10. Miscellaneous.

To Joseph Cooke Grant, of Stamford, Lincolnshire, for his Lever Horse Drag-Rake, 5 sovs.

To William Blurton, of Field Hall, Uttoxeter, Staffordshire, for his Revolving Cheese-Drying Frame, 3 sovs.

To Robert Parkinson, of Knowsley, near Prescot, Lancashire, for his Pendulum Churn, 2 sovs.

To Michael Lea, of Liverpool, for his Double-acting Vertical Churn, 2 sovs.

To Thomas Wedlake, of Hornchurch, near Romford, Essex, for his Dibbling Machine, 10 sovs.

To Messrs. Cottam and Hallen, of Winsley Street, Oxford Street, London, for their Portable Weighing Machine for Pigs and Sheep, 3 sovs.

To Messrs. Cottam and Hallen, of London, for their Machine for cutting and breaking Chandlers' Graves for Manure, 3 sovs.

To George Townsend, of Sapcote Fields, near Hinckley, Leicestershire, for his Turnip-cutting Cart, for expeditiously and effectively cutting Turnips, and spreading them when cut over the turf for Cattle or Sheep, 5 sovs.

To Joseph Brewster, of Brewood, near Wolverhampton, Staffordshire, for his Turnip-slicer for Beasts, 2 sovs.

To Messrs. Summers and Sworder, of Bishop's Stortford, Hertfordshire, for their Barley Hummeller and Blower connected, 3 sovs.

To Thomas Wedlake, of Hornchurch, near Romford, Essex, for his improved Haymaking Machine, 2 sovs.

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* Messrs. Thomas Gibbs and Co., on receiving the official announcement of this award of a premium to their exhibition, requested and obtained leave of the Council to resign their claim to it, in consequence of their relative, Humphrey Gibbs, Esq., having filled the office of Honorary Director of the Society's Annual Country Shows on that and former occasions.

To James Smith, of Deanston, near Stirling, for his Chain Brush, or Web Harrow, 2 sovs.

Special Commendations.

The Rev. W. L. Rham's Dibbling Machine.
The Earl of Ducie's Hand Threshing Machine.
Messrs. Ransome's Double-Lever Hand Threshing Machine.
Messrs. Ransome's Portable Disc Steam-Engine, for Agricultural purposes.

Before proceeding to comment upon several of the implements which, on account either of their originality, perfection, or general utility, appeared to deserve special mention, the Judges beg expressly to state that there were others of well-known and acknowledged practical worth, not the less entitled to notice, the mere enumeration of which would exceed the limits of a Report.

To Messrs. Ransome, of Ipswich, the Society is indebted for what may be termed the great novelty of the meeting, viz. the exhibition of a portable Steam-engine for the purposes of threshing corn, as applied by this enterprising and well-known firm, to whom agriculturists are already greatly indebted for their improvements in ploughs, and particularly for the introduction of the cast-iron case-hardened shares, &c. The advantages of steam-power for working fixed threshing-mills have long been acknowledged in the northern parts of England and in Scotland; but we believe this is the first attempt to render it portable, so that it may be transported from one farm to another, or from one part of a farm to another, as easily and as expeditiously as the present machines with horse-works. The patent disc engine invented by Mr. Davies, of Birmingham, is the class of engine selected by Messrs. Ransome for this purpose. This engine has but one moving part, and that of such simple construction and uniform action as to be liable to little depreciation from wear and tear. It has no beam, fly-wheel, parallel motion, guide rods, condenser, air-pump, or other intricate mechanism subject to derangement in work, or to accident from travelling over uneven country roads or fields: nor is its weight an impediment; the engine and boiler of five-horse power, with its carriage on a pair of wheels, not exceeding 35 cwt. By the peculiar construction of the boiler, and method of disposing of the waste steam, danger of ignition from sparks seems to be avoided, and the Judges confidently express their opinion that, with prudence, as great safety may be experienced in the use of this portable steam threshing machine in the stack-yard as is found to be the case with the fixed engine in the barn. As the show-yard offered no convenience for determining the performance of the engine, the Judges refer for more details to a trial made of it by one of their number at the instance of the Council, as also of three threshing-machines at Mr. Falkner's farm at Fairfield, near Liverpool, on the 24th of July.

A prize of 10*l.* was awarded to Mr. Wedlake, of Hornchurch, Essex, for his ingenious and well-executed dibbling machine. This machine

consists of one or more wheels three feet in diameter, having twenty hollow tubes radiating from the centre, and extending through the rim of the wheel to form holes of sufficient size and depth for the seed, and at definite distances from each other. The tube or dibble is composed of two halves, the one being fixed upon the periphery of the wheel, the other sliding downwards and upwards as the wheel revolves. The shape of the tube when closed is similar to that of an Italian iron. It enters the ground closed, forming a taper cylindrical hole, when the sliding half is pressed downwards, and deposits the seed in the hole before the tube quits the earth. The tubes are supplied with seed from the centre or axis of the machine. Each wheel is furnished with a scraper to free it from any adhering soil. The objects proposed by the inventor are—First, to economise seed by administering only a sufficiency of grains, and the determining a precise and proper distance between the plants; Secondly, to insure a greater certainty of growth and produce by depositing the seed at an uniform depth, and by pressing the soil firmly about it. The number of seeds to be placed in each hole is accommodated to its kind, and to the wishes of the cultivator. The mechanical arrangements for accomplishing these important ends appeared on close inspection, and on trial in the field, to be efficient and satisfactory. The additional improvements contemplated by the inventor bid fair to render the implement of great practical value to the agriculturist.

