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THE

FA R M E R ' S  F R I E N D :

A RECORD OF

RECENT DISCOVERIES, IMPROVEMENTS, AND
PRACTICAL SUGGESTIONS

IN


"We intend to pull at every latch-string that we find outside the door or gate, and study the physiology of turnips, hay-ricks, cabbages, hops, &c.; and of all kinds of cattle, sheep, and swine."—ELIHU BURRITT, Letter on his visit to England.

L O N D O N :

S M I T H , E L D E R  A N D  C O . , 6 5 , C O R N H I L L

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London:
Printed by Stewart and Murray,
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ADVERTISEMENT.

Should the present volume meet with sufficient encouragement, it is intended to constitute "The Farmer's Friend" a periodical Record of Improvements in Agriculture, by publishing a half-yearly volume of similar character.

Any suggestions towards increasing the utility of this work, that may be offered by gentlemen favourable to its design and object, will be acceptable, and receive due consideration by the Editor, to whom communications will be forwarded by the Publishers.

65, Cornhill, March 1847.
ERRATA.

Page 129, headline, for Draining Running Sands, read Principles of Draining.

At end of Article 33, insert "Farmer's Magazine."

At end of Articles 42 and 44, insert "Transactions of the Highland and Agricultural Society."

Page 209, line 31, for graze it, read graze them.

Page 287, line 4, for out, read our.
PREFACE.

But few words of introduction can be necessary for this unpretending book. As regards its plan, it has no claim whatever to originality. Similar works, on other subjects than agriculture, have been published, and have been found useful in their respective departments; some, indeed, very extensively so. This volume is permitted to go forth into the world with the hope that it also may establish for itself a character of substantial usefulness; and, should that hope seem to be realized, it is intended to publish a similar volume every half year, so as to concentrate in a convenient form for reference, as much as possible of the varied and valuable information dispersed through a six months' series of our different agricultural journals.

A glance at the contents of the several chapters of this volume, will serve to show how important are the subjects contained in it; and the mere names of many of the talented and experienced authors of the different articles will be a passport to the confidence of the agri-
cultural community. The most studious and intelligent farmers, if actively engaged in agriculture, could rarely devote the time required for such a collection of information as is here offered to them, even were the expense of purchasing several journals of no consideration. And yet there is scarcely a single number of our ably conducted agricultural periodicals which does not contain some matter of interest or practical utility not to be found elsewhere.

The brilliant development of agriculture, which, within the last, comparatively, few years, has been steadily advancing from a state of vague and almost hopelessly unprogressive empiricism to the rank and dignity of a science, has, by increasing the amount of intellectual energy applied to it, also greatly augmented the sum of the *published* results of all that application: and already the task of comparing, sifting, condensing, seems to have become useful and necessary. This task it is attempted, in a very limited measure, and merely as an experimental essay, to perform in the following pages.

Should it be considered that too many extracts relating to the same class of subjects have been introduced in some parts of this work, it is hoped that, on reflection, the error, if such it be, may be regarded as one on the safe side. Into many minds it is very difficult to gain admission for important practical truths, which, therefore, need to be presented in all varieties of form. It requires a reiterated succession of blows to drive a nail well home into tough heart-of-oak. Cobbett clearly understood this when he kept his powerful
logic incessantly at work upon any opinion which he desired to force into the public mind.

Amongst the manifold imperfections incidental to a first volume, one omission may demand a special explanation. In a work, which it is desired to make, as strictly as possible, a record of practical suggestions and well-established principles, it has been deemed premature to introduce extracts from the many interesting and elaborate dissertations and notices which have appeared on the subject of the Potato Disease. The theory has yet to be constructed which shall comprehend and account for all the phenomena of that singular vegetable calamity. In the mean time, a patient accumulation of facts bearing upon the subject is the work to be done; and the Report of the Highland and Agricultural Society of Scotland on the Potato Disease, presents an instructive example of the kind of investigation that is needed. Extensive, however, as has been the field of this inquiry, and carefully as it appears to have been searched, the Report declares that "no satisfactory explanation of the predisposing causes of this destructive disease has yet been given; and that, of the theories promulgated on the subject, none seems calculated to lead to a practical conclusion."  

To the Editors of the several Journals who have so kindly and liberally permitted the Editor of this Book to avail himself of their respective publications, he begs

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1 See Transactions of the Highland and Agricultural Society of Scotland.—October 1846.
to offer his cordial and grateful acknowledgments. He hopes that the value of the extracts which he has made may induce many to have recourse to the original sources for the information which, in this work they can, for the most part, only have in a fragmentary form; and that thus, at least, he may have helped to advance the great cause of agricultural improvement; a cause, the promotion of which is daily becoming a subject more momentous and vital.

*London, March 1847.*
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In attempting to describe the properties which a good short-horn ought to possess, the difficulty would be lessened if they were all of one age and of one size; the relative proportions of each part might then be defined with precision and accuracy, so that, by applying the scale, the defects of symmetry would be immediately discovered: without such a test, we are left to form our own opinion from experience and observation of such animals as have met with general approbation.

In handling a beast, we proceed to put the hand on those parts usually called points, commencing at the rump, thence to the hip, loin, rib, crop, shoulder, neck-vein, fore-breast, back-breast, flank, twist, and udder or cod. Describing these several points so as to be carried into practice has always been found a most difficult undertaking, and for ever must remain so; it would be in vain, therefore, to suppose that these observations will be more successful.

The rump-bone, when the beast is in a lean state, should be about two inches off, and the upper part of it level or even with the under side of the tail. When the rump-bone lies near to the tail, it shows the smallest quantity of fat laid on that part; but the general dislike to this is proved by the name of "Tom Fool's Fat" being given to it. When narrow in this part, there is always a want of substance and lean flesh between that and the hip, and a part between them where the fat of the two points does not join together;
whereas, when the rump is farthest from the tail, the fat is continued from it to the hip. The distance from the hip and rump should be long and full of lean flesh; the hips should be wide, especially those of a female, which should be wider in proportion than those of the male. The shape of the hip is difficult to describe, but should be something like a round-pointed triangle, with one end hanging downwards, and on putting the fingers on to the centre a hollow will be found. The loin should be flat and wide; and when lean, two knobs, or pens, should be felt, which, when fat, will be the base of two ribs, called false ribs, which connect the hip and rib together in mass. The part commonly called "the space," from the hip to the rib, is generally recommended to be short; still it must be borne in mind that the beef on this part is of more value than any other; and if the loin be flat and wide, and the rib high and round, no ill effects will proceed from a moderate length of space, and it unquestionably gives that length and grandeur to the character of an animal which is very desirable: it is the want of a wide loin and round rib, and not the length of space, that causes gut. The rib should come well out of the back, and be broad, round, and deep. (It has been taught that the top of the back and underneath the belly should form two parallel lines, but there are few graziers who do not know the value of a deep body, more especially in a Highland Scot.) On putting the fingers and thumb on each side of the rib, and drawing them together, the skin should be thick, pliant, and mellow, and the hand be filled with long soft hair; and the feel underneath should be smooth and pleasant. The sensation derived from a fine touch is delightful to an amateur breeder, but cannot be defined: few things denote a good hardy constitution more than a thick soft skin, full of long hair. Putting the finger and thumb on each side of the rib as above described, is called "handling" in the North, but in the Midland and Southern counties it is generally called "quality." Whether that term had its origin at Smithfield we need not inquire, but certain it is that Mr. Charles Colling knew of no such word as applicable to inclination to fatten. "Quality" is frequently used to denote firmness of flesh, and sometimes it is misapplied, as in hardness of flesh, but seldom used to signify inclination to fatten: the mistake in this particular has done much harm to many herds of short-horns. Let handling and quality go together in a fat animal, and a good-bred short-horn will have weary beef, under a
loose, pliant hide, full of soft long hair; but in a poor beast, "handling" is the only test to discern the inclination to fatten. Handling is the most important subject we have to consider: it is the grand characteristic of a short-horn. Of what value would an animal be, possessed of perfect symmetry, if he could not be made fat without extraordinary keep? It has been said above, that it was Mr. Charles Colling's fine touch in this particular that enabled him to bring the Ketton short-horns to their unrivalled state of excellence: its importance has led me to dwell upon it at some length; but it is impossible to describe the kindly feel which is conveyed to the senses by the handling of a first-rate shorn-horn; yet the knowledge of it is absolutely necessary for a breeder to possess before he can bring his herd to any high state of excellence. The next point of consideration is the crop, in the shape of which, width of the back and roundness of the rib, but in a less degree, should be continued forward so as to leave no hollow behind the shoulders. The shoulder on the outside should have a roll of fat from the lower to the upper part of it; the nearer to the top, the more closely it connects the crop and the collar in front of the shoulder together. In the anatomy of the shoulder, modern breeders have made great improvement on the Ketton short-horns by correcting the defect in the knuckle or shoulder-point, and by laying the top of the shoulder more snugly into the crop, and thereby filling up the hollow behind it. This is an important improvement, but it may be questioned whether the great attention that has been paid to this has not been attended by the neglect of some other more valuable parts, for we now seldom find those long hind quarters so peculiar to the Ketton short-horns. Shoulders should be rather wide at the top; that is, they should not lie close to, nor be quite so high as, the withers; for when they are narrow at the top, and too oblique in shape, they never cover with fat over them properly, and the neck of such animals is often too low. Mr. Mason, of Chilton, whose attention was first drawn to this point, with his wonted skill succeeded to admiration: the prominent breasts and oblique shoulders of his beasts, on a side view, were perfect; but the shoulders were close and narrow at the top, and did not load with fat. The first evidence of this, of notoriety, was in the beautiful cow Gaudy (whose picture is to be seen in the first volume of the
"Herd-book"), who, when slaughtered, was barely covered in this point, although very fat in all other points.

The neck and head are not handling points; but I will briefly notice them before I turn to the lower part of the body: the neck should be thick, and tapering towards the head; a thin neck is strong evidence of a want of flesh and substance in other parts. There are various opinions on the shape of the head: some prefer it to be long and lean, whilst others approve of its being thick and short; but to be broad across the eyes, tapering considerably below them to the nostrils, which should be capacious, with a cream or flesh coloured muzzle, will be nearly correct; although it is but right to state that there are many well-bred short-horns with dark muzzles. This has been considered by many to be a recent introduction, through some inferior cross; but, without denying that, let it not be forgotten that some of the early short-horns were not entirely free from it, although not very common; but the sire of Foljambe could not boast of much delicacy there. The horn has often been called a non-essential, and in some respects that may be true; yet it must be admitted that a small moist white or yellowish horn, coming well off the head with a graceful circle and with a downward tendency at the end in a female, and an inclination upwards in an ox, contributes much to the character and appearance of an animal, and denotes a feeding propensity. The eye has had its fashion at different periods: at one time the eye high and outstanding from the head, and at another time the sleepy eye sunk into the head; but these extremes have merged into the medium of a full, clear, and prominent eye, with a placid look. The neck-vein forms a collar in front of the shoulder, extending from the upper part of it down to the breast end, connecting the fat on the shoulder with the fat on the breast, thereby promoting a uniform covering of fat throughout every part of a beast, commencing at the rump, and proceeding along the back to the hip, loin, rib, crop, shoulder, and breast, without patch, or any one part having excess of fat beyond that of its neighbour. The breast should come prominently out from between the fore legs, and extend down to about two or three inches of the knee-joint, and its width should never be lost sight of. An animal with a wide back and a wide breast cannot fail to have substance, fore flanks, wide fore legs, and other indications of a strong and vigorous constitution. A wide and fat breast should extend itself through the fore legs towards the
udder in rolls of fat. The flank should be full and easily found by the unbent fingers, without having to lift up the flank or close the fingers to find the fat: it should drop into the fingers, as it were. The buttock is a part that is not handled as a fat point, but should not pass entirely unnoticed, although in the best-bred short-horns there is little occasion for caution against the black flesh in this part, which some other animals have; but a want of lean flesh is as great an evil as an excess of it: it is necessary, therefore, that there should be great fulness nearly as low as opposite the flank, tapering from thence to the hock: this fulness should be on the inside as well as on the outside of the thigh, and give a full twist, lining the division between the hams with a continuous roll of fat to the next point under the belly.

Hitherto my observations have been confined to feeding propensities only, without any regard to the dairy. It is notorious, and much to their detriment, that many of the most superior short-horns do not possess that quality in an eminent degree. The annual loss to the breeder on each cow is very considerable, when we see that of two cows consuming an equal quantity of food, one gives six gallons of milk per day, and the other gives two only, this loss in milk will require much gain in beef to compensate for it. Cows for the dairy require to be of the same shape, and possessed of the same feeding propensities as have been attempted to be described above, with the addition of a well-shaped udder. When in full milk, the udder should be capacious and flesh-coloured, with paps standing square and at a distance from each other, the hind part to appear as if it proceeded from the twist: and it is the fore paps that give most milk: the milk-veins under the belly should be large and full. There is no test to determine beforehand whether a cow will give good milk or bad, but it is at all times very essential to rear bulls out of cows that are descended from a tribe of good milkers.

Having given a general outline of all the points of a good short-horn, there is still the outward contour and character deserving of notice. On viewing an animal, all the points described above are brought to our sight at once, and we can almost determine upon their merits at sight, without the more unerring test of the fingers. The placid looks, the graceful head, neck, and horns, the straight top, the prominent breast, the snug-laid shoulders, the wide back and hips,
the round ribs, the fine long quarters, the flowing silvery hair, the clean limbs, and great substance—all present themselves simultaneously, and give an impression that language cannot define. An artist, on looking at a painting, can instantly discern whether it is a highly-finished picture; but if called upon to describe its merits, he would, I presume, be at a loss for language to convey his feelings and judgment to an inexperienced person; and there is the same high finish in a good short-horn, attended with the same difficulty of explanation. Experience is universally allowed to be the best teacher; though, if we are left to our own experience alone, it will require a lifetime of no short duration to become a proficient.


Romely, May 6, 1846.

Art. II.—ON THE REARING OF CATTLE.

By Mr. C. W. Wood, of Woodhouse.

[This formed the subject of a paper read by Mr. Wood, at the June Quarterly Meeting of the Loughborough Agricultural Association. Mr. Wood confined himself strictly to the subject, not of breeding or of fattening, but of rearing stock; treating it under the following heads:—

1. The Constitution and Economy of Agricultural Cattle.  2. The State and Condition in which they exist.  3. Their Food and General Management.]

In the consideration of the substances which compose the animal frame and their qualities, a key may be found to many secrets in the general management of young cattle, particularly as regards their habits and their food. Science points out to us a framework of bones (the principal ingredients of which are phosphorus, lime, &c.), to give form, uprightness, stability, and strength to the machine; next an attachment of muscle (composed chiefly of fibrin or gluten), to give motion and activity to the body; and lastly, a respiratory and circulating apparatus, to supply heat, nourishment, and life to the whole, in order to resist the force of the chemical powers from without. Seeing, therefore, that we have a mixed machine to deal with, it is self-evident that
mixed or combined means are needed to carry out the first intentions of nature, and without which life could not exist. We must have, first, starch or sugar, to supply carbon for respiration; second, fat or oil, to keep up the fat which exists, more or less, in the bodies of all animals; third, gluten or fibrin, to supply muscle and cartilage; fourth, earthy phosphates, for the supply of bones; and fifth, saline substances, sulphates and chlorides, to replace what is daily rejected in the excretions.

The second proposition requires to be clearly defined, viz., the state or condition of animals. We find this to be threefold, each of which requires our anxious attention. We have, first, a foetal state, or one in connection with the mother, which exists before birth; secondly, a state of growth or development, which comprehends the period of birth to maturity; and thirdly, the state of the full-grown animal.

We have no control over the condition of the foetal animal, except through the medium of the mother, the general management of which I shall speak of presently. Of the second condition, nature must be closely observed, and carefully imitated, in order that the third or ultimate condition may be healthy, full-grown, and useful—the great object of the farmer, to repay him for all his expense, anxiety, and toil.

It is a very false economy to stint the allowance of food to a young animal. New milk, or the flour of all leguminous plants, such as beans, peas, lintels, &c., which contain casein, and an infusion of oil-cake to promote fat, seems nearly to approximate to the composition of ordinary milk, skimmed milk being destitute of the principal ingredient required by nature for the support of respiration. This, in addition to warmth and cleanliness, will always keep the vital powers predominant over the chemical—the cardinal point in the rearing of cattle.

I now come to my third proposition, viz. "their food and general management"—and a more important and profitable subject cannot engage your attention. It must be considered in detail. I will begin, therefore, as I proposed, with the foetal condition of the animal, and take a calf as a general example. It, like all other animals, is supported and nourished by the blood circulating from the mother through its own body, from the moment of its earliest formation up to the time of its birth—which blood contains, ready formed, all the various substances which are necessary for its forma-
tion. In addition, therefore, to all that is necessary for its own sustenance and existence, the cow forms a new and complete animal; it also secretes food for this new animal, which is to sustain and increase it for a considerable time after its birth; for the milk, like the blood, is the most perfect food, and contains every substance of which the body is built. When sucking is at an end, should we not imitate nature, a sure and unerring guide to philosophic truth? Any animal—whether cow, horse, sheep, or pig—having its own existence to support (I will add, in agricultural language, "in good condition"), a new animal to form, and one also to feed, is, to say the least of it, in a most important and interesting condition. Is such an animal to be sent to feed upon a scanty pasture, to be turned into a wet and miserable farm-yard, or kept upon straw, and an occasional turnip, until she is little better than a bag of bones; and then, forsooth, to expect a fine healthy offspring, with an abundance of milk for its sustenance? And if such brilliant expectations are not realized, the fault is to be laid upon the poor beast,—"She is not a good milker;" or to the land,—"It will not do for rearing, or for dairy purposes;" in short, upon anything rather than upon their own stupid, ignorant, and thoughtless minds. Breeding stock, gentlemen, cannot be kept too well; they are, in truth, feeding stock to others, and ought to have the best a farm affords; the best pastures in the summer, with cabbage, and common turnips in the autumn; Swedes, sweet straw, oil-cake, and hay in the winter; and in the spring, after calving, some mangel-wurzel, steamed potatoes, and hay, until the grass time again.

To nourish the young animal in the womb of its mother, an additional quantity of food must be given, and this quantity must be increased as the state of pregnancy advances; and the kind of additional food must readily supply the materials of the growing bones and muscles of the foetus, and contain a larger quantity of starch or sugar, also, than the mother in her ordinary state would require. This is required by the circumstance that the mother must now breathe for herself and her young—the quantity of blood is increased, more oxygen is taken in by the lungs, and consequently more carbonic acid is given off. A certain proportion of bone and muscle also must be supplied to the young animal by the food given to the mother, or the bones and muscles of the mother herself will be laid under contri-
bution to supply it; this must be effected by the quantity of phosphates, gluten, fibrin, or casein, which are given in the food with which the mother is fed.

An animal thus kept, will be in the most profitable condition to rear its young; and bear in mind, that as the calf grows rapidly, the food it requires increases daily with its bulk, and the demands upon the mother every day become greater. At this period, therefore, the cow must obtain larger supplies of food to sustain herself, and to produce a sufficient quantity of milk for her calf. If, then, adequate supplies are not given, a portion is daily taken from her own substance, which causes her to be lean and feeble, and her young stinted and puny in its growth.

What has been said regarding the food given to the cow, will be more or less effective in promoting the growth of the young animal fed solely on milk; when richer in curd, it will promote more muscle; when richer in phosphates, more bone; and in butter, more fat. Milk is a perfect food for a growing animal; nothing is wanted in it; the mother selects all the ingredients of this perfect food from the substances which are mingled in her stomach from the food she eats; she changes them chemically in such a degree as to present them to the young animal in a state in which it can most easily, and with least labour, employ them for sustaining its body, and all this at a given and appointed moment of time. In due time, the young animal begins to feed for itself; and then the mother improves in condition. Warmth, exercise, and good food are all that is then required, always bearing in mind that, as nature prepares the food for young animals in a state in which they can most easily digest it, so we should prepare by boiling or steaming all dry food and roots for the same purpose. In the growing animal the food has a double function to perform—it must sustain and it must increase the body; hence, whatever tends to decrease the sustaining quantity (and cold, exercise, and uneasiness do so) will tend in an equal degree to lessen the value of a given weight of food in adding to the weight of the animal’s body. To the pregnant and to the milking cow the same remarks apply. The custom of allowing young cattle to remain during the whole winter in straw-yards, exposed to all the variations of weather, cannot be too loudly condemned; oil-cake, it is true, which is sometimes given in large quantities, makes some small amends by the supply of carbon to the system; but if a warm, dry, and clean shed was
substituted, with turnips instead of cake, the condition and quality of the animal would be very much improved, and a considerable saving of expense be effected, to say nothing of the improvement in the manure.

All vegetables contain, ready formed (which they extract from the food on which they live), the substances of which the parts of animals are composed. The animal consequently draws, ready formed, the materials of its own body from the vegetable food it eats. The starch, sugar, and gum in vegetables are to supply carbon for respiration. Carnivorous animals obtain it from the fat of the food; starving animals from the fat of their own bodies; and young animals, which live upon milk, by the milk sugar it contains. In the young animal we find an excess of life; it has to increase as well as sustain itself. In the full-grown animal we find the daily waste of substance which is carried out of the body in the excretions, made up by the gluten, phosphates, and the saline substances in its food, and a balance kept up between the powers of life and the bodily structure it simply has to sustain itself. In the old animal, when life is diminished, we observe a proportionate decrease of bodily substance.

It is interesting and wonderful, when we thus trace the existence of the bodily structure of all animals ready formed in the vegetable—which property in vegetables is formed during their growth—is derived from sources purely gaseous and inorganic, by chemical, mechanical, and physical operations. It is the duty of the practical farmer to adopt these methods for improving the soil; but this forms no part of my subject.

Sheep.—The additional value to your flock, by this mode of management, and especially in giving them some dry food, such as hay or corn, before lambing is very great. It gives firmness of fibre, and adds greater vigour to life, a greater activity to the vital powers, by which alone it is capable of resisting disease, and of arriving at an early maturity. The improvement of the fleece, by such a course, will be fifty per cent. The old breed were kept from two years to two years and a half old before sold, and rarely exceeded 10 lb. or 15 lb. a quarter. It is true, breed has much to do with this question; but in sheep of the same breed, kept in different ways, a difference of twenty-five per cent. may be frequently observed. To insure a healthy offspring,
a good fleece of wool, and of sound staple, sheep require to be kept well, in the spring months particularly.

**Pigs.**—Pigs ought never to lose the fat or condition they receive from the mother, which is easily kept up by milk, peas, or beans, and all of which contain flesh. A small quantity of oil-cake, once or twice a day, in addition to turnips, mangel-wurzel, or any vegetable food; fed in this way, many months are saved in time, and you have the advantage of summer feeding, which, on account of the warmth, is by far the best period of the year for this purpose.

**Horses.**—I need only say that where great muscular development is required, as in the case of race-horses which run for the two-year-old stakes, they are corned very high as soon as they can eat it; and it is astonishing to see the strength and activity resulting from such a plan. Early maturity is very profitable here. Give your yearlings plenty of oats and beans, with steamed potatoes during the winter, and you gain a complete year in time, besides the increased value you put upon the animal: and in the summer feed them upon rye, dills, or clover, the best possible food for horses. The sooner they are broken the better; their tempers become quieter, and they thrive more. I wish to mention here the great value of salt to all young animals; it destroys bots and worms, it promotes digestion, and assists the secretion of healthy bile, the medium through which respiration is supported; this, however, should be given in moderate quantities.

Having now spoken upon the general management of the various kinds of cattle usually reared by the farmer, I shall conclude with a few remarks upon their food; and I deem you will not consider this out of place. The amount of food either for man or beast which a given acre will produce depends considerably upon the kind of crops which is raised. Thus, a crop of thirty bushels of wheat will yield only about 1400 lb. of fine flour, while a crop of six tons of potatoes will give about 4400 lb. of an agreeable, dry, and meally food.

It is said, on the authority of the Board of Agriculture, that a crop of clover, tares, rape, or potatoes, cabbage, or turnips, will furnish at least three times as much food for cattle, as an equal breadth of pasture-grass of medium quality. This, however, being but a hint, I will at once give you a table of the nutritive qualities of the various sorts of food now in common use. It is selected with some care from the various
tables published, and has direct reference to the subject before us, on account of the proportions of gluten, starch, and oil which each article contains.

In the root crops I place first carrots; second, mangel-wurzel; third, Swedes; fourth, potatoes; fifth, cabbage; sixth, common turnips.

In the green crops—first, dills; second, rye; third, clover; and fourth, grass.

In the corn crops—first, beans; second, peas; third, linseeds; fourth, wheat; fifth, barley and Indian corn; sixth, oats; seventh, rye; eighth, buckwheat.

In the straw crops—first, pea-straw, which is nearly equal to hay; second, oat and barley straw; fourth, wheat-straw; fifth, rye-straw; and sixth, bean-straw.

Three pounds of oil-cake are equal to about ten pounds of hay.


Art. III.—ON THE BREEDING, REARING, AND FEEDING OF CATTLE,

WITH A VIEW TO EARLY MATURITY, AS PRACTISED BY THE WRITER FOR UPWARDS OF TWENTY YEARS.

BY GEORGE LOWES RIDLEY, ESQ., BANKS HALL, NEAR BARNSLEY.

If experience in any particular branch of business is to be gained from a length of servitude, I may fairly be allowed to claim to myself that privilege; and it is for the benefit of the younger branches of my brother farmers, that I attempt to make known to them my system of rearing and feeding my own stock, not with any view of showing up my management as superior to that of many other breeders more fortunate than myself.

Firstly, I must strongly impress on all farmers whose farms are adapted to the rearing of stock, that their first great object should be to possess themselves of a good and
useful lot of cows—good well-formed short-horns (not too high-bred), with plenty of substance, good sound constitution, plenty of soft hair, and of good quality; above all, good milkers, as the number of calves reared will depend much upon the quantity of milk produced. The next most important object is a first-rate bull, whose substance, constitution, and quality must, if possible, excel that of your cows; for it is now an admitted and well-authenticated fact, that the sire has more to do with the progeny than the dam, and that, as "like begets like," so you ought to be the more careful in selecting a good sire, with a good frame and great inclination to fatten. And I would strongly urge upon the breeder whose yearly cast of stock is an object to him, never to use a bull from his own herd, but, if possible, to procure a yearling from some well-known stock when need requires.

Secondly, I should recommend, where a herd of from eight to twelve cows are kept, that not less than three or four should drop their calves in the latter part of November or beginning of December. Calves are, with proper care, easily brought through the winter, and with less milk, it being supposed that you have by you a supply of hay, cakes, and turnips; the latter of which they are soon taught to eat, if cut into small slices, and put into their mouths to suck, two or three days running, by their attendant; this, with the addition of one or two pounds of cake per day, and plenty of good seed hay, will quickly bring them forward to do without milk. And here I will take the liberty of impressing upon the breeders of stock the absolute necessity of proper ventilation and cleanliness in their calf pens, which ought all to be boarded with slabs, and raised about ten or twelve inches from the ground, either leaving a space of an inch and a half between each slab, or perforating the slabs with a number of holes to allow their water to pass off into a gutter or drain, which will not only keep the pens dry, but prevent all unpleasant smells. Each pen should be large enough to contain two milk calves, with a larger one to remove them to as they get older, and are taken off milk; each pen should be furnished with a small rack and trough, and a place to fix in either a piece of chalk or rock-salt for the calves to lick, which will add very materially to their general health. With three or four cows, you will easily rear six or eight calves through the winter, which you would be able to put to grass nearly as good as yearlings; and as you can
quit your fat stock in the spring or first cast, you will be able to remove the oldest calves into the feeding sheds, where they will have more room, and be better prepared for turning into pasture at the proper time. As it will be necessary to purchase calves to make up your cast of stock, I have generally made a bargain with some of my neighbours or cottagers, who dispose of their calves, to send cows that I approve of to my bull, and taking the calf, if I like it, at a fixed price, two days after it is dropped, which I have found a ready way of making up my number of calves. I should strongly recommend to all breeders not to attempt to rear more calves than is required for a regular yearly cast of stock; it is more profitable to do a given number well, than a great number badly, to say nothing of the great liability to disease of the poor half-starved animal.

Thirdly, Your next lot of cows should begin to drop their calves about the end of February, none later than May-day (and those last always your first calf heifers). Calves dropped about this time require more milk and more attention to get them through winter than the older calves, and are much more subject to local complaints; as also, from their size, they spoil the uniformity of your cast of stock. Your summer calves should have new milk at least four weeks, if not six; and the milk should be given three times in the day, as it is better and more natural to give six quarts at three times than twice; the calves thrive better and keep their forms better, and are not so liable to get what is termed "pot-bellied." When it is not convenient to have milk from the cows in the middle of the day, I should recommend the morning's milk to be given, with a little warm water added, to give it the proper heat, for the calves under six weeks old; the older ones will do with a little old milk at mid-day. The writer has found it a very good plan, when milk was scarce, to boil linseed for the older calves, and give this in their new milk when it is found necessary to increase their quantity; by this plan you have a greater quantity of new milk at your disposal for the younger calves. After my calves get past their sixth week, their new milk is gradually decreased, and the quantity made up of old milk, until the new is taken off them entirely, and their food is then linseed and old milk till they are twelve weeks old; they are then gradually weaned with a drink of milk and water, and a pound of cake allowed twice a day (if thought necessary), with a good, well-sheltered pasture and
a plentiful supply of water, and, if possible, a shed to retire into at pleasure, which will protect them from both sun and rain. The linseed is best prepared by steeping in cold water from morning to night, and from night to morning; and when put upon the fire, not to boil more than twenty minutes, thereby retaining more of the essential oil, a great part of which is too frequently evaporated in steam by an excess of boiling; thereby rendering the food less nutritious.

When your cows are put to grass in the spring, they will improve in their milk, so as to enable you to allow your last dropped calves a plentiful supply of milk thrice in the day, by which means you must try to get them up to the older calves both in size and condition (and this may be done by continuing their new milk two or three weeks longer, or, if butter is an object, by giving, after they are six weeks old, half new milk for a few weeks); for nothing adds so much to the beauty of a young stock, as to have them well matched both in size and condition.

After your calves are weaned, they must be forced forward with the best keep you can afford them, such as clover fog, old land fog, or young seeds; but care should be taken that they never go upon clovers after rain, or when there is dew upon them; for at such times they are liable to get hoven, or, if not, the effect of too much damp luxuriant food taken upon the stomach is more than likely to produce other complaints, and none sooner than that fatal one known as black quarter.

About the middle or end of October, they should be brought into a shed at nights, or, if the weather be cold, taken in for winter; they should then be supplied regularly with good seed hay, and Swede turnips, cut, with one or two pounds of cake each per day, and a plentiful supply of litter, never forgetting that cleanliness is half meat. Choose the warmest and best sheltered sheds for your young stock, as they are most liable to take cold; in the following spring they will go out fresh to a good pasture; and, if fortunate, will come up in October good rough beef, and then be put on full turnips, with oat straw and a few pounds of cake per day; about the following March or April, your first lot of winter calves will be fit for the butcher, being then two years and four or five months old. Your next lot of spring calves must then be pushed forward, and by the end of May will also be fit for the butcher (they being about two years and four months old), and may either be sold or put to grass
a few weeks, as deemed advisable, according to the then state of the markets.

In conclusion, the writer begs to state that under this system of management he has sold his cast-off stock for from 16/ to 21/., their price being partly regulated by a greater or less number of steers, as well as the price of beef at the time of the selling of the stock.


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Art. IV.—ON SOILING AND SHED-FEEDING.

By John Bravender, F.G.S., Surveyor, Cirencester.

Shed-feeding sheep, stall-feeding cattle, and soiling, are practices which will gradually force themselves on the farmer's notice. It is also more profitable to keep working horses and oxen in yards on clover, vetches, and sainfoin; and were the plan to be generally adopted, all the land on which they have hitherto been grazing would be better broken up. Those lands are, generally speaking, not of the best quality, and for that, amongst other reasons, would answer better under the plough than in pasture. It may be so said of dairy cows, but that cannot be realized until we shall have advanced some steps further in agricultural science, and are enabled to make good butter and cheese from seed pasture, vetches, sainfoin, clover, and roots. If we could accomplish this, cows might be soiled in yards, and supplied with food from the arable land, which would be the means of creating a vast amount of additional employment for the labourer, independent of the breaking up of their former pastures. Nearly all the lands occupied by dairy farming might then be broken up, without fear of a scarcity of cheese, butter, or milk. Should the time ever arrive when even half of the land thus occupied can be spared to be converted into arable, we shall increase our produce of food for man and beast to an amazing extent, and there would not be found a man, who is willing and able to
work, out of employment: and what is more, the labourer would obtain fair wages for his services, in consequence of the removal from the market of his brethren, who have hitherto been driven to the necessity of underbidding him, and who have been involuntarily running a race with him to obtain employment.

*Jour. of the R. A. S. E. vol. vii. part 1.*

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**Art. V.—ON STALL-FEEDING.**

**By the Editor of Farmer’s Almanac.**

This is the month (October) when stall-feeding is very commonly commenced. Here, again, it is gratifying to find how well the observations of the practical farmer and those of the man of science illustrate each other. The first point, says Mr. G. Dobito,¹ is to have a good sort of animal to begin upon. Never buy a coarse half-bred beast because you may fancy it is cheap; note its points—its temper; do not regard merely the heaviest; always, therefore, select the beasts before purchasing, rather than agree to give a certain price per head to pick where you like from the drove; attend to quality more than form. Tie up in October. In the feeding, the great points to be attended to are, cleanliness, warmth, quiet, and good and regular feeding. When fat, sell them to butchers at home if you can; estimate the weight and value of your bullocks the day before any one is coming to buy them, and after letting the butcher handle and examine them well, let them out into a yard for him to see; they will always show better than when tied up. According to Mr. Hillyard, beasts should increase in the 1st month 64 lbs., in the second 80 lbs., in the last fortnight 48 lbs., in the ten weeks 192 lbs. In some experiments by Mr. J. H. Leigh,² with thirty beasts, each daily fed as follows (to this was added, March 10, either 2 lbs. per head of hay, valued at 6d. per week, or about an equal value of Indian corn, bean-meal, crushed wheat, or sugar):

² Ibid. p. 237.
ON STALL FEEDING.

4 lbs. of oil-cake, at 9l. per ton ...... s. d. 2 6
4 ,, of bean-meal, 7d. ...... 2 4
10 ,, of cut oat straw, 2s. 6d. per cwt. ...... 1 5½
20 ,, of turnips or beet, at 20s. per ton ...... 1 3

Weekly cost each ...... 7 8½

These thirty beasts being weighed, were found to have gained from—

February 5 to February 17—12 days .......... 2124 lbs.
,, 17 to ,, 24—7 days .......... 1531 ,, 
,, 24 to March 3—7 days .......... 1036 ,, 
March 3 to ,, 10—7 days .......... 811 ,, 
,, 10 to ,, 17—7 days .......... 648 ,, 
,, 17 to ,, 24—7 days .......... 603 ,, 
,, 24 to ,, 31—7 days .......... 554 ,, 
,, 31 to April 7—7 days .......... 539 ,, 
April 7 to ,, 14—7 days .......... 527 ,, 
,, 14 to ,, 21—7 days .......... 566 ,, 

Total .......... 9111

It forms, as Mr. Karkeek remarks, a curious and instructive subject for the feeder to ascertain the respective fleshing and fattening properties contained in the produce of an acre of the different crops commonly used in the rearing and fattening of stock. In the following table the proportions of gluten, &c., will indicate the fleshing properties, and the starch, &c., the fattening properties—

<table>
<thead>
<tr>
<th>AN ACRE OF—</th>
<th>Gluten, Albu-</th>
<th>Starch, Gum, Sugar, &amp; Fat.</th>
<th>Water.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carrots, or 25 tons</td>
<td>1120</td>
<td>5800</td>
<td>47600</td>
</tr>
<tr>
<td>Turnips, or 30 tons</td>
<td>800</td>
<td>6700</td>
<td>56950</td>
</tr>
<tr>
<td>Potatoes, or 12 tons</td>
<td>600</td>
<td>3330</td>
<td>20250</td>
</tr>
<tr>
<td>Hay, or 3 tons</td>
<td>480</td>
<td>2780</td>
<td>752</td>
</tr>
<tr>
<td>Beans, or 25 bushels</td>
<td>450</td>
<td>672</td>
<td>256</td>
</tr>
<tr>
<td>Peas, or 25 bushels</td>
<td>380</td>
<td>845</td>
<td>208</td>
</tr>
<tr>
<td>Oats, or 50 bushels</td>
<td>290</td>
<td>1168</td>
<td>336</td>
</tr>
<tr>
<td>Wheat straw, or 3000 lb.</td>
<td>40</td>
<td>940</td>
<td>450</td>
</tr>
<tr>
<td>Oat straw, or 2700 lb.</td>
<td>36</td>
<td>970</td>
<td>324</td>
</tr>
<tr>
<td>Barley straw, or 2100 lb.</td>
<td>28</td>
<td>616</td>
<td>252</td>
</tr>
</tbody>
</table>

The milk of animals contains the same ingredients in varying proportions; these are—¹

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Casein or curd</td>
<td>4:5</td>
<td>1:8</td>
<td>4:1</td>
<td>4:5</td>
</tr>
<tr>
<td>Butter</td>
<td>3:1</td>
<td>0:1</td>
<td>3:3</td>
<td>4:2</td>
</tr>
<tr>
<td>Milk sugar</td>
<td>4:8</td>
<td>6:1</td>
<td>5:3</td>
<td>5:0</td>
</tr>
<tr>
<td>Saline matter</td>
<td>0:6</td>
<td>0:3</td>
<td>0:6</td>
<td>0:7</td>
</tr>
<tr>
<td>Water</td>
<td>87:0</td>
<td>91:7</td>
<td>86:7</td>
<td>85:6</td>
</tr>
</tbody>
</table>

It is very important to know how much water each kind of food contains. The following table, drawn up by Dr. Playfair, exhibits the amount of dry organic matter contained in various kinds of food:—

<table>
<thead>
<tr>
<th>Food</th>
<th>Water Matter</th>
<th>Organic Matter</th>
<th>Ashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 lb. of oatmeal contain 9 lb.</td>
<td>89 lb.</td>
<td>2 lb.</td>
<td></td>
</tr>
<tr>
<td>bran</td>
<td>14</td>
<td>81</td>
<td>5</td>
</tr>
<tr>
<td>peas</td>
<td>16</td>
<td>89½</td>
<td>3½</td>
</tr>
<tr>
<td>beans</td>
<td>14</td>
<td>82½</td>
<td>3½</td>
</tr>
<tr>
<td>barleymeal</td>
<td>15½</td>
<td>82½</td>
<td>2</td>
</tr>
<tr>
<td>lentils</td>
<td>16</td>
<td>81</td>
<td>3</td>
</tr>
<tr>
<td>hay</td>
<td>16</td>
<td>76½</td>
<td>7½</td>
</tr>
<tr>
<td>linseed cake</td>
<td>17</td>
<td>75½</td>
<td>7½</td>
</tr>
<tr>
<td>wheat-straw</td>
<td>18</td>
<td>79</td>
<td>3</td>
</tr>
<tr>
<td>oats</td>
<td>18</td>
<td>79</td>
<td>3</td>
</tr>
<tr>
<td>turnips</td>
<td>89</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>Swede turnips</td>
<td>85</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>mangel-wurzel</td>
<td>89</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>white carrot</td>
<td>87</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>potatoes</td>
<td>72</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>red beet</td>
<td>89</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

Warmth is an equivalent for food; food, therefore, may be economised by protecting cattle from the cold.

The observations of Dr. Lyon Playfair ² on the food of animals, will be read with the highest interest by the practical farmer. He remarks, “All vegetable food has been found to contain a peculiar substance—gluten, or albumen, which is precisely identical, in chemical composition, with the albumen obtained from the white of an egg. This substance, invariably present in all nutritious food, is quite identical with the flesh and blood of animals. By identity in composition, is not meant a mere similarity, but an absolute identity.” In support of this conclusion, let the farmer compare the result of the chemical examination of 100 parts of each of these varieties:—

Thus we are led to the startling conclusion that plants contain within them the flesh of animals ready formed, and that the only duty of animals subsisting upon them is to give this flesh a place and form in their organism.