The Rev. W. L. Rham, of Winkfield, Berkshire, exhibited an implement, the principal object of which is to extend and improve the system of drilling and dibbling wheat and beans. It is chiefly in its latter capacity, as a dibbler of seed and manure, that we shall attempt to give a slight description of it. The operative part of the machine is suspended upon an iron carriage having four wheels, the two hinder ones being fast upon their axle and turning with it; on this axle is a spur-wheel, giving motion to a pinion on an intermediate axle, which carries a wheel geared into a second pinion fixed on an axis, having six cranks arranged spirally. The velocity given to this axis is such that the cranks make one revolution for every six inches of the circumference of the hind wheels, or whatever is the distance desired between the dibble-holes. The radius of each crank is such that this distance shall be equal to the circumference described by it in one revolution. Thus the space described by every crank coincides with that passed over in the same time by the hind-wheels. And, as the cranks turn during the half of a revolution in an opposite direction to that of the wheels, the result of this compound motion is a pause or rest of short duration, at the point where the crank in its rotation commences to retrograde from the line of progress of the machine—*i. e.* at the lowest point, and when the dibbles are in the ground. The cranks raise the dibbles up and down by means of connecting rods and levers, which double the vertical, without increasing the horizontal motion; and in order that the point when in the ground may be perfectly stationary, it is made the centre of motion while the machine progresses; and to enable it to retain that position for a sufficient length of time for the purpose of leaving a hole truly vertical, the dibble moves between cheeks in the rod which connects it with the crank, and has a spring to restore it quickly to its proper

place in rising out of the ground. During, therefore, the entire time occupied in its piercing the hole, and being withdrawn from the soil, the dibble retains its perpendicularity.

By an ingenious and simple contrivance a slow rotatory motion about its own axis is given to the dibble, by which means its point may be said to bore into the ground, thus assisting in the formation of the hole; and by the same action the dibble is cleared of any adhering soil, and the hole left firm and clear.

The seed-valve consists of a cylinder, with a cavity cut in it of dimensions sufficient to hold one or more seeds. This cylinder is *tumbled* over, and the seed discharged into a recipient of the shape of a quadrant, from which it is *pushed out;* when the cylinder returns to its first position and takes in a fresh supply. As this motion is sudden, the seed is surely delivered, even when rather damp. When the cylinder is delivering, the quadrant is receiving, and *vice versâ.* The delivery of the manure is effected by similar apparatus, only of a larger size, the valves being furnished with brushes or other means to remove the superfluity.

The valves are connected with the dibbles in such a manner as to deposit the manure and seed in the hole last formed, whilst the dibbles are stationary in the advancing one. The dibbles bore their holes in shallow drills made by the pressure and sliding action of an iron shoe, shaped like a boat and forming a smooth furrow.

The whole of the machinery is supported by an iron frame, one end of which rests on trunnions attached to a projecting part of the back of the carriage. It is suspended at the other end by a cross shaft carrying two pinions, working into arcs of circles fixed on the carriage, so that it can be raised or depressed as desired, or elevated clear of the ground by one turn of the winch. At the same time the pinion connecting the machinery with the hind wheels is put out of gear, and the whole can then be moved about on the carriage. The implement is steered in a manner somewhat analogous to Lord Western's drill.

The object of the Rev. Gentleman, in contriving this original and singularly ingenious implement, has been to imitate the more minute and certain manipulations of the gardener; and so to adapt his machinery to the drilling and dibbling of seed upon land previously laid flat and well prepared, that every field, however extensive, should present the neatness and the regularity of a highly-finished garden.

The distinguishing peculiarities of this remarkable piece of mechanism are the arrangements for the dibbles to *bore* the holes, causing them to be perpendicular, and truly cylindric; and the apparatus for giving certainty to the valves in receiving and delivering the seed and manure. The Judges, not having had an opportunity of inspecting the practical working of this machine, are limited to the expression of their high commendation of its ingenuity and principles, and their hope that the author's sanguine expectations may be crowned with the success his perseverance and inventive genius so richly deserve.

The Uley Cultivator, invented by Mr. Morton of Chester Hill, is an implement of great strength and utility: its peculiar merits consist in an improved form and disposition of the tines or teeth, which enter the

ground in a manner effectually to move the couch, or weeds, before they arise from the ground, and to leave them unbroken on the surface. The teeth, five in number, are so arranged, that although drawing lines only 8 inches apart, they are 2 feet asunder, which, with their curved shape, and length, and their being suspended on wheels 3 feet 4 inches in diameter, renders it impossible for the implement to choke, however foul and encumbered the soil may be. The depth to which the teeth are let into the soil is readily determined by a winch acting on a worm and wheel; and by the same means they are raised clear of the ground. For the preparation of light soils for barley, the teeth are provided with cast-iron shares, which effectually shallow-plough the surface without reversing it. Points of different widths, and also steel blades for paring, are furnished to fit on the tines without pins or other fastenings.

Biddell's Extirpating Harrow, exhibited by Messrs. Ransome, is well adapted for preparing pea and bean stubbles for the efficacious working of the common harrow. As the teeth or tines of this implement are only 4 inches asunder, it is eminently calculated for the raising of short couch to the surface, as well as for the general purposes of pulverization.

The horse-hoes were very numerous, and several were constructed upon original or greatly improved principles; the judges selected four of great and deserving merit for reward.

Messrs. Garrett and Son's hoe deserves the notice of the agriculturist as an implement that will greatly tend to give an horticultural finish to field operations. It is adapted to all the prevailing methods of drill culture, either for the cleansing of corn crops, drilled at narrow intervals, or for turnip crops drilled upon the level surface or on ridges; the axle of the wheels being moveable at both ends, to suit the varied intervals between the rows of plants, and as each hoe works by a separate lever, the weeds are effectually destroyed however uneven the surface of the ground, each hoe being kept at an uniform depth by means of regulating keys. The swing steerage, adapted to this implement, is a valuable addition to horse-hoes, as they may thereby be guided with the greatest precision, perfectly scarifying the intervals without the possibility of injuring the corn or plants.

Mr. Hamilton of Torthorwald, near Dumfries, N. B., has added an improvement to his expanding turnip-hoe, by placing skim coulters to the hoes, working the nearest to the rows of plants, turning the weeds and loose soil from the young plants, the covering of which at an early stage of their growth is injurious to them.

A hoe, invented by Mr. Huckvale of Over-Norton, Oxon, attracted the attention of the Judges as a novel implement displaying considerable ingenuity, and promising to be a valuable acquisition to the cultivator of turnips upon light soils. The originality of the invention consists in working a hoe on each side of a row of turnips, instead of between two rows as is usual, enabling the weeds to be cut nearer to the plants without injury than can be effected by hoes on the common principle. Also in the addition of revolving knives for thinning the turnips in the rows, motion for which is derived from the axle of the wheels by means of bevilled gear. These knives can be so regulated as to leave the

turnips 8, 10, or 12 inches apart. A pair of sloping blades follow to clean the sides; children alone then suffice to separate the double plants and complete the operation.

The peculiarity of the parallel expanding horse-hoe exhibited by Lord Ducie consists in an improvement of the expanding principle, the suggestion of Mr. John Morton of Chester Hill. The wings or supports of the tines, in this ingenious implement, instead of opening and closing upon a common centre—such as the vertex of an angle, as is usually the case, which has the effect of causing the teeth or cutting edges to cross the line of draught—move parallel with the beam and with each other, on the principle of the parallel ruler: by these means the teeth or cutting edges retain their primitive and true position. The width between the tines is capable of being regulated from 12 to 27 inches. The regulation of the depth into the ground, and the steerage, is also simply and conveniently accomplished.

An excellent show of drills was produced by Messrs. Hornsby, Garrett and Son, Smyth, and others. The drill exhibited by Mr. Hornsby of Spittlegate, Grantham, to whom the prize of 25 sovs. was awarded, is admirably calculated for depositing, either on hilly or level ground, any description of pulverized manure, even in a damp state, and in any quantity from 8 to 200 bushels per acre. The corn or seed and manure may, at the will of the cultivator, be deposited at an uniform depth; or, if required, the manure may be buried deeply, and the corn or seed placed by a separate coulter above the manure. Hitherto great difficulty has been encountered in effecting a regular delivery of damp manures, from their liability to form an arch in the box over the stirrer. To obviate this imperfection Mr. Hornsby has ingeniously contrived, by means of an endless screw, to give to his stirrer in the box a traversing motion lengthwise, as well as a rotary motion, so that as the points revolve they change their position, the whole line of the box being traversed, and a continuous train of manure deposited. The Judges highly commend the workmanship and superior finish of Mr. Hornsby's drills.

The Suffolk drills, exhibited by Messrs. Garrett and Son, and Smyth, to whom prizes were also awarded, displayed great ingenuity and completeness in their construction, but neither were they so durable nor so well adapted for the depositing of manures as the drills manufactured by Mr. Hornsby.

Numerous chaff-engines were exhibited of superior construction and highly-finished workmanship. The Judges, however, did not discover any improvement in the principle of working the well-known varieties.

The Earl of Ducie and Messrs. Clyburn and Budding introduced a patented chaff-cutter of their own invention, the principle of which appeared to the judges quite novel; upon trial this implement performed its work admirably. The cutters consist of two series of thin blades or knives, with serrated edges, coiled spirally round a horizontal rotating cylinder, and presenting their edges at an angle to it. The one series is coiled from left to right, and the other from right to left, meeting in the middle of the cylinder; an unbroken continuity of cutting action is thus attained. A pair of feed-rollers is driven from the spindle of the cut-

ting cylinder, which again gives motion to an endless cloth, upon which the material to be cut is placed and by which the supply is maintained. The speed of the feeding-rollers is regulated by a highly ingenious and simple application of the worm and wheel. The wheel fixed on the roller is so constructed as to admit of being driven by worms, with threads varying from one to four: thus, by changing the worm on the axis of the cylinder (which is also accomplished in a dexterously mechanical manner) the hay or straw is cut into lengths of from ¼ of an inch to 1 inch. This machine may be worked by manual, animal, or steam power with equal convenience.

To Messrs. White and Leith of Worksop, Notts, the judges awarded the Society's prize of 20 sovs. for the most effective instrument exhibited for the preparation of Gorse as a food for cattle, &c. The Gorse is first cut into small lengths by knives, it is then drawn forwards by rollers, similar to the straw-cutting machines, which press or squeeze it, and finally passes through a pair of fluted cylinders, by the action of which it is sufficiently bruised and rendered pulpy for the mastication of ruminating animals. Though awarding this prize for an efficient and well-executed machine, the judges cannot avoid expressing their opinion that it is still a desideratum to diminish the amount of power required, and to increase the quantity of work executed, in order to render gorse-crushers of general use.

The ploughs far exceeded in variety and constructive skill those shown at any previous exhibition, and the judges deemed it requisite to divide the sums appropriated by the Council to reward this class of implements amongst many well-deserving competitors.

Of the turn-wrest plough there were several specimens of great merit. Messrs. Ransome's large collection contained an improved plough, of the old Kentish kind, made under the direction of Mr. Wm. Smart of Rainham, by which the holder is enabled, without leaving his place at the handles, to shift the wrest and coulter, and change the "dip" of the plough; also another variety termed the "Belton Turn-wrest," in which the body is so formed as to represent two ploughs attached heel to point, the handles and beam being connected by a pivot to the centre, so as to admit of reversing at each turn without difficulty.

Mr. Smith of Deanston exhibited an exceedingly simple and ingenious implement of this kind, with a grain-drill attached when required. In this plough the wrest or mould-board alone is moved, turning upon a rod extending longitudinally in the centre of the instrument, so that the position neither of the handles, share, nor coulter require to be changed. It was furnished also with an improved bridle for regulating the point of traction.

Mr. Wilkie of Uddington, near Glasgow, also exhibited a turn-wrest plough on the plan of Mr. Smith's, chiefly varying from it in the convenience provided for reversing the wrest, and retaining it in a vertical position whilst the plough is being turned round at the end of a bout. This instrument, like Mr. Smith's, is entirely composed of iron; but Mr. Wilkie's wrest is of wrought-iron, and very light. It was furnished with a self-regulating bridle, by which the coulter was made to present

its cutting edge always to the land-side. The exquisite workmanship of this plough, and of several other implements exhibited by Mr. Wilkie, excited universal admiration.

Mr. Huckvale of Over-Norton, Oxon, showed a plough of this description, the chief novelty of which consisted in its having a double share, or a share formed like the letter L, each face of which acted alternately as share and coulter. The spindle by which it was reversed adjusted the mould-boards.

The subsoil-plough has become for certain soils an indispensable instrument; and it was gratifying to observe that many of the principal machine-makers had turned their attention to its adaptation for the various uses to which it is applicable. A great variety was exhibited both with and without a wheel, including the one originally made by Mr. Smith of Deanston. The prize of 10*l.* was awarded to Mr. Wilkie for one furnished with a leading-wheel, uniting great strength with lightness, and which proved on trial to be easily managed, and to maintain a very uniform depth below the surface. To diminish the force of draught by increasing the steadiness of action of this important implement, is yet a desideratum to which it is hoped the continued efforts of mechanics will be directed.