In the following table, by Professor Johnston, the proportions of starch, gum, and sugar, will give a rough approximation as to the per-cent age of fat or tallow which the food is capable of yielding; whilst the gluten, albumen, and casein will give a correct indication of its flesh-forming power:

<table>
<thead>
<tr>
<th>100 parts of</th>
<th>Water</th>
<th>Husk or woody fibre</th>
<th>Starch, gum, &amp; sugar</th>
<th>Gluten, albumen, &amp; casein</th>
<th>Fatty matter</th>
<th>Saline matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field beans</td>
<td>16-0</td>
<td>10-0</td>
<td>40-0</td>
<td>28-0</td>
<td>2-0</td>
<td>3-0</td>
</tr>
<tr>
<td>Peas</td>
<td>13-0</td>
<td>8-0</td>
<td>50-0</td>
<td>24-6</td>
<td>2-8</td>
<td>2-8</td>
</tr>
<tr>
<td>Barley</td>
<td>15-0</td>
<td>15-0</td>
<td>60-0</td>
<td>12-0</td>
<td>2-5</td>
<td>2-0</td>
</tr>
<tr>
<td>Oats</td>
<td>16-0</td>
<td>20-0</td>
<td>50-0</td>
<td>14-5</td>
<td>5-6</td>
<td>3-5</td>
</tr>
<tr>
<td>Meadow hay</td>
<td>14-0</td>
<td>30-0</td>
<td>40-0</td>
<td>7-1</td>
<td>2- to 5-</td>
<td>5- to 10-</td>
</tr>
<tr>
<td>Clover hay</td>
<td>14-0</td>
<td>25-0</td>
<td>40-0</td>
<td>9-3</td>
<td>3-0</td>
<td>9-0</td>
</tr>
<tr>
<td>Potatoes</td>
<td>75-0</td>
<td>5-0</td>
<td>12-0</td>
<td>2-25</td>
<td>0-3</td>
<td>0-8 to 1-</td>
</tr>
<tr>
<td>Carrots</td>
<td>85-0</td>
<td>3-0</td>
<td>10-0</td>
<td>2-0</td>
<td>0-4</td>
<td>1-0</td>
</tr>
<tr>
<td>Turnips</td>
<td>85-0</td>
<td>3-0</td>
<td>10-0</td>
<td>1-2</td>
<td>—</td>
<td>0-8 to 1-</td>
</tr>
<tr>
<td>Oat straw</td>
<td>12-0</td>
<td>45-0</td>
<td>35-0</td>
<td>1-3</td>
<td>0-8</td>
<td>6-0</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>12- to 15</td>
<td>50-0</td>
<td>30-0</td>
<td>1-3</td>
<td>0-5</td>
<td>5-0</td>
</tr>
</tbody>
</table>

_Farmer’s Almanack, 1846._
Art. VI.—ON BOX-FEEDING CATTLE.

By Mr. Glover.

[The following is extracted from a very instructive paper by Mr. Glover, lately read before the Newcastle Farmers' Club, of which he is Honorary Secretary,]

It is almost impossible for any one who has not seen and paid attention to the subject, to form a correct estimate of the advantage of box-feeding cattle. The plan is extremely simple and feasible, which is one of its greatest recommendations. The advantage of feeding cattle in boxes consists in the absence of all waste of food, which in a yard it is impossible to prevent. It affords the opportunity of placing before the animal an equal portion of food, which cannot be the case in a yard where cattle are indiscriminately mixed. It allows each animal to eat at its leisure, ruminate unmolested, and take its rest undisturbed. In yards where there are a number of cattle, the master cattle consume the choicest part of the food; they drive the weak ones about, and allow them little rest. Hence the great inequality observable in the condition of yard-fed cattle compared to those fed in boxes; and hence the astonishment so often expressed by farmers that after their fattest cattle have been sent to market, the remainder thrive rapidly. It is then perceived that those cattle which appeared the least prone to fatten would perhaps have been the most forward in condition, had they been separated from others. In fact, the system of feeding cattle in boxes can be regulated to the greatest nicety; while that in the yards must ever remain slovenly, wasteful, and imperfect.

I shall now proceed to give you a description of the boxes, according to the plan of Mr. Warnes. We will suppose that you wish to erect ten boxes, for which you will require a space of 90 feet long, and 12½ wide; then let a line be drawn from one end to the other, 3½ feet wide, from the side most convenient for the passage. Next, let the mould, to the depth of a foot, be excavated from the other part, and thrown on the side intended for the front, and spread to the thickness of a foot deep. This will give 2 feet from the bottom of the boxes to the surface. A wall of brick-work, 4 inches wide and 2 feet high, is next to be built round the inside of
the part excavated, and intersected at distances of 8\(\frac{1}{2}\) feet. At each angle the brick-work should be 9 or 12 inches square, which will both support the posts and afford strength and durability. Upon the wall a sill of wood is next to be placed; for which purpose large poles, either square or split, are adopted. The foundation being now complete, posts 6 feet long, and the necessary sills and ties, may be placed upon it. Across the ties the most ordinary poles may be laid to support a roof composed of the trimmings from hedges and ditches, and completed with a thatch of straw or rushes. Two gates must be added to each box; one of which moves on hinges, and the other to be secured at the top and bottom sills of the building, so as to be taken down at pleasure. Presuming that we have taken advantage of a barn, or other walls or farm premises, the external part is finished; the internal has merely to be parted off with a few poles between each box, and the passage separated by the cribs, which are to move up and down between the interior posts, which are placed upon the angles of each box, and support the roof on the passage side.

Such boxes as I have described, where advantage can be taken of an unoccupied wall (which ought to be from 6 to 8 feet in height), may be erected for 30s. each. These boxes are 8\(\frac{1}{2}\) feet square. From what I have seen, I think that they would be too small for our large short-horns; they should be from 9 to 10 feet square. I would not recommend them to be made larger than 10 feet, for if so the manure will not get properly trodden down. Good strong substantial boxes, back wall 8 feet high, interior 10 feet square, and with slatted roof, can be erected in this neighbourhood for £7. 15s. Each box acts as a small tank, the whole of the urine being taken up by the straw, or other absorbents; such as sawdust, dry mould, &c. If cattle are properly littered in this way, the manure will only rise about 3 inches in a week, it becomes compressed into a hard compacted mass, turning out about 5 or 6 cubic yards of manure, two loads of which being equal to three made any other way by cattle.

I shall now proceed to describe the different things that are required for making the "cattle compound." The only apparatus required for carrying out the system is a linseed-crusher, an iron cauldron, a hand-cup, a stirrer, one or two hogsheads, two or three pails, and a wooden rammer. The probable cost will be about 12l. Large cauldrons are found inconvenient for stirring where compounds are made with
the meal of peas, beans, &c. The size most preferable are those to contain from 30 to 40 gallons. The stirrer is an iron spoon fastened to a shaft of wood 4 feet long. The rammer is 3 feet long, about 5 inches square at the bottom, and 2½ inches at the top, through which a pin 14 inches long is passed, for the convenience of being raised with both hands. The compounds are made as follows:—Upon every six pails (a pail is supposed to contain six gallons) of boiling water, one of fine crushed linseed is sprinkled by the hand of one person, while another rapidly stirs it round. In five minutes, the mucilage being formed, a half hogshead is placed close to the cauldron, and one bushel of turnips or tops and cut straw are put in. Two or three hand-cupsfuls of the mucilage are then poured upon it and stirred. Another bushel of the cut turnips, chaff, &c. is next added, and two or three cups of the jelly as before, all of which is expeditiously stirred and worked together with the stirrer and the rammer. It is pressed down as firmly as the nature of the mixture will allow with the rammer, which completes the first layer. Another bushel of the cut straw, chaff, &c. is thrown into the tub, the mucilage poured upon it as before, and so on until the cauldron is emptied. The contents of the tub are, lastly, smoothed over with a trowel, covered down, and in two or three hours the straw, having absorbed the mucilage, will also, with the turnips, have become partially cooked. The compound is then usually given to the cattle, but sometimes allowed to remain till cold. The cattle, however, prefer it warm; but whether hot or cold, they devour it with avidity. Either potatoes, carrots, turnips, or mangel-wurzel, boiled and incorporated with linseed meal, form a compound upon which cattle fatten with great rapidity. To make it, nothing more is required than to fill the cauldron with washed potatoes, or carrots, &c. sliced. Supposing the cauldron would contain eight or nine pails of water, let only one be added. In a few minutes the water will boil, and the steam will speedily cook the roots, then a convenient portion should be put into the half hogshead, with a little linseed meal, and smashed with the rammer. The remainder must be prepared in the same way. As the mass increases in the tub, it should be pressed firmly down, in order that it may retain the heat as long as possible.

In the spring and summer months, germinated barley may be made into a compound with great advantage, mixed with linseed, cut clover, grass, or lucerne; cattle eat it with
great avidity, and thrive fast upon it. The process is simple—let some barley be steeped about two days, and the water drained off. After the radical or root has grown to nearly a quarter of an inch in length, it must be well bruised by the crushing mill, and as much as possible forced into some boiling mucilage, containing the same quantity of linseed, but a fourth less of water than would have been prepared for dry barley. Care must be taken lest the sprouts are suffered to grow beyond the prescribed length, or the quality will be materially injured; therefore it will be necessary to destroy their growth, by passing the barley through the crushing mill. It may then be used at pleasure. In August, when I was at Trimingham, Mr. Warnes was using wheat for his compound, as he found it was more profitable to feed his cattle upon it than to sell it at the price then offered. The wheat was steeped for twenty-four hours, then taken out of the steep, and allowed to sprout, which it did in two or three days; it was then put through the crushing mill. Three pails of wheat were put into the boiling cauldron, containing seven pails of water, it was well stirred, and one pail of crushed linseed was sprinkled into the cauldron; a layer of cut clover, chaff, &c., was put into the half hogshead, two or three of the hand-cupfuls of the boiling mucilage was then poured upon the cut clover, &c., it was then well stirred and rammed down, and the same was repeated until the cauldron was emptied. To lay down any general rule for making the compound would be to destroy one of the great advantages of the system; provide yourselves from the resources of your farms, with whatever is necessary to form cattle compound. The superiority of the cattle compound to foreign oil-cake is explained by the fact that the one, at the best, is merely the refuse of linseed; while the other is made of the seed itself. The real fattening properties of the compound is in the linseed; and that in order to produce a greater or less effect it is only necessary to regulate the quantity of that important ingredient. Wheat, oats, barley, straw, or bean stalks, may be used either with or without turnips, according to circumstances; nothing more being required than fibrous matter to act as a vehicle for conveying the linseed to the stomach of the animal, and for reconveying to the mouth for rumination.

The following compound may be used with great advantage for feeding sheep:—Let a quantity of linseed be re-
duced to fine meal, and barley to the thickness of a wafer, by the crushing mill. Put 18 gallons of water into the cauldron, and as soon as it boils, not before, stir in 21 lb. of linseed meal; continue to stir it for about five minutes, then let 63 lb. of crushed barley be sprinkled by the hand of one person upon the boiling mucilage, while another rapidly stirs and crams it in. After the whole has been carefully incorporated, which will not occupy more than five or ten minutes, cover it down, and then throw open the furnace door; should there be much fire put it out. The mass will continue to simmer, from the heat of the cauldron, till the barley has absorbed the mucilage, when the kernels will have resumed nearly their original shape, and may justly be compared to little oil-cakes, which, when cold, will be devoured with great avidity. I have no doubt some of you will be apt to say, oh! but there is a great deal of labour attending the labour. A lot of twelve beasts were equally divided by Mr. Postle, six were fed on oil-cake, and six on Mr. Warnes's compound. The account of their food was kept with scrupulous accuracy for nearly six months. The following were the results:

<table>
<thead>
<tr>
<th>Expense of oil cake</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21</td>
<td>14</td>
<td>9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expense of compound</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19</td>
<td>6</td>
<td>1½</td>
</tr>
</tbody>
</table>

Balance in favour of compound |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>£2 8 7½</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dead weight.</th>
<th>Loose fat.</th>
<th>Hides.</th>
</tr>
</thead>
<tbody>
<tr>
<td>st. lb.</td>
<td>st. lb.</td>
<td>st. lb.</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
<td>--------</td>
</tr>
<tr>
<td>Six cattle fed on compound</td>
<td>432 7</td>
<td>55 9</td>
</tr>
<tr>
<td>Six ditto oil cake</td>
<td>387 12</td>
<td>51 7</td>
</tr>
</tbody>
</table>

Difference of weight in favour of compound |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>44 9 4 2 1 9</td>
</tr>
</tbody>
</table>

So that we have in favour of the cattle compound upon the six beasts—44 st. 9 lb. at 6s. 6d. per stone |
| £  | s. | d. |
|-------------------|
| 14 10 2           |

Difference of expense of compound |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2 8 7½</td>
</tr>
</tbody>
</table>

Total difference in favour of compound |
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>£16 18 9½</td>
</tr>
</tbody>
</table>

By this system of feeding Mr. Warnes says that he could compete with the foreigner, as he could send cattle to market at 4½d. per lb., and pay himself an ample return. Since he had followed the system of box-feeding, he knows not of a single instance where he has not realized 8l. for every head of cattle he kept for six months. At the farm where he now
resides, he fattened last winter for market the following cattle, after being six months box-feeding:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seven Durham steers, cost 8l. 10s. each, sold for 19l. 10s. each</td>
<td>£ 77 0 0</td>
</tr>
<tr>
<td>Six Scotch steers, cost 10l. each, sold for 22l. 10s. each</td>
<td>£ 75 0 0</td>
</tr>
<tr>
<td>One cow, cost 5l. 5s., sold for 15l.</td>
<td>£ 9 15 0</td>
</tr>
<tr>
<td>Four Scotch steers, cost 10l. each, sold for 20l. each</td>
<td>£ 40 0 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£201 15 0</strong></td>
</tr>
</tbody>
</table>

The above cattle were bought in and disposed of within six months. They consumed, with the following now in herd, 19 acres of turnips, about 14 quarters of linseed, and a few bushels of barley-meal, with several acres of pea straw:

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three Durham heifers, estimated value above the cost price</td>
<td>£ 22 10 0</td>
</tr>
<tr>
<td>Two Irish steers</td>
<td>£ 13 0 0</td>
</tr>
<tr>
<td>Five small steers and heifers</td>
<td>£ 30 0 0</td>
</tr>
<tr>
<td>Three calves, and butter from two cows</td>
<td>£ 18 10 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£285 15 0</strong></td>
</tr>
</tbody>
</table>

Deduct, for 14 qrs. of linseed, mostly grown upon the farm, 35l., also for barley, 4l. | £ 39 0 0      |

Leaves a return of | £246 15 0

The next item of profit is the manure, to form a just estimate of which is impossible; of course the rent of the land, rates, &c., and expenses for attendance, &c., must be enumerated to show a clear profit; but the utmost allowance that the severest critic could make, would leave a balance unprecedented in favour of box-feeding. In bringing this paper to a conclusion, I cannot do so without strongly urging upon you all to follow the system so successfully and profitably carried out by Mr. Warnes—a system by which you can double the number of cattle usually kept on your farms, you can turn your money over twice in the year instead of once—you can double your profit, increase the quantity of your manure, by which means you increase the fertility of your land—a system simple in practice, powerful in effect, and applicable to every grade of farmer.

_Agricultural Gazette_, November 28, 1846.
Art. VII.—ON STALL-FEEDING COWS.

By Mr. Blacker.1

By referring to the experience of all good farmers, in all countries, and under all circumstances, it is ascertained beyond dispute, that by the practice of sowing green crops, such as clover and rye-grass, winter and spring vetches, turnips, mangel-wurzel, &c., the same ground which, in poor pasture, would scarcely feed one cow in summer, would, under the crops mentioned, feed three, or perhaps four, the whole year round, by keeping the cattle in the house, and bringing the food there to them; and the manure produced by one of these cows so fed, and well bedded with the straw saved by the supply of better food, would be more than equal to that produced by three cows pastured in summer and fed in winter upon dry straw or hay, and badly littered.

Here, then, are two assertions well worthy your serious attention,—first, that three cows may be provided with food in the house all the year from the same quantity of ground which would scarcely feed one under pasture for the summer; and secondly, that one cow so fed in the house will give as much manure as three fed in the field. I call these important assertions; for, if they are really founded in fact, then any of you who may now be only able to keep one cow, would, by changing his plan, be able to keep three; and each one of them producing as much manure as three fed in the way they have hitherto been accustomed to adopt, the result will be, that you would have nine times as much manure by the new method as you have hitherto had by the old. Now, as I do not think there can be a single individual among you so blind as not to see at once the great advantage it would be to have such an immense addition to his manure heap, it appears to me that the best thing I can do is, in the first instance, to endeavour to impress firmly upon your minds the conviction that this fact, so much entitled to your attention, and yet so little attended to, is in reality a truth that may be relied on, and may be practically adopted without any fear of disappointment. It is upon this foundation that the practicability of almost every improvement I mean to suggest in the cropping of your land must ultimately depend; and it is, therefore, indispensable to the success of

any arguments I may offer, to place it before you in the
clearest point of view, and remove from your minds every
doubt whatever upon the subject.

To draw the necessary proof, therefore, from what comes
under your own observation (I may say, every day of your
lives, and which must, therefore, have more weight with you
than anything else I could say), I refer you with confidence
to the exhausted miserable pasture upon which your cattle
are now almost universally fed, two or three acres of which
are often barely sufficient to keep one cow alive for the
summer months, but by no means to afford her a sufficiency
of food. Now one acre of good clover and rye-grass, one
rood of vetches, and three roods of turnips (making up in all
two acres, which are now allotted for grazing one cow in
summer), taking a stolen crop of rape after the vetches, will
afford ample provision for three cows the year round. For
you all know that an acre of good clover will house-feed
three cows from the middle of May to the middle of October;
and, with the help of a rood of vetches, you will be able to
save half the first cutting for hay to use during the winter.
Then, when the first frosts, about the middle of October,
may have stripped the clover of its leaves, the early sown
rape, which ought to be put in ridge by ridge as the vetches
are cut, and the land well manured (if the seed has been
sown by the middle of July); will be ready to cut and feed
the cattle until the turnips are ripe. Here then you have
plainly provision secured until towards the middle of No-
vember; and we have to calculate what remains to feed the
cattle until the middle of the May following. For this pur-
pose there is a rood of turnips for each cow. Now, an acre
of the white globe and yellow Aberdeen turnip ought to
produce from 35 to 40 tons per acre; but supposing one-half
to be of the Swedish kind, let us calculate only on 28 tons
to the acre, which is not more than an average produce, even
if they were all Swedish, and see what that calculation will
yield per day for 190 days, which is rather more than the six
months. If an acre yields 28 tons, a rood will yield 7 tons,
which, being brought into pounds, will amount to 15,680
pounds, and this, divided by 190 days, will leave 83 pounds
of turnips for each cow every day, which, with a small por-
tion of the hay and straw you are possessed of, is a very
sufficient allowance for a common-sized milch cow; and,
over and above all this, you have the second growth of the
rood of rape coming forward in March and April, which
would feed all the three cows much longer than would be necessary to meet the coming clover crop, even in the latest season.

Here, then, the facts of the case are brought before you, for your own decision; and I fearlessly appeal to yourselves,—is it true that two to three acres (I make my calculation on two only) are frequently allotted to graze one cow during summer? And again—is it true that an acre of clover and grass-seed, a rood of vetches, and three roods of turnips, with the stolen crop of rape after the vetches, will fully supply food for three cows the year round? I defy any one of you to reply to either of these questions in the negative. The straw of the farm, in any case, belongs to the cattle; but, in the latter case, where turnips are provided for food, it is chiefly used for bedding; and the additional quantity of grain which will be raised by means of the increased quantity of manured land, will always keep pace with the increase of the stock, and provide the increased quantity of bedding required. I think, therefore, I am warranted in considering my first assertion proved, namely, that the ground generally allotted to feed one cow, will in reality supply food for three; and have only now to offer some calculations as to the accumulation of manure, which I hope will be considered equally conclusive.

During the summer months, your cow, which is only in the house at milking time (and perhaps not even then, for the practice is sometimes to milk her in the field), can afford little or no addition to the manure-heap, being upon the grass both day and night; and even in winter and spring, whilst there is any open weather, they are always to be seen ranging over the fields in search of food; so that I think you cannot but admit (upon a calculation for the entire year round), the animal is not in the house more than eight hours out of the twenty-four, and it is only the manure made during this period which can be reckoned upon; therefore, upon this supposition (which I think is sufficiently correct to show the strength of my argument), if there is any truth in arithmetic, one cow fed, as I have calculated on, in the house for the entire twenty-four hours, will yield as much manure as three cows that are only kept in the house for eight hours—the quality of the food being supposed the same in both cases; and this would manifestly prove my assertion, namely, that one cow fed within, would give as much manure as three fed without; and, therefore, when three can be
kept in the one way, as I have already shown, for one kept in the other, it is as clear as three times three make nine, that the result of the calculation will be just as I have stated, namely, that the farmer will obtain by the change of system nine times as much manure in the one case as he would have in the other.