The turf and stubble-paring plough, invented by Mr. Thomas Glover of Thrussington, Leicestershire, is a new implement of great value. The Judges highly commended the construction and working of this plough. The surface is pared with great precision and despatch, leaving the turf in a curl or roll, the grass side inwards, a position in which it is sooner dried, and rendered fit for burning, without the necessity of turning it over, as is generally required when cut by the breast-spade.

In conformity with the arrangements made by the Council, the Judges submitted to trial the qualities of many of the ploughs designed for the general purposes of the farm, with the view of guiding their judgment in the award of prizes. These trials were made on the race-course at Aintree, the surface consisting of old sward upon a light loam, and sandy subsoil. After the implements had been at work for some time, so that each competitor might have the opportunity of getting his plough into working trim, the judges proceeded to test each with the dynamometer, in order to fulfil, as nearly as they could, the condition annexed to the prizes, viz., that "lightness of draught will be considered as well as quality of work performed." For this purpose, and in order to insure as nearly as possible an equality of circumstances, each plough was set to cut the furrow-slice, as nearly as it was practicable, 5 inches deep, 11 inches in breadth, and leaving an open furrow of about 11 inches. The dynamometer (constructed by Messrs. Cottam and Hallen of London) was then applied, and the resistance noted at the time when the plough in every case appeared to be working in similar soil, and doing its best. The results of these experiments are arranged in the following table:—

EXPERIMENTS ON THE DRAUGHT OF PLOUGHS.

Makers' Names.	Residence.	Number of Horses.	Number of Wheels.	Slice cut.		Draught in Stones.	
				Depth inches.	Width inches		
Perry, Barrett, and Co.	Reading . . .	1	1	4½	10	22	
Hart . . .	Wantage, Berks. . .	1	1	5	10½	26	
Ditto . . .	Ditto	2	1	5	11	28	
Ransome . . .	Ipswich . . .	2	2	5	11	28	Rutland, N.L.
Sanders, Williams & Co.	Bedford . . .	2	2	5	11	28	Patent Coulter.
Howard . . .	Ditto	2	2	5	11	28	Patent Scotch.
Ditto . . .	Ditto	2	2	5	11	32	
Adams . . .	Northampton . .	2	2	5	11	32	
Sanders, Williams & Co.	Bedford . . .	2	2	5	11	32	
Hart . . .	Wantage . . .	2	2	2¾	8	34	Double Furrow.
Hughes . . .	Halkin, Flintshire .	2	Swing	5	11	28	
Harling . . .	Sedgwick, Kendal .	1	,,	5	11	30	Friction Sole Wheel.
Wilkie . . .	Uddington, near Glasgow	2	,,	5	11	32	
Ditto . . .	Ditto	2	,,	5	11	36	
H. Turner . .	Killingworth, near Newcastle .	2	,,	5	11	36	
E. Brayton . .	Carlisle . . .	2	,,	5	11	36	
Love . . .	Northampton . .	2	,,	5	11	40	
Drummond . .	Stirling, N.B. . .	2	,,	5	11	40	
Glover . . .	Thrussington . .	2	2	1	11½ to 13	24	Turf Parer.]

A few observations are requisite lest these experiments should be considered as determinate, in the opinion of the Judges, not only of the intrinsic merits of any particular plough, but of the debateable question of the relative advantages of swing and wheel ploughs. The peculiar circumstances under which these experiments were tried do not permit such final conclusions to be safely drawn. First, the greater number of the ploughs were new, and many of the mould-boards were freshly painted, or had never been in the ground, which must have necessarily augmented their friction: secondly, some of the ploughmen were inexperienced in the management of the plough which they directed: thirdly, where so many teams of horses were required, some of them were unaccustomed to the work, and did not draw well together. Still, with these reservations, the trials greatly tended to assist the Judges in their awards; and the dynamometer disclosed facts, as to the relative resistance opposed by the different kinds of ploughs, which cannot fail to be of interest and utility to the agriculturist, and also to the constructor.

It appears that, in almost every case, the draught of the wheel-ploughs was less than that of the swing kind; and it must not be concealed that the wheel-ploughs, in every case, actually turned over more soil than the swing: for the share and sole of the former maintained a flat, horizontal position; whereas all the swing-ploughs leaned more or less to the land-side, cutting to a less depth on the right than on the left hand side. Consequently, the furrow bottoms left by the wheel-ploughs were more even than those excavated by the swing-ploughs. This difference in the action of the two kinds of ploughs was less observable in the swing-plough made by Mr. Hughes of Halkin (exhibited by the Hon. E. Mostyn), which cut a much more even sole than the others, and offered the least resistance of any plough of that description. It is worthy of

remark that this swing-plough had a particularly fine and easy entrance —a share somewhat broader than the slice cut—and a longer mould-board than usual.

The Judges regret that the delays incident to the presence of so large an assemblage of spectators, and to the numerous implements requiring their attention, did not permit them to pursue these experiments, so as to evolve more important results, and, particularly, as regarded the draught of several excellent double-furrow ploughs which were on the ground, but not brought into working trim early enough for satisfactory trial.

Amongst the miscellaneous implements a turnip-cutter, attached to a cart, was exhibited by Mr. G. Townsend, of Hinckley, Leicestershire, for cutting and spreading turnips for sheep and cattle upon grass leys. It consists of a cutting apparatus upon the disc principle, worked horizontally underneath the hind part of a cart. Motion is obtained from a toothed wheel clamped to the spokes of the cart wheel. On trial, the turnips were expeditiously cut, and evenly spread on the surface of the grass. From the simplicity of the apparatus, and its being readily fixed to any cart, the Judges considered that it might prove of valuable assistance to the consumers of turnips upon grass lands.

The lever horse drag-rake, contrived by Mr. Grant of Stamford, appeared to attract great attention on the day of trial. Its advantages over the common horse-rake arise from the application of a lever to raise all the teeth at once when filled, without the necessity of stopping the horse, and from each tooth depending separately from the common axis, like the mechanical road-scraper, so that the inequalities of the land cannot escape its action.

The patent wrought-iron harrows made and exhibited by Mr. Howard of Bedford, are a valuable addition to this class of implements. The improvement consists in the tines or teeth being so arranged that each cuts a separate furrow, and is kept in the line or furrow by a central draught from the swingletree, so that if the horses draw ever so irregularly the tines cannot be thrown out of their direct line.

The chain-brush or web-harrow, the invention of Mr. Smith of Deanstone, is ingeniously calculated to answer all the purposes for which the hurdle drawn with thorns is now applied. Upon light sandy soils, where the wheat crops are infested by the "red poppy," a free application of this implement may, possibly, prove of great service in eradicating this destructive weed during its early growth.

The dairy department of husbandry is indebted to Mr. Blurton of Field-Hall, near Uttoxeter, for the introduction of a very simple contrivance, by which fifty cheeses are turned over at once. The cheeses are arranged on shelves in a frame, suspended on centres to two side-posts, forming part of the machine, so that a half revolution reverses the whole at once, thus economising the labour of the domestic, and the space of the cheese room. To this frame, and to two churns of merit, by Mr. Lea of Liverpool, and Mr. Parkinson of Knowsley, prizes were considered to be due.

To Messrs. Drummond and Son of Stirling a prize was awarded for a single-rowed dropping-drill for depositing turnip-seed and manure,

much used and approved in Scotland. These gentlemen greatly contributed to the interest of the show-yard by the exhibition of a variety of implements, chiefly of iron, many of them distinguished as articles of ingenuity, and usefulness, and superior workmanship. Amongst them were Mr. Smith's (of Deanston) ploughs and implements for draining; also models of drains excavated and refilled; also Mr. Smith's reaping-machine.

The Judges regret that the season of the year prevented the opportunity of witnessing the performance of this powerful implement in practical operation.

The Society is indebted to Mr. Crosskill for the exhibition of his well-known and highly-approved implement, the clod-crusher, and also for his liquid-manure cart; to Messrs. Edmunds and Huckvale, of Banbury, for their drill and lever furrow-presser; to Mr. Beart, of Godmanchester, for his draining-tile and sole-making machine, lately much improved; to Mr. Bigg for his sheep-dipping apparatus; to Mr. Edgington, of London, for his marquees and stack-covers; to Messrs. Cottam and Hallen, London, for the various instruments constructed by them; and generally to all the exhibitors who, at great cost, responded to the Society's invitation, and sent their implements from all quarters of the country, enabling the Society to present for the inspection of agriculturists assembled from the three kingdoms, a more extensive, varied, and better manufactured collection of implements than was ever displayed in one show-yard.

Josiah Parkes.
George Legard.
R. S. Graburn.

REPORT

Of a Trial of Messrs. Ransome's Portable Steam Threshing-Engine, and of two Hand Threshing-Machines, at Mr. Falkner's Farm, Fairfield, near Liverpool. July 24th.

The Portable Disc-Engine was coupled to one of Messrs. Ransome's Threshing-Machines by means of a shaft having universal joints, as exhibited in the show-yard. The carriage remained steady during the working of the engine—its wheels being let a little into the ground and the shafts supported. The engine performed its work easily and satisfactorily; no sparks issued from the chimney. To prove this important desideratum an elbow-pipe was attached to the summit of the funnel, and joined to other pipes descending to the ground 4 or 5 yards distant from the engine. Straw was laid about the extremity of the pipe to ascertain if ignition were possible close to the orifice. It was evident, from the wet state of the straw quickly produced by the steam, and condensed water issuing from the chimney, that no danger of fire is to be apprehended in a barn-yard from this source. The furnace was fed with both coal and coke, with equal freedom from sparks; the temperature at the orifice of the funnel was below that necessary to inflame straw.

The short duration of the experiment precluded the possibility of de-

termining the consumption of fuel, but it may be safely estimated at the rate of about ½ cwt. of good coke per hour, when the engine is doing the work of about five horses; and that about 36 gallons of water would be required per hour to supply the boiler.

In the present experiment, judging from the number of sheaves threshed by the respective machines in a given time, the engine did the work of twenty-four or twenty-five men: but it was evident that the men could not long have worked the hand-machines without repose or relay, so that no exact comparison can be instituted of the power exerted; and the engine could have performed more work at a moderate and safe pressure of steam.

The weight of the engine, boiler, and carriage is about 35 cwt., moved by two horses, with a supply of water in the boiler.

Were the carriage mounted on four wheels, and the threshing-machine fixed and worked upon it, as is contemplated by the inventors, the whole would be still more complete in many points of view.

The Hand Threshing-Machines submitted to trial were those commended by the judges of implements; the one constructed by the Earl of Ducie, the other by Messrs. Ransome. These two implements involved the use of distinct principles in the method of separating the grain from the ear, as also in the manner of applying the power.

In Lord Ducie's machine the straw is fed in at a tangent to the drum, and has consequently only to pass round its circumference, the corn being *scutched* or stripped off by the revolving action of eight narrow blades or scutchers. At the back of the drum, and forming the end of the machine, is an open work concave screen of cast-iron, rendered adjustable so as to be set nearer to or farther from the drum, as required by the sort of grain to be threshed. A large portion of the corn, on being stripped from the ear, falls immediately through the interstices of this screen; the remainder passes with the straw down a wood grating. The object of this arrangement is to effect a greater separation of the straw and grain, for the more easy collection of the latter.

The framing is constructed entirely of cast-iron. At one end of the machine is an axis having a fly-wheel, with a handle for a man at each end of it. The end of the drum-spindle carries a pulley, to which motion is given by a strap passing round the fly-wheel. By fixing a pulley in place of one of the handles on the fly-wheel shaft, the machine may be driven by animal, or other power, equally as well as by men; or even altogether without the fly-wheel, by passing a strap from the moter round the drum-pulley, as was done, experimentally, with the disc-engine.

The mechanical construction and execution of this machine merit the highest praise. All the requisites of portability are self-contained; it will stand on any spot; it is not disturbed by the action of the power; and extraneous means of fastening it are unnecessary.

The threshing principle of Messrs. Ransome's machine is similar to that of their others, and to the more general practice, viz., the shaking out the grain from the ear by sharp blows inflicted by the beaters; a description, therefore, of the mechanism for effecting this process is unnecessary.

The peculiarity of the machine consisted chiefly in the application of the power by means of side levers or bars, standing out at right angles to the machine. One of these levers is applied on each side, having connecting-rods for communicating the power to the acting parts. Two men work each lever by alternately pushing and pulling, the reciprocating being converted into rotative motion by the connecting-rods and cranks. This arrangement is ingenious, and it would seem to be an economical application of human force, as it is exerted in a manner convenient to the physical structure of the human frame. Practically, however, to a certain extent, and for the purpose of a portable machine, this advantage is counteracted by the disturbing effect produced on the machine by the alternate action of the levers on its opposite sides; an effect which requires that the machine be firmly fixed to the spot on which it is to be worked.