Now, if, after all that has been said (which seems to me, at least, quite convincing), any of you should be so astonished by the quantity of manure thus proved to be gained, as still to have some misgivings on the subject, and be inclined to think that matters would not turn out so favourable in practice as I have shown in theory, I would wish any such person to consider one very material point, which I have not yet touched upon; for, in the foregoing, the argument is founded entirely on the time the animals are kept within, viz., it is stated that one cow kept within for twenty-four hours will give as much manure as three cows which are only kept in for eight hours, the food being assumed to be the same in both cases; but it is quite evident that if the cow kept within should be fed with turnips, and bedded with straw, which the others are fed upon, leaving them little or no bedding whatever, that the calculation must turn decidedly in favour of the animal which is well fed and bedded, both as regards the quantity and quality of the manure; so that it appears the estimate I have made is decidedly under the mark.

_Agricultural Gazette, December 12, 1846._

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**ART. VIII.—ADVANTAGE OF RAPE IN COW-FEEDING.**

**By Mr. Blacker.**

_The case of James O'Neil, of Gareagh._—This man was a complete pauper when Lord Gosford bought the Graham estate; but, by the assistance and instructions afforded to him, had got his small portion of land into a good state, and last summer I lent him a cow, seeing that he would be able, by proper attention, to have kept her in the house all the year. He had not been possessed of one for years, perhaps never in his life; but his conduct did not afterwards show him to be deserving of what had been done for him. He would
not sow his rape in proper time as he was desired, and I was at last obliged to discharge him from the work at Gosford, before he would be at the trouble of doing so. This neglect occasioned the crop to be late coming forward in spring; and having wasted his turnips, in beginning to them before they were ripe, and using them extravagantly, they were all finished before the rape was fit for cutting. This being the case, he turned his cow into the rape to graze, by which the crop was completely destroyed; and this failing, he put the cow to graze upon the young clover. This being soon eat down, I found the animal eating the tender shoots of the young quicks, in one of the new made ditches, when, upon inquiry; all the foregoing circumstances came out. Being provoked at such conduct, I ordered the cow to be sold; but, when the day of sale came, he was able, from the improved state of his farm, to get one of his neighbours to go security for the payment of his arrears, his rent, and the price of his cow; and also that he would buy rape elsewhere, and feed his cow in the house, as I required; upon which I did not persist in my intention of selling her. He accordingly bought a small piece of rape ground (10 Irish perches, or 70 yards long, and 2 yards broad), which, with a little dry fodder, kept his cow in full milk for thirty days; and, upon that feeding; gave 14 quarts daily, whereas, upon dry food, she had fallen off to half the quantity. The immense produce of rape, when well manured, is beyond anything almost that can be imagined, if let stand until it gets into blossom, which was the case in this instance. Manure makes the stalk tender and juicy, which would otherwise be hard and dry, so that if cut into small pieces, not a bit will be lost, and it grows to a height of six feet. I am almost afraid to say that I believe, with the addition of some straw, an acre will keep thirty head of cattle in full milk for a month. I state these particulars to show you the folly and blindness of this man to his own interest. By neglecting to sow the rape in proper time, it was not ready to supply the place of his turnips; and everything went wrong by this first neglect, which appeared to him of no importance. If the turnips had been properly managed, they would have lasted out longer; if the rape had been properly treated, it would have been ready sooner; and, if it had not been trampled down, would have lasted until the clover supplied its place, and everything would have answered in its turn. Now he has been obliged to buy from others, at the rate of fully 10l.
an acre, that rape which his own land would have supplied him with in abundance; and he has injured his clover, so that he will lose half the benefit of it. But the advantage of the rape is seen particularly in this, that, notwithstanding the high price he paid for it, it was better for him to buy it than to feed his cow on straw; even supposing that he had got the straw for nothing, which is very easily demonstrated:

For the 14 quarts produced by the rape feeding, at 1s. a quart, comes to 1s. 9d.

The price paid for it only cost 2d. per day, to which add a half stone of straw, 1d. (being at the rate of 16d. per 112 lb. which is above the general price of that article), and the expense, daily, comes to 0 3

Leaving a clear profit, per day, arising from feeding on rape, of 1 6

When the cow had been fed on straw, she only gave seven quarts, and very soon would have given still less, the price of which, daily, would be only 10½d.; therefore, if he got the straw for nothing, he would only have 10½d. a day by the cow; whereas, after paying for the rape, he gained 18d.; but if he had to pay for the straw (the cow would require three stone, which, at 16d. a cwt. would be 6d. and deducting this from 10½d. the price of the seven quarts of milk), there would only be a profit by the cow of 4½d. a day, in place of the 18d. a day yielded by the rape. The same thing may be proved in regard to turnip feeding in winter. If a cow calves at November, and is fed on turnips, she will keep up her milking; but, if fed on straw, she will fall off immediately to half the quantity. Now, allowing the acre of turnips to be worth 10l., which is more than any other crop generally produces, and reckoning the produce at thirty tons (although by good cultivation, Mr. Mitchell had fifty-five tons to the acre last year):—

The 5 stone of turnips, which I reckon good daily feeding for a milk cow, would cost 2½d.

And a stone of straw would cost, at 16d. a cwt. 2

Total cost per day for turnips and straw 4½

Whereas, three stone of straw, which she would require if fed on straw alone, at 16d. per cwt. comes to 6d. a day; so that, by the use of turnips in winter, it appears you can feed your cow (after allowing 10l. an acre for the farm)
at 1½d. a day less than upon straw alone, and you get double the quantity of milk; so that one cow fed in this way yields you fully as much milk as two would give fed on straw, and the manure is also twice as valuable. This ought to show you all the error you fall into. When you talk of keeping a cow all the winter upon straw, you merely talk of keeping her alive; but your object should be to keep her so as to yield you a profit, and this can only be done by keeping her on moist food, which, I have shown you above, it is more profitable for you to do than to feed her on straw, supposing the straw was made a present to you.

Agricultural Gazette, Dec. 19, 1846.

Art. IX.—EXPERIMENT ON SHED-FEEDING SHEEP.

By Richard Woods, Scafton Farm, Osberton.

The flock of sheep consists of the pure Leicester breed, Southdowns, and half-breds, viz. between Leicesters and Southdowns. Consequently, to test the relative qualities of the Leicesters and half-breds, there was twenty-two of each kind chosen from the flock, and placed in two separate yards, the size of the yards being 12 yards by 10 yards, including sheds for them to run under during the inclemency of the weather. I must here remark, that at the time of folding up they were in a condition that would be called fat, in consequence of which they did not gain so much weight as they might have done had they been in a much lower state when folded up. The kind and quantity of food given to each sheep per day was half a pound of linseed cake, half a pound of barley, and as many turnips as they could eat. The following is the exact and monthly weight of each lot, being from the 13th December 1845 (the time of their first being folded) until the 13th April 1846:

<table>
<thead>
<tr>
<th>Date</th>
<th>LEICESTERS</th>
<th>1845.</th>
<th></th>
<th>HALF-BREDS</th>
<th>1846.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>st.  lb.</td>
<td></td>
<td></td>
<td>st.  lb.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13th Dec.</td>
<td>207 6</td>
<td>Increase.</td>
<td></td>
<td>207 9</td>
<td>Increase.</td>
<td></td>
</tr>
<tr>
<td>13th Jan.</td>
<td>224 4</td>
<td>16 12</td>
<td></td>
<td>222 11</td>
<td>15 12</td>
<td></td>
</tr>
<tr>
<td>13th Feb.</td>
<td>241 2</td>
<td>16 12</td>
<td></td>
<td>238 13</td>
<td>16 2</td>
<td></td>
</tr>
<tr>
<td>13th March</td>
<td>257 9</td>
<td>16 7</td>
<td></td>
<td>254 2</td>
<td>15 3</td>
<td></td>
</tr>
<tr>
<td>13th April</td>
<td>270 2</td>
<td>12 7</td>
<td></td>
<td>274 11</td>
<td>20 9</td>
<td></td>
</tr>
</tbody>
</table>

62 10

In favour of Half-breds 4 6

67 2

D
It will be observed that the sheep of the Leicester breed increased more during the first months, when it will also be perceived that the half-breds gradually began to increase more, and continued so to do until the time they were slaughtered. It appears from the above tables of weights, that the Leicester sheep would for a limited time, on first putting up, gain a greater weight than the half-breds, but if kept for a moderate length of time the half-breds will obtain the lead of weight, and continue so to do as long as it may be the wish to keep them, for I find that when the Leicester breed of sheep has obtained a certain weight, their increase afterwards is but a mere trifle compared with the half-breds, and, as far as my judgment and experience goes, I should prefer for general feeding on poor soils the half-breds.

Agricultural Gazette, Oct. 3, 1846.

Art. X.—ECONOMY OF SHED-FEEDING SHEEP.

By the Editor of the Agricultural Gazette.

In calculating on the number of sheep that may be fed off a given acreage of turnips (white and yellow, Swedes and mangel-wurzel), it is assumed that good crops of the above roots, on ordinary soils, will yield per acre 24, 20, 20, and 26 tons of clean roots respectively; and that a fatting animal, either sheep or ox, supposing it full-grown, will in general, when out of doors, eat a weight of these roots equal to about a quarter of the carcass weight it is expected to attain when ready for the butcher. If fed under shelter, three-fourths of this quantity may be assumed as the basis of calculation. "Three-fourths!" if this be true, and from a somewhat extended experience on this subject, we believe it to be so, what a saving does this shed-feeding hold out to the winter grazier! It is objected to the system that it entails the heavy expense of carting the crop to the buildings, and the dung back again; and, in the case of sheep, that it renders them especially liable to the foot-rot; but the first item may be greatly diminished by erecting a temporary shed on the neighbouring stubble-field, which will require all the manure made there for the ensuing green crop, and thus the second item will disappear. Such a shed may be easily erected; the subjoined is a plan of it, which has already appeared in
this Journal. A few larch poles, nails, hurdles, and bundles of straw, are the materials required; they are not costly, and certainly they will not exceed in expense sixpence for each of the sheep they shelter. And as regards the foot-rot, we have not suffered from it during the last two winters, probably owing to the monthly paring which the sheep's feet received.

_Agricultural Gazette, Oct. 3, 1846._

**Art. XI.—ON CATTLE-SHEDS AND FOLDS.**

It is not the intention of the writer to occupy the pages of _The Plough_ with further discussion on the merits of a subject on which two opinions can scarcely exist. The purpose of this paper is to show, that the principal and almost only obstacle to the general adoption of so obviously beneficial a practice as summer-soiling cattle in sheds, or the only objection that can, in any way, be tenable by those who may be inclined to raise arguments against the system, is not of a magnitude but to be easily surmounted.

The only serious objection to the practice seems to be the expense of providing shelter for a great number of cattle. It certainly must be admitted that the materials commonly used for buildings for such purposes, are not only very considerably expensive, but many of them are also liable to objection from want of durability, especially the materials for roofing. The materials most commonly in use for covering roofs are tiles and slates. Tiles, from their great weight, require much timber in the roof for their support, and when unglazed they absorb water, thereby rendering them liable to be crumbled by the action of frost; they therefore form both an expensive and an unserviceable kind of roof. Slates, although free from the last-named objection in tiles, also require stout timber for support.

There are, however, some roofing materials, not in common use, of so trifling a cost, and so admirably adapted for the purpose under consideration, that by their application the expense of the erection of sheds for summer-soiling cattle cannot be an object to proprietors, and scarcely any even to a tenant, when the advantages to be derived from the prac-
tice are properly weighed against the cost of providing the necessary convenience. One of the materials alluded to is paper, which is extremely light, and therefore requiring no more timber for its support than sufficient to resist the force of wind to which the roof may be exposed. When properly prepared, paper may be rendered extremely durable for covering roofs, quite impervious to rain, and perfectly fireproof; which, with the trifling expense of the article, is a material combining every requisite that can be desired for the purpose. Before describing the process of preparing the paper, it will perhaps be well to point out the proper situation, the form, and construction of cattle sheds in which paper covering may be applied.

The proposed sheds should be in a well-sheltered farm-yard; and for every two of a large, or three of a smaller kind of beast, a space of twenty-four feet by twelve feet should be allowed, and enclosed with strong hurdles of 4\(\frac{1}{2}\) to 5 feet in height; one-half of this space, viz., twelve feet square, should be a covered shed, 6 feet high in front, and 9 or 10 feet high at the back. The construction of such sheds may be at once simple and economical; and the following specification will be sufficient for the desired purpose:—

Suppose a range of sheds to be commenced at the angle or corner of a fold-yard, and ranged along one side of it; let the wall or fence of this side be carried up to 9 feet, if not already that height, with rubble walling sufficient to keep out the wind: this will serve for the back, and the wall at a right angle forming the corner will answer for a side of the intended range of sheds. Let rough posts, 5 inches diameter at the smaller ends, ranged in a straight line parallel to, and 12 feet distance from the back wall, and at 12 feet distance from each other, be sunk 1\(\frac{1}{2}\) or 2 feet into the ground, and rising 6 feet above the surface: the part under ground, and for 6 inches above, should be well charred to prevent the posts rotting, which they are very liable to do, at the part immediately above and below the surface—of all kinds of wood, larch is best suited for the posts. Let beams or joists extend from post to post, resting on and firmly spiked to them; these joists set on edge need not be more than 4\(\frac{1}{2}\) inches by 2\(\frac{1}{2}\) inches, or two-thirds the breadth and the thickness of a Norway batten, which kind of deal will answer the purpose admirably, and save expense in labour and stuff. Let three principal rafters of 4\(\frac{1}{2}\) inches by 2\(\frac{1}{2}\)
On Cattle-Sheds and Folds.

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Inches extend from the tops of the posts to the back wall at 9 feet high, with a purline of the same scantling running across at their mid-length. Let also rafter spars 2½ by 2 inches, cut from Norway battens of their breadth into three, proceed from the top of the joist in front, resting on the purlines, and extending to the back wall firmly fixed to a spar fastened to the wall; these small rafters should be at 2 feet intervals. And lastly, let eaves boards half inch thick, the breadth of a batten, be placed across the ends of the rafters in front, and projecting 4 inches beyond the line of the tops of the posts; and similar boards across the ends of the rafters next the back wall; then across the rafters, in the space between the boards, let laths of 1 inch wide and half an inch thick be nailed at intervals of 15 inches. The shed will now be ready to receive the paper covering, which will be next described.

The description of paper most suitable for the purpose of roofing is that used for laying on ships' bottoms under copper sheathing, and known by the name of sheathing-paper; a very common size of which is 30 inches by 24 inches, and weighing about half a pound the sheet,—such size is exactly that to suit the roof specified above. The paper is prepared and laid on in the following manner: viz., cover one side of the sheets of paper with hot coal-tar, and whilst the tar is still hot, dredge or sift on it as much dry sea, or clear washed river sand, well dried in an oven, as will adhere to the tar; then cover the sand, when the tar has become cold and set, with a thick coat of lime slaked with a saturated solution of alum or soda; this white-wash should be of the consistence of thick cream, with a portion of glue or other sizing matter in it. Let the sheet of paper thus prepared be laid on the roof with the prepared side downwards, and nailed to the laths with fine short and very flat headed scupper-nails; and so cover the entire roof with prepared sheets of paper, the edges of which must be laid as closely together as possible without over-lapping. The upper side of the paper thus laid on must be thickly and evenly covered with hot coal-tar, and another stratum of paper laid upon it; after which, the outer side of this second stratum of paper must be prepared with coal-tar and sand in the same manner as the under side of the first.

To make the roof complete, it should be neatly pointed with Roman cement wherever it may join any wall, in order to prevent any wet finding its way in at the junction. To
finish all, the whole must be covered with a lime-wash, described above, to which a slate, tile, or stone colour may be communicated by the addition of a little lamp-black, Venetian red, or umber. This will form an extremely durable covering, quite impervious to rain, and perfectly safe from fire; and, at a very trifling increase of expense, the whole of the timber used in the construction of the shed may be rendered fire-proof by being immersed, for twenty-four hours, in a saturated solution of alum or soda.

At the present prices of materials and labour, the cost of shed and fold, for 32 square yards, complete, according to the specification above (carriage of materials not included), will be as follows, viz.,—

<table>
<thead>
<tr>
<th>Item</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber for the shed, sawed to the proper dimensions</td>
<td>17</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Labour in putting up, and nails</td>
<td>7</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Hurdles—of larch, for fences</td>
<td>0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Paper for covering at 28s. per cwt.</td>
<td>8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Preparing and laying on</td>
<td>7</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Sundries for levelling ground, &amp;c.</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£3</strong></td>
<td><strong>4</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

or at the rate of 2s. per square yard for shed and fold—an expense which would be repaid in a single year by the benefit that would be derived from the convenience. The erections would last good for many years, and might be erected by such farmers even as had not a long and certain tenure of their farms; as an arrangement might easily be made with any reasonable landlord for being permitted, on any sudden termination of tenancy, at a short period after incurring the expense, to receive a portion back, either from the proprietor of the land himself or the next occupier.

The application of paper for roofing need not be confined to open sheds, but may be used with equal advantage to every description of agricultural buildings, and even to dwelling-houses.

When protection can be obtained at so trifling a cost as that stated in the foregoing account, or even at a considerable advance upon it, it is unpardonable in any person not providing the means of comfort so conducive to the thriving of their cattle, and consequently to their own pecuniary gain.

The Plough, November 1846.
FEEDING STOCK.

Art. XII.—FEEDING STOCK.

On the use of Prepared Food in feeding Cattle.

By Professor Johnston.

[The following Lecture was delivered at the meeting of the Agricultural Chemistry Association at Inverness. The Professor commenced by observing that no district was more interested in the feeding of cattle than that of Inverness. As a cattle-exporting district, the extension of sound information in regard to the economical use of food, must be of the greatest importance. He proceeded to prove the interest that was being awakened on this subject, by the variety of implements having a bearing upon it exhibited at the recent cattle show at Newcastle.]