As regards the relative perfection of the work accomplished by these two machines, there was no very distinguishable difference, judging from the state of the straw and the cleanness of the ears. The performance of both was considered to be very good. The following table contains the numerical results, being data from which useful comparisons may be drawn of the cost and relative economy of effecting the process of threshing by the flail, by the hand-machines, and by animal or steam power.

Sheaves of Wheat Threshed.	Time.		Produce.	Men Employed.	Machines.
Number.	Min.	Sec.	Lbs.	Number.	
20	22	40	106	2	Lord Ducie's.
20	11	20	103	4	Messrs. Ransome's.
245	23	30	1260	=24	Steam-Engine.

The produce of each machine was kept separate, and subsequently weighed by Mr. Falkner, after passing the corn once through the winnowing-machine. He observes that the yield of each machine, proportionally to the number of sheaves, may be fairly considered as identical. He remarks that the sheaves supplied to the steam-machine were taken at random, and that a part of them had grown alongside a plantation, and would not yield so well as the others; whereas, the forty sheaves supplied to the hand-machines were picked.

A repetition of experiments of this nature, conducted for a greater length of time, with the attention directed to the difference in the power and effect produced by varying the velocity of the beaters, their number, &c., might be expected to elicit information of much value to the constructor. It was very apparent, during these trials, that skill in feeding exercises no slight influence both over the consumption of power, and the completeness of the operation.

JOSIAH PARKES.

VETERINARY COMMITTEE.

Report on the Epidemic among Cattle. By Professor Sewell.

The Veterinary Committee of the Royal Agricultural Society of England, having, in compliance with a resolution of the Council, sent a circular to each member, containing queries for information on the nature and extent of the prevailing epidemic among cattle and other domestic stock, have received nearly 700 communications, which may be generalised, as in the following Report:—

The disease had not made its appearance in England before the summer of 1839, and with few exceptions had broken out in the stock of those members who have sent communications, and the information is mostly confined to what occurred on their own farms and premises.

Some members state that it prevails in their immediate neighbourhood, and others at several miles' distance. It is generally reported not to have prevailed extensively before 1840, and then to have attacked all kinds of stock indiscriminately, even poultry, dogs, cats, and deer. Influenza, by some called distemper, catarrhs, and sore throats, prevailed much among horses, before the epidemic, during its prevalence, and after it had ceased; and pulmonary diseases, proving fatal in several cases.

As far as situation, nature of the soil, and general features or aspect of the country are described, no exemption from disease is recorded, whether mountainous, hilly, flat, wooded or open, dry or damp, intersected by rivers or canals, or in the vicinity of marshes, ponds, ditches, or any stagnant waters.

It has been attributed by some to the prevalence of east or north-east winds; others supposed it induced or brought by the south and west winds. Some are of opinion it has been produced by fogs, and abounded more in valleys, on the banks of rivers, and low damp situations; others attribute the outbreaks to communication by the herdsmen, shepherds, or persons employed.

Its attacks appear to have commenced, whatever was the quarter from which the wind blew, and under all temperatures, throughout the year, commencing and ceasing at uncertain periods; and the disease did not vary in its symptoms except when the atmospheric temperature was highest: then inflammatory action was more intense, and the disease more fatal, especially among animals that travelled to fairs or markets; by which it was introduced into premises and farms heretofore exempt, and thus became disseminated in healthy districts. Fever was increased by fatigue in travelling.

The feet became acutely inflamed, causing the hoofs to shed or exfoliate, and many animals were in consequence slaughtered on the roads.

Young animals appeared to be more exempt from attacks than the full-grown; but in comparing the number affected it was more fatal, and often more speedily so, in them than in the adult animals. The house and exposed stock of all ages and conditions were equally subject to attacks from general causes. In some cases, supposed to arise from infection or contagion, the symptoms appeared as early as the second day; in others several weeks elapsed after exposure to infection, before the disease appeared.* One correspondent states that himself and all his family and domestics were attacked on the lips and in the mouth in consequence of using *the milk* of his diseased cows; and that a foal living with them had an attack of farcy and glanders, of which it died.

The disease generally commenced in the mouths of bullocks, cows, and calves, by the appearance of blisters and ulcers on the tongue, and sore throats in some; the feet at the same time, or very soon after, became ulcerated, as also the palate, lips, and nose. It was accompanied by rigors or chills, succeeded by feverish heat. The noses and feet of pigs were attacked, but the feet only of sheep, except in a few instances in which the mouths were affected, as in cattle.

In dairy-cows the teats became affected with pustules and ulcers at the same time as the mouth, the udders subsequently became inflamed and tumefied; and abscesses were formed, terminating frequently in a total loss of milk, and, in less severe cases, in a diminution of quantity.

The pregnant or in-calf cows and barren cows were less violently affected, but cows having recently calved suffered most, more especially in the udders, from the formation of tumours and milk abscesses, constituting the disease commonly called garge; abscesses and ulcers also were formed in various parts of the limbs and body, especially the points bearing the animal's weight when lying down. At this stage of the disease it was often attended with so much fever and prostration of strength and constitutional debility, that the animal was incapable of rising or changing its position, which caused extensive ulcers, abscesses, and frequently death from irritation and exhaustion.

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* The following circumstance was related to me by the dairyman of a large farm in Dorsetshire:—The smell of fresh blood often affects cows in a straw-yard, making them appear as if frantic. After milking the diseased cows the dairyman overturned the pail in the straw-yard; the cows were greatly excited in the same manner, smelling at it, and fighting to keep each other away from the spot where the diseased milk lay.—C. Lemon.

A few cases of second attacks are reported to have occurred, and even third attacks are mentioned; but these are exceptions.

There are reports of some having been herded with infected animals and entirely escaping, and some that had gone through the disease, and, although re-exposed in diseased herds, had no renewal. In one report vaccine inoculation from a child is said to have lessened the severity of the disease. Low condition is also said to have diminished its virulence. In the few that had second attacks the disease in some is stated to have been in a severer, and in others in its usual form.*

The medical treatment has generally been of a purgative nature, sometimes too strong and probably injurious, frequently combined with diuretics and stimulants, &c.; and astringents were used externally to the teats, feet, and mouths, and tar in some cases to the feet, and occasionally mild caustic applications. Bleeding has also been practised by some and disapproved of by others. Setons, issues, and blisters have also been employed.

Abortion has seldom occurred, nor has the produce of any stock been born diseased, although the mothers were labouring under it during parturition.

Some newly-born animals became sickly in two or three days after birth, and died apparently from constitutional disturbance. Others, in which the usual symptoms became manifest, were cut off within a week. It is stated to have appeared in the feet only of sucking-pigs.

Upon the subsidence of the disease many cattle were attacked with cutaneous eruptions, which usually yielded to the remedies employed in ordinary cases of mange.

In the few post-mortem examinations that were made, a diseased state of some, and in others of all the vital organs, appeared, and marked inflammatory action had been general throughout the system.

The epidemic disappeared in some farms and dairies in about a month, and in others extended to six months.

The cattle that have suffered from the disease in the country are estimated to have been reduced in value 5 per cent., which is much below the London estimate, and dairy-cows having newly calved are calculated to have lost 30 per cent. of their original value.

Wm. Sewell,
Professor, Royal Veterinary College.

July 17*th*, 1841.

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* Preventive treatment has been resorted to successfully as reported in some cases, but failed in others, such as smearing the noses, feet, backs, loins, and horns at intervals with tar. Others have applied it about the premises.

Bristol Meeting.

Principal Day of the Show, Thursday, July 14th, 1842.

THE PRIZES ARE OPEN TO GENERAL COMPETITION.

Prizes for Improving the Breed of Cattle.—1842.

Short-Horns.

CLASS

1. To the owner of the best Bull calved previously to the 1st of January, 1840 . . . . Thirty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1840, and more than one year old . . . . . Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . Ten Sovereigns.

Herefords.

1. To the owner of the best Bull calved previously to the 1st of January, 1840 . . . . Thirty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1840, and more than one year old . . . . . Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . Ten Sovereigns.

Devons.

1. To the owner of the best Bull calved previously to the 1st of January, 1840 . . . . . Thirty Sovereigns.
   To the owner of the second-best ditto ditto . . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1840, and more than one year old . . . . . Twenty Sovereigns.

CLASS

3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . Ten Sovereigns.

Cattle of any Breed, or Cross:

Not qualified to compete as Short-horns, Herefords, or Devons.

1. To the owner of the best Bull calved previously to the 1st of January, 1840 . . . . Thirty Sovereigns.
   To the owner of the second-best ditto ditto . Fifteen Sovereigns.
2. To the owner of the best Bull calved since the 1st of January, 1840, and more than one year old . . . . . Twenty Sovereigns.
3. To the owner of the best Cow in milk . . . Fifteen Sovereigns.
4. To the owner of the best in-calf Heifer, not exceeding three years old . . . . . Fifteen Sovereigns.
5. To the owner of the best Yearling Heifer . . Ten Sovereigns.

Horses for Agricultural Purposes.

1. To the owner of the best Cart-Stallion of 4 years old and upwards . . . . . Thirty Sovereigns.
   To the owner of the second-best ditto ditto . Twenty Sovereigns.
2. To the owner of the best two years old ditto foaled since the 1st of January, 1840 . . Fifteen Sovereigns.
3. To the owner of the best Cart-Mare and Foal . Twenty Sovereigns.
   To the owner of the second-best ditto . . . Ten Sovereigns.
4. To the owner of the best two years old Filly . Ten Sovereigns.
5. To the owner of the best Thorough-bred Stallion, which shall have served Mares at a price not exceeding three guineas, in the season of 1842 . . . . . Thirty Sovereigns.

SHEEP.

Prizes for Improving the Breed of Sheep.—1842.

Leicesters.

CLASS

1. To the owner of the best Shearling Ram . . Thirty Sovereigns.
   To the owner of the second-best ditto . . . Fifteen Sovereigns.
2. To the owner of the best Ram of any other age . Thirty Sovereigns.
   To the owner of the second-best ditto . . . Fifteen Sovereigns.
3. To the owner of the best pen of Five Shearling Ewes . . . . . Ten Sovereigns.
   To the owner of the second-best ditto ditto . Five Sovereigns.

South Downs, or other Short-woolled Sheep.

CLASS		
1.	To the owner of the best Shearling Ram . .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.
	To the owner of the second-best ditto ditto . .	Five Sovereigns.

Long-woolled Sheep:

Not qualified to compete as Leicesters.

1.	To the owner of the best Shearling Ram . .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
2.	To the owner of the best Ram of any other age .	Thirty Sovereigns.
	To the owner of the second-best ditto . . .	Fifteen Sovereigns.
3.	To the owner of the best pen of Five Shearling Ewes	Ten Sovereigns.
	To the owner of the second-best ditto ditto . .	Five Sovereigns.

Pigs.

1.	To the owner of the best Boar	Fifteen Sovereigns.
	To the owner of the second-best ditto . . .	Five Sovereigns.
2.	To the owner of the best breeding Sow . . .	Ten Sovereigns.
3.	To the owner of the best pen of three breeding Sow-Pigs of the same litter, above four and under nine months old	Ten Sovereigns.

Implements.

A sum not exceeding Three Hundred Sovereigns.

Extra Stock, Roots, and Seeds.

For Extra Stock of any kind, not shown for any of the above Prizes, and for Roots, Seeds, &c., Prizes may be awarded and apportioned, by the Committee and Judges, to an amount not exceeding in the whole . . . . . Fifty Sovereigns.

Any New Implement.

For the Invention of any new Agricultural Implement, such sum as the Society may think proper to award.

Seed-Wheat.

I. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor at the Bristol Meeting of the best 14 bushels of White Wheat, of the harvest of 1841, and grown by himself.

II. Thirty Sovereigns, or a Piece of Plate of that value, will be given to the Exhibitor at the Bristol Meeting of the best 14 bushels of Red Wheat, of the harvest of 1841, and grown by himself.

[12 bushels of the wheat will be sealed up by the judges, and one of the remaining bushels of each variety will be exhibited as a sample to the public. At the General Meeting in December, 1843, the prizes will be awarded.]

The three best samples of both red and white wheat, without distinguishing at that time between the three, will be selected by judges appointed at the Bristol Meeting, and will be sown, under the direction of the Society, in the autumn of 1842, by three farmers, who will make their report, upon which the prizes will be awarded. Ten Sovereigns will be given at the Bristol Meeting to the Exhibitor of each of these three samples, on account of his Wheat thus selected for trial.