Amongst these he found chaff-cutters, a peculiar machine for crushing corn and other seeds, and other instruments—all showing how much regard was being paid to this subject by practical men. There was no doubt but that the subject of the quantity of food which cattle required to produce a certain weight of beef was beginning to attract general attention; and before he entered upon the few points which he meant to notice in connection with this question, perhaps it would be necessary to explain, shortly, the general composition of food. In all kinds of bread, there were contained three different kinds of matter. First of all, there was a certain quantity of fat, which the butter they ate represented. Secondly, there was a certain amount of sugar; and then there was besides, the third constituent, which was represented by the white of an egg. Now it was of the very greatest importance what description of food was used, and what proportion it contained of those three kinds of matter, as bearing upon the purpose it was intended to serve. Cattle had in their bodies different forms of matter also, but particularly flesh and fat; and the farmer should be sufficiently acquainted with the nature of food, to be able to distinguish what he should use when he wished to produce fat, or when he wished to produce fat and lean both together; and the food which was given would effect the one or the other of those purposes, according to its composition. The white of an egg, or albumen, would supply nothing; or nearly so, to the animal but muscle. Then the fat went directly to form fat. The starch in food kept the body warm, and when fat was wanted, served the purpose of
making the oily matter more readily become fat in the body of the animal." Now in fattening cattle, as in everything else, using the proper means produced the proper effects; and after the explanation which he had given, they would see at once that a mixture of food was better than the use of one kind alone. If they wanted to lay on muscle, they would feed with food containing the largest amount of gluten; and if they wanted to lay on fat, they would give starch and oily substances, and only a small proportion of the other ingredient. Selecting food in any other way would not serve the purpose they had in view in the most economical way. He had a table representing the different proportions of fat in the food which they were in the habit of using; but he would illustrate what he had to say by a few simple illustrations. Wheat contained two per cent. of fat, and sometimes a little more; but oats contained sometimes from four to five per cent. or about double the amount which was to be found in wheat. Oats was next to Indian corn in this respect, for it contained a large amount of fat. Gluten was the matter out of which the muscle was produced, and there were more of that substance in the bean and the pea than in the oat; but the oat was better than wheat. But there was another kind of food used for fattening cattle, namely, oil-cake, which contained a greater amount of fat than the same weight of any other kind of grain. Linseed, from which oil-cake was made, differed from other descriptions of grain, in containing a greater amount of fat, and a larger amount of gluten, likewise, with the exception of the bean. Now practical men had derived great advantage from feeding their cattle on oil-seeds; that food, from the peculiarity of its composition, laying on fat and muscle at the same time. Oil-cake, however, was the best food only when the greatest amount of fat was required, and according to the purpose which they had in view, farmers would give to their cattle other descriptions of food. It was a remarkable circumstance that the bean and pea contained very little fat, and as the wheels of the animal system required to be greased, these kinds of grain would not serve for that purpose, although they contained what made muscle. Although bean and pea were good food, therefore, they were not good as the sole food of animals. Besides, they would observe that from their different constituents, plenty of oil-seeds, and plenty of beans and peas, would be far more profitable than if they were to give either of them singly. That was
the principle upon which the use of mixed food was founded—to give all the substances the animal required, and to give them at the cheapest rate; and the researches of the scientific man were directed to discovering the means by which these objects could be best accomplished. He had selected oil-seeds; but he might have taken potatoes or turnips for his illustration. He had taken the oil-seeds, however, because very great attention had been recently directed to the value of those seeds in the feeding of stock, and to the culture of flax, which they knew was advancing with great rapidity in the neighbouring country of Ireland, and which was even progressing in England at a great rate. He might mention a remarkable fact connected with the improvement of the flax cultivation in Ireland, that a society which was established for the encouragement of that cultivation, and which had its seat in Belfast, had an annual revenue of between 2000l. and 3000l.; while the income of the Royal Agricultural Association of Ireland was less than one-half of that sum. From the progress the cultivation of flax was making in Ireland, it was very deserving of attention by those who thought a change in the rotation of the crops would be useful in other parts of the country. The person who had most directed his attention, practically, to the effects of feeding stock with mixed food, and to feeding on linseed, was Mr. Warnes, of Trimingham, Norfolk, and he (Professor J.) would point out to them the principles on which he proceeded; and they were sound scientific principles. He commenced by boiling the linseed in water until it formed a kind of jelly; then he stirred in a certain quantity of cut straw and chaff, and crushed corn. The mixture was then poured into moulds, and afterwards served to the cattle warm, which they liked remarkably well. With this food the cattle thrived, and acquired beef in an extraordinary manner. By this system of feeding, Mr. Warnes said he could compete with any man, whether foreign or not, as he could send cattle to Smithfield at 4½d. per lb. and pay him an ample return; and, in illustration of this, he gives the results of two experiments, which he would read to the meeting, and which were as follows:

"Since he followed out box-feeding, he knew not a single instance where he had not realized 8l. for every head of cattle he had kept for six months. At the farm where he now resided, he had reared for market the following cattle, after only six months' box-feeding:
Seven Durham steers cost 8l. 10s. each, sold for 19l. 10s. £ s. d. 
67 0 0
Six Scotch steers cost 10l. each, sold for 22l. 10s. each 75 0 0
One cow cost 5l. 5s. sold for 15l. 40 0 0
Four Scotch steers cost 10l. each, sold for 20l. each... £201 15 0

"The above cattle were brought in and disposed of within six months. They consumed, with the following now in herd, nineteen acres of turnips, about fourteen quarters of linseed, and a few bushels of barley meal, with several acres of pea-straw:—

Three Durham heifers, estimated value above the cost price ........................................ £ 22 10 0
Two Irish steers ........................................ 13 0 0
Five small steers and heifers .......................... 30 0 0
Three calves, and butter from two cows ............ 11 0 0

£76 10 0

Deduct for fourteen quarters of linseed, mostly grown upon the farm, 35l.; also for barley 4l. 39 0 0

Profit £37 10 0"

In reference to Mr. Warnes's experiments, too, it was to be observed that the value of the manure was very much increased in comparison with that derived from the ordinary method of feeding. But, besides this, there was another method of feeding, of which he would speak from personal observation, and which he had witnessed in the neighbourhood of Northallerton. He went to that place because he had heard that Mr. Marshall was keeping double the amount of stock, with the same quantity of turnips, which he had been in the habit of doing only two years ago; the other food used being ground oats, barley, rye, and old beans, and chopped hay, instead of straw at times: but the cattle did best with the straw. Hearing, as he had stated, that Mr. Marshall kept double the stock upon the same amount of turnips, by his system of feeding, he (Professor J.) was very anxious to see the mode of carrying his system into operation, and went down to Yorkshire for that purpose. There he saw about 200 head of cattle feeding—a portion of which was sold off every week, and their places supplied by others. What struck him as very remarkable was, the state of absolute rest in which he found the cattle. There was not a
single beast upon its legs; no motion was observed, which, they were aware, was a circumstance favourable for fattening.

In connection with this subject, he got the following information; and in order that they might fully understand it, he would present it in a tabular form. It was as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linseed, boiled</td>
<td>2 lb.</td>
</tr>
<tr>
<td>Cut straw, mixed</td>
<td>10 lb.</td>
</tr>
<tr>
<td>Growing corn, boiled</td>
<td>5 lb.</td>
</tr>
<tr>
<td>Jelly</td>
<td></td>
</tr>
</tbody>
</table>

To be given in two messes, alternately with two feeds of Swedes.

Now, the mode in which the linseed was boiled was of considerable consequence. In the first place, it was boiled for three hours. The jelly was then poured upon crushed grain and cut straw, much in the same manner in which a man made mortar, being mixed together with a shovel, and allowed to stand for an hour. It was then stirred again, and after the lapse of two hours it was given to the cattle in a hot state, and the result was, that if the animals are fed regularly on this kind of food, and turnips alternately, they remain in a state of extraordinary quiet. They become exceedingly fond of it, and commence bellowing whenever they hear their neighbours being served before themselves. The practice was to give them a meal of the linseed mixture at six in the morning; turnips at ten; another mess of linseed in the afternoon; and turnips again in the evening. When he saw them first in the morning, it was after they had got their mess, and he was much astonished to see them on visiting them on the second occasion, when they were all on the qui vive for their meal. Two things were to be observed in regard to this system of feeding—first, that it consisted, in addition to turnips, of a mixture of grain, straw, and linseed, in certain quantities; that it was prepared in a particular way, and given hot; and that the result was double the amount of stock kept on the same amount of land. The proportion of turnips which would be grown upon a farm usually determined the quantity of stock a man might keep; and if, by an improvement in the system of feeding, the quantity of cattle could be doubled, by turning the money twice instead of once within a year, the farmer would obtain double the profit. But this was not the only advantage. He would double the manure which he made at the same time, which would contribute very much to the fertility
of his land; he being enabled, by the use of the linseed, to return more than he took out of it. The proportion of the food had other important consequences in regard to manuring the soil. The crushing of the grain and seeds, by reducing them to the minutest particles, made the substances of which they were composed more easily assimilated as the food of plants, and made it better manure, because of the extreme division which it had undergone. Now, they would observe that, by having this large additional amount of manure, they would get larger crops, and introduce a system which would go on annually increasing the amount of their produce, and consequently the amount of their profits.

Mr. Grey, of Dilston, agreed very much with what was said by Professor Johnston, more particularly in reference to the great improvement in manure by the use of prepared food. He had seen instances where an acre of turnips was worth other three acres differently manured. It was well known that, in Surrey, farmers could be found who would give their fields to be consumed by sheep for nothing, if the parties became bound to supply them with a certain quantity of oil-cake and hay. He knew a place in Croydon himself, where, on condition that a large quantity of that kind of food was given to the sheep, that the turnips were allowed to be consumed on the field without charge. This showed the extraordinary effect which it was believed manure produced from that kind of food had in raising crops, more particularly as in the case to which he referred, on that description of land which required to be trodden out to make it produce good crops.

Mr. Watson, of Keilor, said there was one article of food much talked of in Scotland, which he thought was deserving of attention. The article he referred to was malt; and he thought if they were allowed to convert their light barleys into that form, it would be one of the very greatest improvements, and a most economical food for their cattle. He spoke partly from experience on this subject. Some years ago, a late field of barley of his began to malt before he could get it thrashed, and he continued the malting process, and afterwards gave the grain, in a state of malt, to his stock, with more profit than he ever derived from cattle before. He would like Professor Johnston, therefore, to turn his attention to that subject, as he (Mr. W.) was of opinion, that permission to use malt for food to cattle would be of great value to farmers in this part of the country.
Mr. Black of Dalkeith, could speak from experience of the benefit of salted feeding; as he was in the habit of putting a piece of rock salt in his stalls, and of putting pieces likewise amongst his pastures, so covered that water could not melt them. He found this to be of great use.

Captain Elphinstone, of Dalrymeple, said, Professor Johnston having alluded to the application of flax-seed to the feeding of cattle, he would state the result of an experiment which he had made in the growing of that crop. He had put an acre of land under that crop, and it produced 27½ cwt. of flax. He had tried in this experiment various kinds of manure, and six different kinds of seed. By this means he had discovered the most advantageous description of seed to use, and he was quite satisfied that they could grow flax as well as foreigners. The importance of this subject would be apparent, when he informed them that this country paid from 8,000,000l. to 9,000,000l. a year for flax, and would it not be better if they could grow a quantity of that produce for themselves? He did not find that flax was an exhausting crop, as was supposed. Within his recollection turnips were considered an exhausting crop; and by the application of liquid manures, and the practice of a judicious system of rotation, he believed flax would not be found more exhausting to the ground than some other crops. He was determined, therefore, to try the experiment further next year, by sowing ten acres of flax. He was likewise going to Ireland for the purpose of ascertaining the best methods in use for riddling and cleaning it, as he believed that in the district in which he lived they could grow as good flax as anywhere.

Mr. Horne remarked, that if the farmers in this country were to raise flax-seed for themselves, he thought it would be of great advantage; for when they looked at the immense expense of the refuse of flax-seed in the shape of oil-cake, and the value which was put upon it for the feeding of cattle, surely flax-seed itself was much more valuable. If they directed their attention to the growing of flax-seed, and could get a good machine which would freely discharge the crushed material, he thought every farmer might be enabled to grow that valuable food for his own cattle.

Mr. Smith, late of Deanston, said, he was lately at a show of implements, where a very perfect machine was exhibited, which was not only capable of bruising linseed and separating it from the rollers, but was most effective for
crushing oats and beans, or any other description of seed. It consisted of two fluted rollers, with simple machinery to drive it; and the price, he thought, was 107. The maker of the machine was a Mr. Richmond, of Manchester. Ten pounds was, perhaps, a large sum, but the advantage to be derived from the use of the machine on a farm of any extent would very soon repay the outlay. They had heard a great deal of the advantages of a mixture of food in producing lean, fat, and muscle, and in the same way it was of importance that farmers should vary their crops, so that they might extract from the soil all the substance it contained which went to the composition of food. With regard to the use of linseed, he had to remark that it was a subject to which he had paid considerable attention, and he could assure them that the graziers in England found very great advantages to result from giving it to their cattle; and he was of opinion that nothing would tend to improve the mountainous districts so much as feeding their stock partly upon linseed, and by that means enriching the soil. By conveying linseed into the mountainous districts, they would carry a greater quantity of manure to enrich the country than they could do in any other shape whatever; while they would be feeding their cattle better, and getting a better price for them.

Professor Johnston then stated that with regard to the use of malted barley, referred to by Mr. Watson, he did not think it would be so advantageous as that gentleman thought. If it was given as a part of the food of cattle, he thought there could be nothing better; but if it was given as the great staple of the food, he did not think it would pay. From the failure of the potato crop, it would be necessary to substitute some other crop to supply its place in the system of rotation; and for this purpose flax was deserving of their attention. As to the question whether flax was exhausting or not, there was this to be observed, that it was different from other crops, in so far as they took away both the straw and the grain; and to keep the soil fertile, it would be necessary to return in the shape of manure, not only what was taken away by the seed, but likewise was taken away by the straw. It was not an exhausting crop, if they took care to manure the soil.

_Agricultural Gazette_, Sept. 12, 1846.
FEEDING OF STOCK WITH PREPARED FOOD.

ART. XIII.—ON THE FEEDING OF STOCK WITH PREPARED FOOD.

[From a Prize Essay entitled, "A Report of the Feeding of Stock with Prepared Food; and a description of the Apparatus employed.

BY JOSEPH MARSHALL, HOLME LODGE, BEDALE, YORKSHIRE.

[From The Transactions of the Yorkshire Agricultural Society,]

"The author does not pretend to have discovered any new way to feed cattle. Nor can the objection of novelty, the current and groundless objection of every foe to improvement, be justly urged against the system which he has adopted; and which he thinks others may adopt if they will, with advantage. The principles here laid down have been long though, perhaps, not generally known. All the merit which he claims is that of having persevered, in spite of friendly remonstrance, ridicule, and commiseration, and the like, in a course which his own reflections and calculations recommended; and which his own experience, and the larger experience of more able and scientific farmers have since proved to be successful. That success has arisen, not from the discovery of any new principles, but from the proper carrying out of principles already known."

Mr. Marshall has succeeded in fattening stock rapidly by giving them good food, and preparing it.

"At six A.M. each beast is supplied with about 40 to 45 lb. of yellow bullock turnips, sliced; at ten A.M. with 1 lb. of linseed, boiled for two or three hours, with about 1½ gallons of water, 2½ lb. of ground corn, and 5 lb. of chopped straw; at one o'clock, P.M., the turnips are repeated; and at five, P.M., the prepared food is repeated. At night a little straw is placed in their racks. If any cattle had refused their mess, it was removed and given to those that had finished theirs, and were desirous of more. It may also be observed that the ground corn and chopped straw must be mixed together first, and then the boiled linseed being poured upon them, and mixed with them, may be allowed to stand for one or two hours, and given while yet warm; for if allowed to stand a few hours, the mass ferments, and quickly turns sour. Hence the necessity for the strictest cleanliness in all the vessels and implements made use of.

"Assuming an acre of land to grow 20 tons of yellow
bullock turnips, and that they are worth about 6l. 15s. per acre, each beast will consume 85 lb. per day, with the prepared food; from this we may calculate that 20 tons of turnips will feed twenty beasts for twenty-six days, at a cost of about 1s. 8d. per week per head.

"Again, assuming an acre of land to yield 20 tons of Swede turnips, and that their value is about 8l. 5s. per acre, each beast will consume 63 lb. daily, along with prepared food; from which we conclude that 20 tons will supply twenty beasts for thirty-five days, at a cost of 1s. 8d. per week per head. Hence five acres of Swedes, yielding 20 tons per acre, will suffice for twenty beasts for twenty-five weeks.

"If, instead of Swede turnips, we supply raw carrots or potatoes to the cattle, they consume the same weight of the latter as of the former, without making any apparently greater progress.

"Regularity and cleanliness, highly important as they are in every system of feeding animals, are, in this method, the basis of success. Without them every attempt must inevitably fail. I have found that the omission of this food once on a Sunday makes the cattle return to it with an increased appetite. Under this mode of feeding, three-year-old heifers increased in weight (calculating by measurement) during the time they were tied up, on an average of the whole lot, about 14 lb. each per week. Two of them made 20 stones each in sixteen weeks. Steers consume less food, and gained weight more slowly."

The author brings forward many witnesses to the excellence of his practice. We quote the following letter from Mr. Thompson:—

"Dear Sir,—I have great pleasure in sending you the result of my trial of your method of preparing food for cattle. I have not had time to make a long trial, but I have taken some pains to make an accurate one. My previous system having been found to work well, I determined to give it a fair chance against the new one; and I accordingly selected two of the most thriving of a lot of twelve bullocks, of nearly the same age and condition, and fed them for the first month on the food I had been in the habit of giving, viz. Swede turnips, linseed-cake, and bean-meal, in the proportions stated below. Two others, of nearly equal weight, had their food prepared according to your directions. All four were weighed at the commencement of the experiment, viz. April 11, 1846. Their weights are given in Table No. I."
WITH PREPARED FOOD.

The numbers are the numbers of their stalls, to prevent mistakes. Nos. 8 and 9 were fed in the new way. Nos. 12 and 13 in the old. They were weighed a second time on the 15th of May.

<table>
<thead>
<tr>
<th>No. of Stall</th>
<th>Live Weight April 11.</th>
<th>Live Weight May 15.</th>
<th>Increase in Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>st. lb.</td>
<td>st. lb.</td>
<td>st. lb.</td>
</tr>
<tr>
<td>8</td>
<td>83 8</td>
<td>88 4</td>
<td>4 10</td>
</tr>
<tr>
<td>9</td>
<td>79 8</td>
<td>85 1</td>
<td>5 7</td>
</tr>
<tr>
<td>12</td>
<td>81 0</td>
<td>85 2</td>
<td>4 2</td>
</tr>
<tr>
<td>13</td>
<td>85 0</td>
<td>89 0</td>
<td>4 0</td>
</tr>
</tbody>
</table>

Thus it will be seen, that the bullocks fed on the old plan gained 8 st. 2 lb. in five weeks; and those fed on the new way gained 10 st. 3 lb. in the same time. As I was convinced that the two bullocks which had made the least progress were nevertheless the most thriving animals, I, for the next month, fed all four alike, viz. on Swedes, mangel-wurzel, and your prepared food. The results are as follows:

<table>
<thead>
<tr>
<th>No. of Stall</th>
<th>Live Weight May 15.</th>
<th>Live Weight June 15.</th>
<th>Increase in Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>st. lb.</td>
<td>st. lb.</td>
<td>st. lb.</td>
</tr>
<tr>
<td>8</td>
<td>88 4</td>
<td>92 4</td>
<td>4 0</td>
</tr>
<tr>
<td>9</td>
<td>85 1</td>
<td>90 12</td>
<td>5 11</td>
</tr>
<tr>
<td>12</td>
<td>85 2</td>
<td>92 7</td>
<td>7 5</td>
</tr>
<tr>
<td>13</td>
<td>89 0</td>
<td>96 0</td>
<td>7 0</td>
</tr>
</tbody>
</table>

The impression that the bullocks Nos. 12 and 13 were better thrivers than Nos. 8 and 9 were, it will be observed, fully borne out, when the four were fed alike, the latter two having made 14 st. 5 lb. in the thirty-one days, and the former only 9 st. 11 lb. If we compare the increase of weight of the two bullocks Nos. 12 and 13 when fed on the old plan for thirty-four days, viz. 8 st. 2 lb., with the increase of the same bullocks when fed on your plan for thirty-one days, viz. 14 st. 5 lb., the superiority of this method is very apparent.
Let us next compare their cost.

**First Method of Feeding.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost per head, per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>10½ lb. of linseed at 7s. a bushel, of 56 lb., or 1½d a lb.</td>
<td>1 3%</td>
</tr>
<tr>
<td>35 lb. of bean meal, at 1s. a stone</td>
<td>2 6</td>
</tr>
<tr>
<td>100 lb. of coal daily, at 14s. a ton, or 4s. 5½d. a week, for twenty bullocks, or for each per week</td>
<td>0 2%</td>
</tr>
<tr>
<td>Extra wages, 4s. a week, or 2·12d. a head, say</td>
<td>0 2%</td>
</tr>
</tbody>
</table>

By the above calculations, it appears that the cost of the two methods is about the same. I have, however, to observe, that, to avoid raising the expectations of those who wish to try your plan too high, I have throughout the two estimates favoured the old system rather than the new. The price of the linseed is decidedly above the average. Coal can, in most situations in the north, be had for less than 14s. per ton; and the charge both for coals and wages would be lower, per head, if I had made my calculation for forty bullocks instead of twenty. On the other hand, had I in the second estimate valued the oil-cake at what I have given, on the average, for the last five years, viz. 11l. per ton (for the best English-made cake, including carriage), and estimated the turnips at 10s. per ton, instead of 7s. 6d. (a very low value), the comparison between the two plans of feeding would have been very decidedly in favour of the new system in point of economy.

Before leaving this part of the subject, I would wish to remark, that, though I have given an estimate of the cost of the food for seven days, I really only use it six days out of the seven, as, if the steamer were kept going on the Sunday, the men in charge of the cattle would have to work as hard on that day as on any other day of the week. I consequently substitute linseed-cake for the prepared food on Sundays, and am of opinion that this slight change of food is rather beneficial than otherwise. The cost of the linseed-cake is so nearly equal to that of the prepared food, that I have
not thought it necessary to make any difference in the calculation on that account.

"I have now given you the result of my trial of two different systems of feeding; and also estimates of their cost, and will next endeavour to answer a question which has already been frequently put to me, viz., What are the peculiar advantages attendant upon this system, which should induce farmers to incur an expense of 50l. (price of apparatus and cost of fixing) for the sake of introducing it? One of the principal advantages is, that the animals make greater progress at the same cost. In all the instances that I have heard of or seen, the cattle treated in this way have fed unusually fast. In my own case, this was very striking. The twelve bullocks mentioned above were, in March, taken lean from the straw-yard; quite unfit, in fact, for tying up to feed, except by way of experiment; yet they made such rapid progress that some of them were sold to the butchers at 7s. 3d. per stone, at the end of May; and the last were sold the third week in June, in good killing condition. One of the main causes of this rapid progress is, I conceive, the perfect state of health the animals enjoy. Linseed-oil is a mild purgative; and, when combined with meal, especially bean-meal, the bowels and skin are kept uniformly in a state of health, which I think cannot be surpassed, and which I never before saw equalled.

"Another reason which appears to conduce much to their thriving is, that the food prepared in this way approaches so much more nearly to the natural food of the animal. In grass, and other green food, we find a very small per-centage of nourishing ingredients combined with a large proportion of woody fibre, water, and other matters, which are not fitted for assimilation by the animal, and are rejected as useless, after the nourishing parts have been extracted by digestion. These apparently superfluous matters have, however, very important uses; one of the most striking of which is, to give bulk to the food, and therefore distension to the stomach. If the stomach is not moderately filled by a meal, those muscles are not called into active exercise, which tend so much to promote healthy digestion, by keeping the food in constant motion; and, accordingly, we find that if we supply a feeding bullock with cake or meal, which, though highly nourishing, lies in a small bulk, the animal will, if not supplied with a sufficiency of other food, eat a portion of his litter, old thatch, or almost any other vegetable matter,
however unpalatable, to satisfy that craving which an empty stomach is sure to produce. Though, however, an animal will swallow a certain portion of food for which he has no relish, rather than lie down with an empty stomach, he will not fill himself properly unless he likes his food; and, on the other hand, if an unlimited supply of favourite food be furnished to him, he will take it in quantities injurious to his health. The following is a case in point:

"Before tying up the twelve bullocks, mentioned in a former part of this letter, I desired that they might have a fair allowance of Swede turnips given them for a short time, lest a too sudden change of diet should disagree. They, accordingly, had four or five stones of Swede turnips per head, daily, and with this they did well; consuming, at the same time, a considerable quantity of straw. After having given this quantity for a week or two, I increased their allowance of turnips; and, finding their appetites kept pace with their increased allowance, I ordered them as much as they would eat. At the end of about a month, I found they were each consuming about fourteen or fifteen stones of turnips daily, and that they ate no straw. This was continued for a short time, in consequence of my apparatus for boiling linseed not being completed as soon as I had expected. And I found, that though the turnips were sound and good, the animals' bowels began to be affected, their coats grew rough and staring, and the purging increased to such an extent that, without a change of meat, dysentery and inflammation of the bowels would have been the result. The same turnips, when given in so limited a quantity that they were obliged to eat a certain quantity of straw to fill their stomachs, agreed perfectly well; but when they could fill themselves with turnips, they refused the straw, and became ill in consequence. This might, probably, not have occurred had the straw been very good, which it was not; but it is a good instance to show the importance of a well-regulated diet.

"As soon as they were fed with the prepared linseed, and had but fifty pounds of turnips per head per day, they at once recovered their health. Other instances, also, have come under my own observation, where severe purging has been brought on by improper diet. I have seen it produced by mangel-wurzel, by carrots, and by potatoes, when given in large quantities."
"Another advantage of your system is, the great saving of turnips. To keep a farm in a high state of fertility, it is, on almost all descriptions of land, necessary to fatten cattle in yards during winter; and as turnips and other root crops are indispensable for this purpose, any system which economizes their use is equally important to strong and light land farms; as, in the latter case, it leaves a greater proportion of the turnip crop to be consumed on the land by sheep, and on the former, a larger number of cattle can be fed on the same breadth of fallow crop; which, to those who know the difficulty of catching a season for even a few acres of such crops on really stiff land, will be felt to be a point of material importance.

"Allow me, in conclusion, briefly to point out the many points of resemblance between your prepared food and that obtained by a grazing bullock in a pasture. The grass is in short lengths, and requiring little mastication before swallowing; it contains much water, and nourishing ingredients are mixed with a large proportion of what may be called neutral matters, to give distension to the stomach. In the artificial food, by using chaff or chopped straw, you also save the labour of long mastication, and furnish the neutral ingredients which give the required bulk. The boiled linseed and meal, intimately mixed with the straw, furnish the nutritive matter, and give an agreeable flavour to the whole; a sufficient quantity of water is also thus supplied, and the warmth is artificially furnished, which, in summer grazing, the temperature of the air supplies. The parallel is very complete, and its success is such as a close imitation of nature usually ensures.

"I beg to state, that as I intend (D. v.) to have your system in full operation during the whole winter, any brother farmer who may wish to see it at work will be heartily welcome to do so at my farm, whether he wishes to take a hint, or merely to examine and criticize. I am, dear sir, yours truly,

H. S. THOMPSON."

"Mont Hall, York, Sept. 14th, 1846."

We have only to add, that the system recommended by Mr. Marshall is the same that we have adopted for the last two seasons; and that our practice, which consists in mixing linseed-meal and bean-meal with hay and straw chaff, and roots, given to cattle and sheep in "boxes," was copied from Mr. Warnes, of Trimingham, in Norfolk, and Mr.
Let us survey a few of the valuable facts with regard to sheep which have been noted during the past year. Mr. Pawlett, of Beeston, from a series of careful examinations, concludes,¹ that the general opinion is correct, that the sheep goes with young longer with males than with females. He found that the longest time that any ewe went with

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ram lamb, was</td>
<td>22</td>
</tr>
<tr>
<td>The shortest</td>
<td>21</td>
</tr>
<tr>
<td>The longest with a ewe lamb</td>
<td>22</td>
</tr>
<tr>
<td>The shortest</td>
<td>20</td>
</tr>
</tbody>
</table>

He says, “cabbages planted out in April or May are the best food to make lambs fat that I ever met with; but they are expensive, and would scarcely pay any one to grow for sheep in a general way.” Next to cabbages, white turnips, he thinks, are the best for lambs in September and October, and preferable to Swedes, if they are not too old and are cut by a machine. In a careful comparative experiment, he found that in a month eight lambs fed on cabbages and clover chaff gained each 11 lb.; eight fed with Swedes and chaff gained 8 ¹/₂ lb. Washing the food of the lambs he found to be prejudicial. During the month of December 1836, he fed two lots of lambs with carrots and Swedes. The lot fed with the unwashed gained in weight each 7 ½ lb.; the lot fed with the washed gained only 4 ⅓ lb. He approves of the early shearing of sheep; he says, “I am convinced that the sheep thrive much faster during the summer if their wool is taken off on the 1st of May, than if it were left on until the first or second week in June.” From some careful experiments of Mr. Bruce, of Waughton, in East

Lothian, 1 with linseed-cake and other substances in sheep feeding, he concludes that "mutton can be produced at a lower rate per pound upon liberal use of foreign keep along with turnips, than upon turnips alone, taking, of course, the increased value of the manure into account;" that of this foreign keep "linseed is the most valuable, and beans the least so; but that the mixture of both forms a useful and nutritious article of food." In his trials ninety-five Cheviot ewes were divided into five lots, and enclosed and fed with turnip tops and the following substances, upon portions of equally sheltered grass land. Lot A consisted of fifteen ewes; B, C, D, and E, of twenty each.

<table>
<thead>
<tr>
<th>Lot</th>
<th>Weight</th>
<th>Average consumption of each Sheep per week</th>
<th>Cost of production per lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oct. 21</td>
<td>Dec. 23</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>lb.</td>
<td>lb.</td>
<td>oz.</td>
</tr>
<tr>
<td></td>
<td>1839</td>
<td>2008</td>
<td>56(\frac{1}{2}) linseed</td>
</tr>
<tr>
<td>B</td>
<td>2401</td>
<td>2603</td>
<td>113(\frac{1}{2}) linseed-ck.</td>
</tr>
<tr>
<td>C</td>
<td>2382</td>
<td>—</td>
<td>157(\frac{1}{4}) poppy-ck.</td>
</tr>
<tr>
<td>D</td>
<td>2404</td>
<td>2557</td>
<td>100 beans and linseed</td>
</tr>
<tr>
<td>E</td>
<td>2417</td>
<td>2736</td>
<td></td>
</tr>
</tbody>
</table>

The urine of the sheep, "so valuable as a manure for every kind of crop," has been carefully analyzed under the direction of Professor J. F. Johnstone. 2 Ten gallons of the urine contain 7 lb. of dry fertilizing matter. The dry matter contained, in 100 parts,—

- Dry organic matter, containing nitrogen ............ 71:86
- Inorganic or saline matter .................................. 28:14

The saline matter or ash contained, in 100 parts,—

- Sulphate of potash ........................................... 2:98
- soda .......................................................... 7:72
- Chloride of potassium .................................... 12:0
- sodium ....................................................... 32:01
- Carbonate of soda .......................................... 12:25
- lime .......................................................... 0:82
- magnesia .................................................... 0:46
- Phosphates of lime, magnesia, and iron .............. 0:70
- Silica ........................................................ 1:06

The urine of the sheep, therefore, contains only a very

2 Ibid. 1846, p. 309.
small quantity of phosphoric acid in combination with lime and magnesia. It agrees very closely in this respect with that of the ox and the horse, in which no trace of phosphate has yet been detected. It abounds also, like the urine of these animals, in salts of potash and soda. It is especially rich in common salt, and in soda, which in the ash is in the state of carbonate, but which in the urine is no doubt combined with some organic acid. If it be natural to the urine of healthy sheep to contain so much soda, we may find in this one reason why they relish salt so highly, and thrive so much better when it is abundantly supplied to them. The organic portion of the urine contains, in 1000 parts,—

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>928.97</td>
</tr>
<tr>
<td>Urea</td>
<td>12.62</td>
</tr>
<tr>
<td>Organic matter soluble in alcohol</td>
<td>33.30</td>
</tr>
<tr>
<td>Organic matter soluble in water, insoluble in alcohol</td>
<td>3.40</td>
</tr>
<tr>
<td>Organic matter soluble in weak potash, insoluble in water and alcohol</td>
<td>0.10</td>
</tr>
<tr>
<td>Organic matter insoluble in any of these liquids</td>
<td>0.15</td>
</tr>
</tbody>
</table>

**Inorganic matter consisting of**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphate of potash, soda</td>
<td>0.51, 1.32</td>
</tr>
<tr>
<td>Chloride of potassium</td>
<td>2.05</td>
</tr>
<tr>
<td>Common salt</td>
<td>5.47</td>
</tr>
<tr>
<td>Sal ammoniac</td>
<td>3.00</td>
</tr>
<tr>
<td>Chalk</td>
<td>0.14</td>
</tr>
<tr>
<td>Carbonate of soda, magnesia</td>
<td>7.22, 0.08</td>
</tr>
<tr>
<td>Phosphate of lime and magnesia, with a trace of phosphate of iron</td>
<td>0.12</td>
</tr>
<tr>
<td>Silica, with trace of oxide of iron</td>
<td>0.18</td>
</tr>
</tbody>
</table>

*Farmer’s Almanac, 1847.*

**Art. XV.—STEAMED FOOD FOR PIGS.**

*Quoted by Mr. Fennell.*

In Wade’s British History it is stated, that a gentleman in Norfolk put six pigs, of nearly equal weight, on the same food and litter for seven weeks. Three of the lot were kept as clean as possible with a curry-comb and brush, and were found to consume, in seven weeks, fewer peas by five bushels than the other three, yet weighed more when killed by two stones and four pounds, on the average: a strong argument in favour of keeping pigs _personally_ clean.
From Mr. Boswell's experiments, we learn that, during an equal space of time, the increase in the live weight of five pigs fed on steam-boiled food was 4 cwt. 2 qr. 7 lb., at an expense of 6l. 19s. 4d.; while the increase in the live weight of five pigs fed on raw food, was only 2 cwt. 2 qr. 21 lb., at an expense of 5l. 8s. 6d.: a result highly favourable to the practice of feeding swine on steamed food.

Journal of Agriculture, July 1846.

Art. XVI.—ON FATTENING PIGS.

By Mr. J. Steel.

[As quoted by J. H. Fennell, Author of "A Natural History of British Quadrupeds"]

In fattening pigs, I have always found a mixture of barley and peasmeal, moistened with milk in sufficient quantity to make it of a drinkable nature, to be the best; the pigs must be rung to make them lie quiet; the sty should be warm and airy, and the sun not suffered to scorch their backs, as thin-skinned white pigs are blistered by it, which not only renders them of an unsightly appearance, but retards their thriving. They should be protected from exposure to cold winds, cold rains, sleet, and snow,—a subject not sufficiently attended to on many farms, where they are allowed to lie in heaps, shivering with the cold, in which case it is utterly impossible that they can thrive. On the other hand, when they are kept constantly in a close, pestilential atmosphere, their constitution becomes undermined, they look very delicate and sickly, like consumptive subjects, and never arrive at any size or weight for their age. These extremes must be carefully avoided, and the sty should have an open-barred door, permitting a current of fresh air to incessantly set in and purify the place, conducing to the animals acquiring a vigorous habit, and a doubly increased size. Too much cleanliness cannot be observed; for nothing tends more to their well-doing than dry feet, a dry bed, and sweet air. It is true that in summer they wallow in the mud, to get a coat to shield them from the sun and flies; but this only proves that they require protection from excessive heat and
the teasing of flies, and all who wish their pigs to thrive will provide shelter. Pigs intended to fatten should never be allowed to run about, as no food they can get by prowling about will compensate for the loss of flesh sustained by the continual state of motion. In a farm it may be very well to have some running about to pick up dropped offal; but where the pigs are regularly fed with a sufficient supply, it is a thriftless plan to waste by exercise the flesh that by a state of rest would make a good return for the food consumed and the expense of attendance. The strong food above mentioned is chiefly recommended to fatten hogs to a larger size, but does not exactly suit quarter porkers; it is too heating, and produces pimples which give a diseased appearance; therefore, for quarter pork, use either fine middlings with milk or pure water, or reduce the strength of the barley or peasmeal by adding an equal quantity of pollard; wash or pot liquor is unpalatable to pigs during the process of fattening on meal.

If, from change of weather or other causes, my pigs get costive and are off their food, I supply them with a little green food, according to the season of the year, as a few cabbage-leaves, lettuces, or potato-tops, or with potatoes and mangel-wurzel; if, on the other hand, they are purged, I have a sod dug from the roadside and given them; or, which I sometimes think is better, I let them into a yard where there are cinders, mould, brick, and chalk rubbish. I think very little of garden-stuff as a means of keeping a pig in a good growing condition; it is no help further than satisfying occasionally the cravings of hunger; sows will do on it, or on grass, if there can be added daily a feed or two from the wash-tub. Sows, during the time of gestation, should have their diet restricted to articles that will not produce obesity; for sows, as well as cows, are apt to be attacked with what is called the milk-fever; and, besides, unwieldy sows have not that command over their movements that sows with a less proportion of flesh have, and are very likely to crush many of their young ones. For the first fortnight, the sow should be fed in such a manner as to leave off with a good appetite, and no better or more forcing food be given than fine pollard or coarse middlings; but as soon as all fever has disappeared, and the pigs can take the milk as fast as the sow can supply it, the finest middlings or oatmeal, or sometimes boiled rice, when it can be procured at about 8s. or 8s. 6d. a cwt., may be given three times a day. My little
PIGS.

Pigs are cut when five or six weeks old; but my sows, if intended for quarter pork, are not spayed, as this operation both throws them back and disfigures them. Many people recommend a spayed sow for the poor, but I always recommend a barrow pig, as growing to a larger size than the spayed sow pig, and in being far superior meat to an old spayed sow. In choosing a pig, look out for one with a wide open chest, well filled up from the ears to the tail, small-toed, and with meat in the fore-arm down to the knee, and in the ham down to the hock; a fine and short tail, with a small spread of hairs at the end. Let the breed be more inclined to make flesh than fat, and fine in the grain; and the preference should be given to a breed famed for broad backs and small entrails, for large-bellied pigs do not pull down the scale.¹

Journal of Agriculture, July 1846.

Art. XVII.—PIGS.


Mr. Barnes's pigs form, as far as the deputation know, a unique feature in farm management. He has some young ones which were very promising; and some eight or ten splendid animals fattening in the bay of a barn. The greater number of these pigs, however, amounting to 300 in number, have liberty to go where they please; in and about the orchards, meadows, yards, &c. excepting at dinner and supper time. This fact speaks highly for the state of Mr. Barnes's gates and fences, and the diligence of his swine-herd. Mr. Barnes makes these animals dress one of his meadows somewhat in the manner of folding. The pigman takes a sack of peas on his back, and drops them in a small train along the ground as he walks, for the pigs to pick up, making a wider circle day by day, till the pigs have been over the whole ground.

Agricultural Gazette, Sept. 5, 1846.

¹ For further information on Fattening Swine, see the Journal of Agriculture for September 1839.
ART. XVIII.—TRANSPORT OF LIVE STOCK.


On an average, three fat bullocks weigh one ton. On the road, a fat bullock travels on the average fifteen miles in one day, costing per day 1s. or three farthings per mile. About five and a half lean bullocks weigh one ton; these travel from fifteen to twenty miles per day,—say seventeen miles,—costing, on an average of seasons, 3s. 6d. per 100 miles—say a halfpenny per mile. On an average, there are four ordinary horses to a ton; travelling on the road from fourteen to twenty miles per day,—say on an average seventeen miles,—costing per day 4s.; or say, per mile, 2½d. Twenty fat sheep weigh on an average a ton: on a road, they travel about eleven miles per day, costing say, per score (this differs, however, very materially according to season and locality), 6d.; or, per mile, about a halfpenny. Sixteen pigs, on an average, weigh a ton: they travel on the common road, about twenty-one miles a day, costing, per score, about 9d.; or, per mile per score, three farthings.

Farmer's Almanac, 1847.
CHAPTER II.

ON IMPLEMENTS.

Art. XIX.—ON THE THRASHING-MACHINE.

By Mr. Sullivan.

[In a series of valuable "Remarks on the Agriculture of Aberdeen-shire," published in the Farmer's Magazine, there occurs the following account of the thrashing-machine, and of the instruments worked in connection with it; with incidental illustrations of the great economy and convenience of water as an impelling power, a resource which is still, for the most part, very grievously neglected.]

In 1799, a machine, propelled by water-power, was erected in the parish of Kintore, in this county, for 317, including the dam and water-course, which thrashed at the expeditious rate of fourteen quarters per hour. This is stated on the best authority—the aged owner of the machine in question. It is proper to add, that it was reckoned a three-horse power. The feeding rollers were 3 feet in length; the drum was 3 feet in diameter, and made eight revolutions for one of the water-wheel, which was 8 feet 8 inches in diameter, and the floats 8 inches in width by 1 foot 4 inches in length. It was what is technically designated an undershot wheel.¹

Few of the thrashing-machines now erected at double the cost and of double the power of the one just referred to will thrash so much as fourteen quarters of oats per hour. In

¹ There are three sorts of water-wheels, commonly known as the overshot, the undershot, and the breast wheel. The first derives its name from the water coming in contact with and passing over the upper part of the wheel; the second, from the water, after impinging on the floats, flowing underneath; and the third, from the water striking at a point in the circumference of the wheel intermediate between the former.
fact, the quantity ordinarily thrashed by a two-horse power
machine does not exceed three quarters per hour. A ma-
chine requiring a motive force of three horses, commonly
thrashes from five to eight quarters; and a four-horse power
is expected to thrash, on an average, about ten quarters per
hour; but it may frequently accomplish twelve, and even
fourteen quarters. It may not be amiss to insert in this
place, the dimensions of the principal parts of a thrashing-
machine of the latter power, which was recently erected for
a gentleman in this county, and is allowed to be of the most
approved construction. The impelling agent is water; the
diameter of the wheel is 11 feet; and the buckets are 3 feet
4 inches in width. The feeding rollers are 3½ feet in length;
the diameter of the drum is 3 feet 2 inches; and that of
the shaker is 5½ feet. A winnowing apparatus, driven by
Barker's centrifugal wheel, is attached to the thrashing-
machine. Being furnished with two "hoppers," it can be
employed in dressing grain either simultaneously with the
thrashing, or when the machine is not in operation. The
cost of erecting the whole machinery was 58l. The average
rate of thrashing is twelve quarters per hour; and the quan-
tity of water necessary to accomplish this work varies from
1600 to 2000 cubic feet for every quarter, according to the
quality of the corn and the length of the straw.