*** No variety of Wheat which has been selected for trial at any previous show shall be qualified to compete.

ESSAYS AND REPORTS ON VARIOUS SUBJECTS.

Prizes for 1842.

PRIZE ESSAYS.

1. Drill Husbandry of Turnips.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Report of Experiments on the Drill Husbandry of Turnips.

Competitors will be required to state—

1. The time of sowing the different varieties, on different soils, and at different elevations and latitudes.
2. The mode of preparing the land, and of drilling the seed; with a description of the implements used.
3. The kind and quantity of manure employed.
4. The distance between the rows.
5. The manner of performing the hoeing.

N.B.—It will be desirable that the mode of cultivation employed by practical farmers in some considerable districts should be described, as well as any variations in the practice, arising from difference in the quality of the soil.

2. Wireworm.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Natural History, Anatomy, Habits, and Economy of the Wireworm, and the best means of protection against its ravages.

Competitors will be required to attend to the following points—

1. The length of time during which the wireworm exists in that state.
2. The vegetable productions on which its depredations are chiefly committed, and the mode by which it effects their injury or destruction.
3. The places in which the perfect insect deposits its eggs; and what seasons aid or retard the development of the gnat, or mark its changes.
4. Whether peculiar soils or aspects are more particularly infested by the insect; and whether preceding crops influence it in its selection.

3. Mechanical Properties of the Plough.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Mechanical Properties of the Plough.

Competitors will be required to define—

1. The form of the cutting and moving parts of the plough, as affecting the work to be performed on various soils.
2. The form of the same, as affecting the draught.
3. The true line of draught, as derived from the shape of the plough, and from the structure of animals employed in drawing.

4. Prognostics of Weather.

The Gold Medal will be given for the best Account or Record of the Prognostics, or Natural Signs, of Changes in the Weather.

Conditions:—

1. Competitors for this prize will be required to draw the rules which they give from such appearances as may be observed, by men living in the country, with ordinary attention to the state of the atmosphere, the habits of animals, and the thermometer and barometer.
2. They will be required to state whether they intend the rules which they give to apply to a hilly or a flat country, to the neighbourhood of the sea, or to inland situations.
3. The merit of the different sets of rules sent in will be decided upon by practical experience in different parts of the country; and the prize awarded to the person whose rules, after twelve months' trial, shall be reported by the gentlemen selected as judges to have proved most generally correct.

5. Making of Cheese.

Ten Sovereigns, or a Piece of Plate of that value, will be given for the best Account of Making Cheese.

Competitors will be required to give—

1. A description in detail of the mode employed in preparing the cheese in some district of established reputation for the production of cheese.
2. An inquiry, how far the excellence of the best cheeses arises from peculiarity of pasture, soil, and situation; or, how far from superior management.
3. It is also desirable to investigate the effects of the colouring matters which are employed in making some kinds of cheese.

6. Rotations of Crops on Light Lands.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Rotation of Crops suited for Light Lands.

Competitors will be required to keep in view—

1. The succession of crops which combines the greatest number and productiveness of crops with the largest profit and most improving condition of the soil.
2. The greatest consumption of the produce by the Stock profitably kept on the land.

7. Rotations of Crops on Heavy Lands.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Rotation of Crops suited for Heavy Lands.

N.B.—The same conditions will apply to this prize as to the last; but particular stress is to be laid on bringing heavy lands more nearly on an equality with light lands, than they at present are, in the Maintenance of Stock.

8. Curing of Butter.

Ten Sovereigns, or a Piece of Plate of that value, will be given for an Account of the best Mode of Curing Butter for future consumption, and for Preservation in foreign countries.

Competitors will be required to attend to the following Conditions—

1. The butter to be made from grass-fed cows, milked between the 20th of May and the 20th of June; stating the exact period at which it was manufactured; and whether made from cream alone, or from the whole milk and cream churned together.
2. That two samples of the butter—of not less than 12 lbs. each—be packed in jars, and sent up (carriage paid) to the Society on or before the 1st day of July: stating the exact quantity of any salt, honey, or other substance used in the curing: with a minute description of the mode employed in effecting it.
3. That each sample be cured with a different sort of salt—if any different kinds can be procured—and not less than 6 lbs. of each be sent up, separately, to the Society: distinguishing the particular kinds which have been used.
4. That the samples of salt will be duly analysed; but those of the butter will be retained in the Society's rooms until the month of December, when they will be opened and valued by two eminent dairymen: the valuation of which to be paid to the makers.

5. That the judgment of those dairymen, in regard to the prize, will be directed not so much to the quality of the butter as to its sweetness, and the probability of its preservation at home and in warm climates.

9. Varieties of Wheat suited to Different Soils.

Fifteen Sovereigns, or a Piece of Plate of that value, will be given for the best Account of the Varieties of Wheat suited to Different Soils.

N.B.—As it is well known that many soils will not bring forth in perfection the best varieties of wheat—particularly of white wheat—it is desirable to know what is the best wheat which each soil is capable of producing.

10. On the Food of Plants.

Twenty Sovereigns, or a Piece of Plate of that value, will be given for the best Essay on the Food of Plants.

Competitors will be required to state—

1. The sources from which plants derive the elements of which they are composed.
2. The mode in which farm-yard dung strengthens the growth of agricultural crops.
3. The mode in which other manures, whether singly or combined, act upon vegetation.

These Essays must be sent to the Secretary on or before March 1st, 1842.

RULES OF COMPETITION FOR PRIZE ESSAYS.

1. That all information contained in Prize Essays shall be founded on experience or observation, and not on simple reference to books, or other sources.
2. That drawings, specimens, or models, shall accompany writings requiring them.
3. That all competitors shall transmit a sealed note, containing their names and addresses, with a motto on it to correspond with the one inscribed on the Essay.
4. That the Society shall have the power to publish the whole or any part of the Essays which gain the prizes; and the other Essays will be returned on the application of the writers.
5. That the Society is not bound to give an award, unless they consider one of the Essays worthy of a prize.
6. That, in all reports of experiments, the expenses shall be accurately detailed: that only the imperial weights and measures are those by which calculations are to be made: that prizes may be taken either in money or plate, at the option of the successful candidates; and that no prize be given for any Essay which has already appeared in print.

All Essays must be sent to the Secretary, at No. 5, Cavendish Square.