The thrashing-machines employed in this county vary
very much in size and power,1 in consequence of the great
diversity that exists in the size of farms. A four-horse-
power machine is commonly used on farms ranging from
150 to 300 acres, a three-horse-power on those varying from
80 to 150 acres, and a two-horse-power on the smaller class
of farms from 25 to 80 acres. A machine requiring only
the power of one horse to propel it, is sometimes resorted to
on small possessions of about 20 acres. The grain-crop on
holdings under the last-mentioned size is most generally
thrashed by the flail; and the cottagers perform this opera-
tion in the winter mornings by the light of the lamp, or
during inclement weather, when out-of-door labour is sus-
pended. It is supposed that the thrashing-machines at
present employed in Aberdeenshire are impelled by an

1 A simple rule for ascertaining the power of a water-impelled thrashing-
machine is to cube the radius of the wheel, multiply the square-root of this
by the area of the transverse section of the water where it impinges on
the wheel, and divide the product by 6 ½ : the quotient is the horse-power to
which the wheel is equivalent.
aggregate force of at least 8000 horses: but, owing to the
great extent of the county, this is a point which it is very
difficult correctly to ascertain.

The motive powers employed in this county for the pur-
pose of impelling thrashing-machines are water and horses.
The former, as being not only the most economical, but
likewise the most effective agent, is, of course, invariably
preferred, and used wherever an adequate supply of it can
conveniently be procured; and as the many hills and dales
with which the surface of the county is diversified give rise
to numerous rivulets, water-impelled machines are very
general throughout Aberdeenshire. The superiority of this
power over horses (irrespective of its greater economy) con-
sists in imparting a more uniform motion to the machinery
and in enabling the farmer to thrash and prepare his corn
for market or other purposes in all states of the weather,
when a sufficiency of water is available. Horse and water
power are occasionally employed in conjunction, which, in
some situations, is found a very useful arrangement. During
the droughty months of summer, the former is put in requi-
sition either by itself or as an auxiliary to the latter, though
at other seasons the supply of water may be quite adequate
to impel the whole machinery. In order to convey some
idea of the comparative advantages of the three modes of
propulsion referred to, viz. by horse-power, water-power,
and both conjointly, a great number of farms of different
sizes have been selected; and the actual power of the
thrashing-machine employed on each having been ascer-
tained, it has been found that on those farms on which
animals alone constitute the motive force, one-horse power
is required for every twenty-four acres on an average; but
that where water alone is employed, one-horse power is found
to be sufficient for thirty-three acres; while on those on
which both agents are used in conjunction when necessary,
the same power is quite adequate for every thirty-four acres
of arable land.

The steam-engine has recently been resorted to by a few
farmers in this county for impelling the thrashing-machine;
but, for several reasons, this all-powerful agent is by no
means likely to be either much or very profitably applied to
farm purposes in Aberdeenshire. In the first place, it is
more expensive than either horse or water power. As no
coil is found in the county, the cost of fuel would amount
to a considerable sum per annum in the internal parts, not
to mention the original cost of an engine and its appurtenances. And, in the second place, this being more a grazing than a corn-growing district, the quantity of grain annually grown on individual farms, of even the largest extent, would hardly warrant the erection of a steam-driven thrashing-machine. This agent, being vastly superior to horse-power, is generally preferred and employed in localities (such as the Lothians and Berwickshire) abounding with extensive farms, where coal is abundant and cheap, and where a very large quantity of grain has annually to be thrashed and prepared for market; but in Aberdeenshire neither of these conditions can be said to exist. The steam-engine is, of course, both inaccessible to, and unnecessary for, small farmers; and to use it with economy, even on large possessions, it is requisite to continue the operation of thrashing throughout a whole day at a time; which in general is neither convenient nor necessary in this part of the country. There are at present, I understand, no more than five thrashing-machines in Aberdeenshire impelled by steam.

The expense of thrashing and dressing grain per quarter varies according to the nature of the motive force employed, the power of the machine, the quality of the crop, and other obvious circumstances. Water, where it can be procured in sufficient quantity for the purpose, constitutes by far the most convenient and economical impelling agent. A most important advantage attending the employment of water-driven machines is, that by them the greater proportion of the crop may be, and in Aberdeenshire generally is, thrashed and dressed in the winter mornings, before the labours of the field could be commenced. The common practice is this:—

A part of the barn having been previously filled with sheaf-corn from the stack, the thrashing is prosecuted for an hour or more every morning, beginning about five o'clock, and leaving off at break of day; the servants then breakfast, groom their horses, and begin the ordinary out-of-door business of the farm. The adoption of this arrangement obviates the necessity of stopping the ploughs during the usual hours of labour for the purpose of thrashing—an advantage which it is impossible to secure when horse-power is employed. In order to illustrate the actual and relative expense of thrashing and dressing grain in Aberdeenshire by the different methods usually practised, I shall here introduce separate statements of the cost of the process by water,
horses, and the flail, on an arable farm of 220 acres, cultivated according to the six-course rotation of cropping, and producing annually about 440 qrs. of grain. In the subjoined calculations, we take the wages at the usual winter rates in Aberdeenshire, viz., a man at 1s. 6d., a woman at 10d., and a pair of horses at 8s. per day. We shall suppose the thrashing; &c. to be executed during the ordinary hours of farm-labour in each of the cases referred to. It has frequently been found that it requires eleven days, of four men and two horses, to cart the unthrashed corn from the stack-yard to the barn. On these data we shall now proceed with our calculations.

1. Water-power.—The first cost of the thrashing-machine and its appendages is assumed at 90l., and interest is allowed on this sum at four per cent. per annum. The winnowing-machine, also, is driven by water, which saves the work of one man. The whole cost of thrashing and dressing 440 qrs. of oats by water-power may be stated as follows, viz.—

To two horses, eleven days carting corn to barn, at 1s.  £ s. d. 4 8 0
To four men, eleven days attending do. at 1s. 6d. each, per day. 3 6 0
To four men, eleven days attending thrashing-machine, at 1s. 6d. each per day. 3 6 0
To two men, eleven days dressing 440 qrs. of grain, at 1s. 6d. per day. 1 13 0
To one woman, eleven days assisting at do. at 10d. per day. 0 9 2
To interest on cost of thrashing-machine, &c. 3 12 0
To annual wear and tear of machinery 3 3 0
To oil and repairs 1 5 0

Cost of thrashing and dressing 440 qrs. £21 2 2

2. Horse-power.—The thrashing-machine is a six-horse power, and is worked ten hours per day, during which forty quarters are thrashed. Four men are required in the barn—one to unbind the sheaves, one to supply them to the machine, one to remove the straw, and one to riddle and remove the grain as it comes from the first farmers. The original cost of the machine and its appendages is assumed at 90l., as before.

£
To carting corn into barn, as before .................................. £ 7 14 0  
To six horses, eleven days working thrashing-machine,  
   at 4s. each per day ........................................... 13 4 0  
To four men, eleven days attending do., at 1s. 6d.  
   each per day .................................................. 3 6 0  
To three men, eleven days dressing grain, at 1s. 6d.  
   each per day .................................................. 2 9 6  
To one woman, eleven days assisting at do., at 10d.  
   per day ........................................................ 0 9 2  
To interest on cost of machine, &c. ......................... 3 12 0  
To annual deterioration of do. ................................. 3 3 0  
To oil and repairs ............................................. 1 5 0 

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrashing and dressing 440 qrs.</td>
<td>£35</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>1 qr.</td>
<td>0</td>
<td>1 7 1/2</td>
</tr>
</tbody>
</table>

3. **The Flail.**—Corn is generally thrashed by the flail at a certain rate per quarter. The winnowing and dressing of the grain commonly require about double the labour which suffices in either of the two former cases. The quantity which a man is capable of thrashing in a day by the flails depends in a great degree on the quality of the corn; but one quarter is allowed to be the usual rate of thrashing per day of ten hours. The following is a statement of the cost, according to the customary allowance per quarter in this district.

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>To carting corn to barn, as above .........................</td>
<td>7 14 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>To thrashing 440 qrs. of oats at 1s. 6d. per qr. .......</td>
<td>33 0 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| To three men twenty-two days dressing do., at 1s. 6d.  
  each per day .............................................. | 4 19 0 |
| To one woman, twenty-two days assisting at do., at  
  10d. per day .............................................. | 0 18 4 |

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrashing and dressing 440 qrs.</td>
<td>£46</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>1 qr.</td>
<td>0</td>
<td>2 1 3/4</td>
</tr>
</tbody>
</table>

It is proper to observe that the cost of thrashing corn by water-power, as given above, is considerably more than the sum usually incurred, since much of the work is accomplished when the servants would be otherwise unemployed. The charge for the horse-power, on the other hand, is rather under the general expense, as the farmers here rarely or never thrash longer than a few hours together, and much time is necessarily lost by short yokings. The preceding observations on the thrashing-machine, &c., having extended to greater length than was intended, my remarks on the other machines belonging to or employed in the barn shall be as compendious as possible.

**Winnowing-machine, or Fanners.**—It appears that the
first winnowing-machine employed in Aberdeenshire was imported from Leith in 1783, and that, so highly was its usefulness estimated even at that period, that not many years elapsed till there was scarcely a farm of any note in the county unprovided with one. A fanner is almost invariably connected with the thrashing-machine (motion being communicated to both by the same impelling power), the function of which is to separate the grain from the chaff, &c., previous to its appearance in the corn-barn. A second fanner, of a somewhat different form, though essentially similar in the main features of its construction, is employed for dressing or finally preparing the grain for market and other purposes. This is also not unfrequently driven by the same power that propels the thrashing-machine, especially where an abundant supply of water is available, motion being communicated to it in the usual manner by means of a leathern belt extending from some part of the machinery. Within the last few years various alterations, and, no doubt, some improvements, have been effected in the construction of the winnowing machine; but no deviation from the general principles has been made; and therefore it is presumed any further notice would be superfluous.

The Hummeller.—Every corn-barn is furnished with a hummeller, for removing the awns from the grains of barley and bear. This instrument is of various sorts. On the smaller class of farms, hand-hummellers are commonly employed, which are either of a square or circular form, and consist of a number of parallel bars of iron fixed to a frame of the same material. The barley to be hummelled is placed upon the barn-floor, and is freed from its awns by repeated strokes of the instrument. Another description of hummeller, which is very commonly employed in this county, consists of a fluted drum-cover, the diameter of which is half-an-inch greater than that of the drum. The number of flutes varies from thirteen to sixteen, and they are placed at intervals of 1\(\frac{1}{2}\) inch. Their length is the same as that of the drum. A space of about six inches in width, adjoining the feeding-rollers of the thrashing-machine, is necessarily unfluted, and, by means of a simple contrivance, it can be elevated or depressed as may be found necessary. This sort of hummeller has been in use in this district from a remote period. It costs very little, and is sufficiently effective for ordinary purposes, but occasions some additional work. It is more generally employed in this county than
any other kind of hummeller. Another instrument, which is now much used for the same purpose, consists of a cast-iron box about two feet in length, one foot three inches in diameter at one end, and one foot at the other. The box is divided into two halves, the uppermost one being threesided, the lower circular; and both are firmly screwed together with bolts. The barley to be hummelled is conveyed into the box through a small hopper at the top, and the awns are broken off by the action of a number of flat, thin blades of iron attached to a spindle or shaft of malleable iron revolving within the cylindrical box at a high velocity. The spindle is an inch square; the blades, of which there are two opposite rows, are one inch in breadth by one-fourth inch thick, and tapered somewhat towards the points. The velocity of the spindle and its attached blades is 700 per minute. This kind of hummeller is so placed in relation to the thrashing-machine as to receive the grain directly from the first fanners. The usual price of this apparatus is 3l. 3s. The several operations of thrashing, hummelling, and winnowing always proceed simultaneously when barley or bear is being prepared for the market or for seed.

The other instruments occasionally worked in connection with the thrashing-machine are a corn-bruiser and a churn. The former apparatus is employed in bruising oats for horses, a practice which is found to effect a considerable saving in the quantity of grain required for feeding. When a sufficiency of water is available, a churn is not unfrequently worked by this power, and with much convenience and advantage. A separate water wheel of small dimensions is sometimes used for this purpose, so that the operation of churning may be at any time carried on independently of the thrashing-machine and its wheel.


Art. XX.—LIQUID MANURE-CART.

Invented by Mr. George Morice, Kenmark.

The cask for containing the liquid is mounted upon an axle and wheels, which are attached in the usual manner to a
LIQUID MANURE-CART.

The machinery for maintaining the cask always in a horizontal position, and for regulating the discharge of the liquid, is both simple and ingenious. At the foremost end of the cart is fixed what is technically termed a "bridle," with a mortice in its centre, in which works an upright bar of iron perforated with a number of holes, and fastened to the cross-bar of the shafts. Attached to this bridle, and within reach of the driver, is a lever, by means of which either end of the cask can readily be elevated or depressed to suit the irregularities of the ground, or in travelling up or down hill. From the circumstance of the cask being maintained in a horizontal position, the weight on the horse's back, as well as the pressure on the discharging apparatus, is always uniform, however uneven may be the surface of the ground. The apparatus at the posterior end of the cask, for regulating the flow of the liquid, is also very simple and effective. The discharging orifice is furnished with a "shutter," which is opened to any required extent by means of a short lever, and attached to it is an iron pipe for conveying the liquid into the spreading-box. This short pipe is closed at its outer extremity, but is provided with two apertures, one on each side, through which the liquid, in escaping from the cask into the spreader, diverges equally on both sides. By means of the lever and shutter, the flow of the liquid can be regulated to any required quantity, while the perforations in the bottom of the spreader admit of being widened or narrowed as may be found necessary. The spreading-box is commonly 7½ feet long, but can be made to any required length, and is easily detached from the cart after being used. The wheel-rims are 5 inches in width, that the grass may not be injured or cut up, and the axle is curved downwards to allow the cask to be kept as low as possible. The weight of the whole cart when the cask (which contains 118 imperial gallons) is full, is 19 cwt. This liquid manure-cart has obtained a prize at each of the annual competitions of the Aberdeen, Banff, and Kincardine Agricultural Association. The inventor is at present attempting some further improvements. The price at Aberdeen is 10l. 10s.

Art. XXI.—Tank for Liquid Manure.

The following estimate for a tank is from the "Transactions of the Highland and Agricultural Society":—

<table>
<thead>
<tr>
<th>ft.</th>
<th>in.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length within</td>
<td>13 6</td>
<td>19 ½ cubic yards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>6 6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>6 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cutting at 3d. per cubic yard</td>
<td>0 7 6</td>
<td></td>
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<td>Plastering and cement</td>
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<td>Covering and flags</td>
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<td><strong>Total</strong></td>
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This would be a tank sufficiently capacious for a farm of from 150 to 200 acres.

Art. XXII.—On the Advantages of One-Horse Carts over WaggonS.

By Mr. P. Love.

[Mr. Love sets about his task of proving these advantages very methodically, taking up in succession each department of farm-work in which carts or wagons are employed. The summing up only of his argument is here presented.]

I think that there is no sort of farm-work for carts or wagons that I have not treated of, and will now therefore sum up the whole, that we may see the final results.

First, I take carting out of manure, which gives rather more than a fourth in favour of one-horse carts over two-horse carts; wagons being out of the question altogether for that sort of work.

Secondly, in the carrying of hay there is a saving of horse labour to the amount of a fourth, as well as some advantage in the manual labour, through their lowness in field, notwithstanding the very small disadvantage of height in the rick-yard.
ON THE ADVANTAGE OF ONE-HORSE CARTS. 71

Thirdly, in the drawing of lime, stones, slates, tiles, or manure, great distances, there is a saving of at least a fourth.

Fourthly, in harvest work there is a saving in one-horse carts over waggon with only two horses in them; and allowing that they would be able to draw two tons in them besides the waggon (which I believe is not possible); but it matters not, for even if they could, carts are then the most economical by at least one-seventh, both in horse and in manual labour at harvest work, which is the most important of all work.

Fifthly, in carting of roots there is the same saving over two-horse carts, as in the drawing on of manure, namely, one-fourth.

Sixthly, in the marketing of corn, the one-horse carts have the same advantages over waggon as in carting lime, &c., namely, one-fourth in horse labour, but a drawback of one-eighth in the manual labour, making a clear saving of one-eighth.

It would appear, from every rule and observation that I have made these five years, that there is a general saving of one-fourth in horse labour at all sorts of work; but in going distances from home there is a drawback of about a third in the manual labour; but when there are four horses and carts going out, a strong boy would do, thereby reducing that expense. In fact, all the increase of men will not amount to more than will pay the interest of the money sunk in waggon; and as every man must have a certain number of carts, whether he keeps waggon or not, therefore it is an important consideration, whether a man buys four or five waggon, besides dung-carts, or whether he should buy six first-rate new harvest-carts, made of good larch or red pine, realizing a saving of about 70 per cent. to buy some good implements with, to assist in growing some long straw, that will lie on the carts.

CHAPTER III.

ON DRAINING.

Art. XXIII.—THE ELKINGTON SYSTEM.

[From Remarks on the Agriculture of Aberdeenshire.]

By Mr. Sullivan.

Dr. Skene Keith mentions that many of the landed proprietors had employed Johnston, a disciple of Elkington, to survey not only their personal farms, but also those of several of their tenants, for the purpose of obtaining directions from him regarding the best method of removing the superabundant moisture which they had found from experience to be most prejudicial to their crops. As the over-wetness arose, in many instances, from water issuing to the surface, in consequence of meeting with some interruption in its subterranean course, the Elkington system was found highly beneficial. In those days it was deemed unnecessary to drain any except springy or spouty land; and it was seldom that the whole of a field was drained, but merely the spots which it was dangerous to allow the working cattle at any season to walk over. When a spouty patch was to be dried, a large drain or trench was formed of sufficient depth to reach the channel or bed along which the water filtered before encountering the obstruction which had forced it to the surface; and so directed as to intercept as many springs as possible. It was found that one drain skilfully placed, and of sufficient depth, frequently rendered a large tract of wet land perfectly dry and firm. Though not now practised to any thing like the same extent as formerly, this method of draining is still adopted in most cases where the wetness proceeds from one or more springs, as in bogs and swamps.
The drains are cut from five to seven, and occasionally nine feet in depth, and most generally filled with stones to within two and a half or two feet of the surface; but they are also not unfrequently left open in bogs, and other situations where the cartage of stones would be difficult, if not altogether impracticable, until the ground has acquired some degree of solidity after the removal of the water with which it was surcharged.

As superfluous moisture (in hilly lands in particular) often arises from both causes associated, namely, springs and (recent) rain-water; so both systems of draining, viz. the Elkington and the Deanstone, are frequently combined with the greatest advantage. Although the latter popular method is beyond question the most applicable to the greater proportion of the wet arable land in this and other parts of the country, yet experience has fully proved that it cannot, in all cases, be practised with equal benefit or economy, and abundantly shown the impropriety of altogether abandoning the system of deep-draining, as has been done in most districts throughout the kingdom. Drains cut to the usual depth of furrow-draining will always more or less mitigate the evil in the case of wetness proceeding from springs; but it is manifest that they cannot remove the cause, as they are too shallow to reach and intercept the current of water. Both remedies are, in reality, applicable to very different cases; and, consequently, neither of them can with propriety be substituted for the other, though both may be, and, indeed, have been practised in conjunction with the most beneficial results where both sources of wetness exist.

Farmer's Magazine, Nov. 1846.

Art. XXIV.—The Deanstone System.

Its Development by Mr. Smith.

[In a brief but interesting sketch, in the Farmer's Magazine, of the career of this distinguished promoter of agricultural improvement, there is an account of the gradual development of his views of draining—the subject with which his name is so inseparably connected.]

He had turned his attention at a very early period to the subject of land-draining, having seen a great deal of money so far fruitlessly expended in deep cross drains, intended
chiefly for carrying off under-water. Furrow-draining with turf had been introduced into the flat clay lands of Stirlingshire and the west of Perthshire, about the year 1806 or 1807, and Mr. Smith had, after he went to reside in Perthshire, opportunities of studying its effect, and the mode of action in draining off the water. He perceived that it was the water that fell upon the surface in the shape of rain which was carried off by these drains; and it then occurred to him that the same system of draining applied to the lands of the up-country would have the effect of carrying off the surface water, which so generally stagnates, especially in cold clay soils, and which is, in fact, the cause of their being cold and tenacious in wet weather, and hard and unworkable in seasons of drought. Not having any land in his possession at this period (after ineffectual efforts to prevail upon others fully to carry out his views), in the year 1823, he was enabled to test their soundness on his own farm of Deanstone, consisting of 189 acres; to which he afterwards added about 25 acres more, and upon this he proceeded to realize his plans of thorough-draining and deep working, desiring to attain a system of garden-culture over the whole farm. The land consisted chiefly of the drifted debris of the old red sandstone, and of various texture; some parts of the subsoil consisting of hard compact soil with stones, and some, in the hollows, of sandy clay composed of the soil which had been washed for ages from the higher parts of the ground; the whole was very much interspersed with large boulder-stones, some of them very near the surface. The active soil was in general very thin, in many places not exceeding four inches. Much of the surface was studded with rushes and other water plants, whilst the drier knolls were covered with furze, heath, and broom. After much consideration, he resolved to carry one uniform mode of drainage over the whole surface of the farm. He fixed upon thirty inches as the best depth to ensure at once efficiency and economy. He laid parallel lines of drains at twenty-one feet apart over the whole surface of each field, without regard to the apparent wet or dry condition of the soil; and he carried those parallel drains as near as possible in the direction of the steepest descent, as being best fitted for carrying off the water quickly. Of course he provided proper out-falls for the main receiving drains. Having abundance of stones—partly on the surface, partly in the subsoil, and partly in old stone fences—which he resolved
to remove, he arranged to preserve the permeability of the drains with the smaller stones, or stones broken to the size of a turkey's egg. The drains he had cut narrow at the bottom, not exceeding four inches in width, in order to confine the current of the water to a narrow channel, thereby ensuring the removal of any casual deposit. He filled up the drain to the depth of twelve inches with stones, leaving eighteen inches from thence to the surface for the working of the plough. He very soon discovered the propriety of closely covering over the stones to prevent the water leaving any direct access, which he accomplished by using a very thin turf, closing in the whole drain, and over this he caused the stiffest soil he could find to be tramped firmly down.

This mode of placing the drains proved very successful, and effected a thorough and uniform dryness over the whole surface. He had not proceeded far in deep ploughing, when he discovered the necessity of having a powerful instrument to stir up the subsoil, and remove the stones which everywhere obstructed the plough. This gave rise to the invention of the subsoil plough, which was designed to stir up the subsoil without bringing it to the surface, or to mix in any material degree with the active soil, as he found that sterile subsoil injured the productiveness of the active soil when mixed with it, before having been exposed to the action of the air for some years. Mr. Smith proceeded in applying this system over his whole farm, and the yearly results of the crops proved the correctness of his theory, and his farm soon became the attraction of enterprising and intelligent agriculturists. He had still great difficulty in persuading his neighbours to make trial of his system to any extent; and it was not till they had seen the result of successive crops that they followed his example; even then they made their trials on a small scale.

Mr. Smith commenced by saying, that the subject of lecture to-night was the important one of thorough-draining, and other matters connected with it; and he would endeavour to give a practical explanation of his views in as few words as possible. The advantages arising from draining the soil were many. On well-drained land there were many more days in the year on which the farmer can plough and harrow than on other land. When he did plough and harrow, the operations were much more easy and efficacious, and thorough harrowing and ploughing of good land was of more advantage than an equal amount of labour expended under less favourable circumstances. Manure, likewise, had much more effect when the land was well drained than if it were put into a wet soil. With a dry soil they had more warmth, and when the sun shone it encouraged the plants to grow; whereas sunshine was rather hurtful for a time to wet land. They knew well it was the practice in hot countries to put a wet cloth round a bottle of wine for the purpose of cooling it by the evaporation of the moisture, and the same effect took place on land, although not so perceptibly. It was a very strange thing that agriculturists had so long known the advantages of thorough-draining, and that it was not more appreciated. A great deal had been done in this country for sixty years, in attempts to dry the soil, but these attempts had been chiefly confined to the removal of water which arises in springs below the soil. That was accomplished by the cutting of deep drains around the margin of the fields, which had the effect of removing at least part of the water from extremely wet and marshy places, but had very little effect in rendering the surface sufficiently dry for the purposes of complete cultivation. It was not until a later period that attention was given to the water which fell on the surface. When rain fell upon land composed of stiff clay, it must either run off or be evaporated. Mr. Smith then, by the use of diagrams, explained the mode in which the rain fell upon the ground, and percolated through the
soil. He alluded to the practice, which he said had existed from time immemorial, of throwing the land into ridges and furrows, and showed that, by the soil being washed from the tops of the ridges into the furrows, the higher parts of the field produced comparatively little crop—the best particles of which the land was composed being carried off into the furrows, and then into some adjoining stream. Whenever they saw a large river running brown after a fall of rain, they might be sure that the best part of the soil was being carried away, never to be recovered, until, in the course of time, it might be thrown up from the bottom of the sea and form land such as their carse:s; but it was lost irrecoverably to the present generation. It was of great importance, therefore, to lay hold of that part of the soil, and not to allow it to be washed away. In thorough-drained land, no drop of water should run on the surface in any direction, but should penetrate into the ground where it fell. By the aid of diagrams, representing a section of the ground, with stone and tile drains in it, the lecturer then explained the manner in which the rain percolated through the active soil, then into the parts of the soil not in use, but which had been stirred by the subsoil plough, and then along the surface of the subsoil, which had never been mechanically moved, into the drains. He next explained, by the same means, the action of the atmosphere upon the soil in thorough-drained land, in producing cracks or fissures, so that water easily found its way into the channels prepared for carrying it off the ground. Wherever the land was drained, it was necessary that the high ridges should be done away with, and the land laid down perfectly level. Some people had an idea that water, when it fell, immediately began to find its way to the drains through the earth in the straight direction; but there was nothing which drew it in any way but gravitation; and its natural action, therefore, was to descend as straight as it could go. When rain fell with great force, if it were allowed to run along the surface, as it did on undrained land, it carried away the whole of the fine soil; but, in consequence of this system of draining, the whole of that valuable matter was left by the water in the soil itself. The water began to clear near the surface, and before it reached the point where it found its way into the drain, it was perfectly pure. No better proof could be given of the effectiveness of draining, than to see the water coming from the drains perfectly clear, which was generally the case. As
regards the depth of drains, there was a just medium, in order to give them most effectually the power of drawing the moisture from the superincumbent soil, and rendering it completely dry; and of allowing the atmosphere to operate freely in producing that effect. Were this not attended to, and the drains made too deep, the water would remain longer in the soil than would be either necessary or useful. He then explained the utility of having frequent drains, and showed that a given quantity of rain would take far more than double the time to find its way to the drains, if they were placed at double the distance from each other. He thought, from all the experience which he had had, that drains should be from about eighteen to twenty-five feet apart, according to the kind of soil which required to be drained. He then showed, at some length, the superiority of the system of laying out drains in parallel lines from the top to the bottom of the field, or in the direction in which the ridges were formed, to laying them out across the ridges or diagonally. He likewise showed the advantage of making them at equal distances, and recommended that every farmer should have a map of his drained fields; in which case, in the event of any of his drains being choked up, he would at once see where the drains had been put. He did not approve, where ridges were retained, of drains being formed in the furrows, and was of opinion that the tops of the ridges was a much better situation. When cutting drains, it was of importance to make them as narrow as possible to receive the water, as more stones were necessary to fill the drains when they were made wider, and were more apt to give way. It was found that from twelve to thirteen inches at the top, in which a man would easily work, was the most convenient width; and from three and a half to four inches at the bottom, would do for a stone drain, and equally well for tile. It was of great consequence to have them so cut when tile was to be used, that it would be easily put in; for when there was any difficulty in that respect, the individual placing it put his foot upon it and probably broke the tile. It was of importance to have them easy, therefore; but, at the same time, not to cut more than was absolutely necessary. With regard to the use of tiles or stones in the formation of drains, he had no doubt but a stone drain, if properly executed, was an imperishable drain. Tiles were more liable to accident, and might be insufficiently burned; and they would not very well distinguish by the eye when this was the case,
and a bad tile destroyed the whole drain. But there were situations in which stones were not to be had, and it then became a matter of necessity to use the tile. He then discussed the question of the size of the tube of the tile to be used, and gave it as his opinion that the bore should never be less than one and a half to two inches. The tile and sole were very good, but it was more expensive than the single tube. With regard to the stones, they should be broken to about the size of an egg; and upon many lands they would get a sufficient quantity of stones to do the whole of their drainage. They would be required, however, to be freed of earth. When he first recommended broken stones for the bottoms of drains, he considered that twelve inches of them would be necessary; but on further consideration of the subject, and from the experience which he had had, he was quite satisfied that a great deal fewer stones would serve the purpose, if properly executed. He found that from six to eight inches of stones, well broken, were quite sufficient to maintain the drain open. But one of the most important points in regard to the formation of drains was, to secure them well above, so that the water might get into them free of sludge. Many people complained of this, and straw and other similar substances were put in, which, being perishable substances, quickly decayed, and assisted to destroy the drain. Turf, in his opinion, was infinitely preferable, which should be covered with four or five inches of the stiffest clay they could get. He wanted no water to get directly into the drain. He next referred to the propriety of ploughing down the ridges, after the soil was properly drained; but recommended that this should not be done too rapidly, by which the higher parts would be rendered sterile. He next referred to the construction of main drains, and illustrated his observations by reference to a diagram. He then entered upon the subject of turf-draining in peat land, of which he had had some experience lately, and exhibited the various implements used for that purpose. The operation consisted of cutting out at once, by a particular process, from twenty-five to thirty inches of the turf, and laying it to one side of the drain. A portion of the peat was then cut by a narrower spade, and laid upon the opposite side of the drain. After this, another cutting, still narrower, was thrown out, and then the peat and the turf—with the exception of the last portion—were put back precisely where they were taken out. Some people thought
the surface-turf the best to be put in first; but the peat being indestructible, and not liable to be acted upon by the atmosphere or the water, was much superior for that purpose. Another great advantage of this mode of improving the land was, that peat land could be completely drained for 1l. an acre, which was cheaper than he had ever known land drained before.

Agricultural Gazette, Sept. 19, 1846.

Art. XXVI.—ON DRAINING.

By Josiah Parkes, Esq., Consulting Engineer to the Royal Agricultural Society.

[The following abridged account is from a valuable paper read by Mr. Parkes before the R. A. Society at Newcastle-upon-Tyne. Mr. Parkes is well known as a warm and talented advocate for deep draining. In his introductory remarks, he quotes the work of Captain Walter Bligh, of which a third edition was published in 1852—no slight proof, at that period, of the popularity of the book—in which the advantages and theory of deep drainage are enforced and explained with remarkable clearness and precision. Mr. Parkes justly gives credit to the sagacity of Bligh for drawing attention to the very important practical difference between the transient effect of rain, and the constant action of stagnant bottom-water, in maintaining land in a wet condition.]

It is this subterranean water, as it may be not improperly termed, to which excessive and injurious wetness is attributable; and if such water be not removed and kept down at a depth exceeding the power of capillary attraction to elevate it near the surface, no drainage can be efficient. It is this force, combined with the absorbent power of the earths, which chiefly maintain those soils in a sufficiently moist state for vegetative perfection, on digging into which, we do not discover any free water within several feet of the surface. The effect of rain is to thoroughly moisten such soil, gravity carrying down below the excess, or that portion which the soil cannot absorb or retain. Evaporation takes place from the surface of the land, and as each atom of moisture is taken up into the atmosphere, its place is supplied by another atom communicated by the contact of the particles of soil, the more superficial acting on the deeper particles like so many pumps to elevate the water.
and supply the loss. In this way the deep rich loams to which I have before adverted as so rare and so coveted, are maintained in a nearly constant condition of moisture, suitable to the necessities of plants. It may and does, though rarely, happen, that even such soils, during long-continued droughts, suffer,—that is, become too dry; but the attentive observer will notice a very beautiful and powerful provision of nature to prevent excessive dryness. During the night, evaporation from the surface of soil commonly ceases, to commence again when the rays of the sun impinge upon it; but capillary action is constant, and of equal intensity, both by night and by day; so that we have, on the average, twelve hours per diem of the sun’s influence to produce evaporation, and twenty-four hours of capillary action to supply the loss from below, and maintain a tolerably uniform hygrometric or moist condition of the active soil. It is, I believe, consistent with the universal opinion, that drained lands do not burn nor suffer from drought so soon, or so much, as those soils which are wet at all periods of the year except during the hottest months. This phenomenon is explained by the fact of a retentive soil swollen by water contracting so much, by the loss of its water, that it is almost inaccessible to air, from which to obtain moisture. After drainage, the mechanical texture of such soils becomes gradually changed; pulverization takes place in the subsoil in a manner precisely similar to the change we see produced in fresh turned-up soil well exposed to the atmosphere; such change of texture in the mass below is doubtless slower than in the superficial soil, but it is equally certain to occur.

Perhaps no more striking illustration of the great importance of securing free ingress to air, and free egress to water, in the mass of the soil, can be given than that which is derived from the fact, that by allowing land to rest without cropping it—in short, by fallowing it—fertility is renewed, and this effect is produced solely by supplies furnished from the inexhaustible magazine of the atmosphere. The atmosphere is our cheapest, it is a boundless storehouse of manure: then why not let it freely and deeply into our soil? The earnestness with which I appeal to the landed proprietary of Britain to drain more deeply, and abandon the oftentimes abortive, and at all times incomplete, system of shallow drains, is derived from the indications of experience; and to those well informed of the superior economy and efficiency
of the deeper system, it is painful to behold the sums of money daily buried in the soil with such good intentions, but with comparatively so little useful effect. In respect, however, of the depth at which drains may, with a certainty of action, be placed in a soil, I pretend to assign no rule; for there cannot, in my opinion, be a more crude or mistaken idea, than that one rule of depth is applicable with equal efficiency to soils of all kinds: the same remark applies in regard to assigning any common rule of distance between drains, which may be greater or less according to the depth of the drains, and the texture of the particular soil. It must be self-evident that water will flow through a gravel, or a sand, or a loam, with less obstruction to its passage than through a clay, and easier through one clay than through another containing different proportions of silica and alumina. There are also many other properties of soil to which the drainer has to pay attention in determining depth and distance, such as tightness or compactness, uniformity, or intermixture of soils of a different texture in the line of his drains in the same field, &c. &c. All these circumstances will affect both his practice and the cost of the work. It consists with my own practice at the present time, that drains are being executed at depths of from four to six feet deep, according to soil and outfall, and at distances varying from twenty to sixty-six feet; complete efficiency being the end studied, and the proof of such efficiency being that, after a due period given for bringing about drainage action in soils unused to it, the water should not stand higher, or much higher, in a hole dug in the middle between a pair of drains than the level of those drains.

The cost of drainage is in like manner affected by the texture of soils, their stoniness, &c.; and rates of work are being paid, varying from 3d. to even 1s. 6d. per rod (5½ yards), causing the cost of drainage per acre to vary from 2l. to even 5l. per acre, according to circumstances.

The following instance is adduced by Mr. Parkes of the necessity of ascertaining the nature of the soil to be drained:—A grass-field at Strathfield-Sayce was found very wet, and it was thought that no drainage deeper than about 2 feet would have any effect upon it, as drains in other parts, which had been made 3 feet 6 inches deep, had not effected much more good than the shallower ones. It was also thought that the mass of clay beneath would be found almost impervious to water, as cracks had only opened in hot seasons to about 15
ON DRAINING.

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inches deep. However, we had the turf and mould borne off a space of about 5 feet square and 22 inches deep, when a bed of yellow plastic clay appeared. Into this bed, which was soft and easily worked by the hand, a hole was sunk. But a very slight quantity of water oozed into the hole until we reached about 4 feet 3 inches, when the hole rapidly filled with water. It was still clay, but evidently of a more porous nature, and there a mass of free water resided. It was apparent that the cause of the upper clay and surface soil being so wet, in defiance of the shallow drains, was now discovered, for as the upper clay repo-ed on what, relatively, may be called a pillar of water below, the capillary force, always in action, continually sucked up this water; and supplied the incumbent soil with a perpetual excess of fluid. The shallow drains might have done their duty in removing the water of rain—the surface water—but they could in nowise affect the liberation of the bottom water. An experimental drain was then made, 5 feet in depth, and 350 yards long, laid with 1½-inch-bore pipes. Clay was puddled in over this line of pipes up to 2 feet 6 inches from the surface, and another line of similar pipes was then laid, so that we had a shallow and deep drain in the same trench, the object being to measure the relative discharges of water from each; and the lower drain was puddled over, to prevent as much as possible the top water from mixing with the bottom. The result was, that the bottom drain discharged, from the commencement, a stream averaging one gallon per minute during seventy-six days, being equal to nearly 5 tons every twenty-four hours. The run then rapidly diminished, and speedily came to drop only. A second 5-feet-deep drain had been made 36 feet distant, so as to insulate a space of land on one side of the experimental drain, and it will be found that, taking the length of 350 yards, with a breadth of 12 yards, as affording water to the bottom drain (6 yards on each side of it), no less than an area of 4200 square yards of water, 5½ inches deep, had been removed by this one drain. The upper line of pipes answered to rain, and removed it; but the observers do not think that any, or much, of this water has reached the lower drain. The land is now reported to me as giving way in cracks to a greater depth than formerly, so that an efficient drainage may be ultimately expected. The following is an analysis of the clays in question, taken at 22 inches and 4 feet 6 inches deep, respectively, beneath the surface, by Mr. Phillips.
ON DRAINING.

Clay at
22 inches
per cent.  Clay at
4 feet 6 inches
per cent.

Silica .......................... 59-0  72-9
Alumina .......................... 23-5  13-4
Peroxide of iron ................. 8-1  6-6
Carbonate of lime ................ 1-0  0-8
Water, with a little carbonaceous matter,
slight traces of magnesia, and sulphate
of lime and loss ................ 8-4  5-5
Carbonate of magnesia .......... 0-0  9-8

100-0  100-0

This is only one out of the numerous examples which I
could cite of the lower clay of a field being more porous
than that nearer the surface. Beds of gravel, sand, or
mixed earth, also, often prevail under superficial clay, at
depths not too great to allow drainage to be made at dis-
tances considerably wider than if the drains were laid in the
clay, effecting thereby the removal of the subterranean water,
permitting the descent of rain water, and causing a less out-
lay of money.

The capillary force, or succulence of soils, varies greatly,
and is often very noticeable. It has occurred to me, in
digging test-holes previous to drainage, to find the water
standing in them not nearer the surface than 3 feet, yet
the surface soil has been so wet that water would drop from
it on squeezing with the hands. This exhibition would
determine me to bleed such soils to the depth of 5 feet at
least, and such drainage has been accompanied with com-
plete success.

Although I am not a practical farmer, I think that I may
very confidently recommend to farmers the laying land
absolutely flat after efficient drainage. It is the practice of
many good agriculturists in the stiffest clays, who con-
sider that even a crease left on the surface is injurious to
drainage.

Causes of obstruction to Drainage.—Mr. Parkes describes
certain causes of obstruction to subterranean drains, with
which, although fortunately few and limited in their extent,
every drainer should be acquainted, and prepared to obviate
the inconvenience they might occasion. The first and most
extensive evil of this kind to which he refers, is the deposit
of a substance of an unctuous sticky nature, in drains laid in
soils containing much ferruginous matter. Some portions
of Sir Robert Peel's estates at Drayton Manor were much
infested by this substance, which manifested itself in masses of red deposit at the mouths of the drains, and on ditch banks. Although Mr. Parkes was not aware of there being much experience in favour of small pipes in such soils, he retained his confidence in pipes as preferable to all other conduits, from the compression of the run of water into the smallest required volume, and therefore as more likely to prevent deposits from occurring or accumulating than larger conduits. He was acquainted with a solitary case in which pipes of an inch bore had been used, and continued to act well for several years without obstruction in a boggy soil charged with iron, though the ditches into which the pipes, always running full bore, discharged their water, require clearing once or twice a year to keep them open. To increase the efficiency of the small pipe, he proposed laying them with collars, which would further help to cover and diminish the size of the crevice between each pair of pipes, and close it against the entrance of solid matter. After devoting a week to the examination of the old drains, he found many of them stopped up with a mixture of earth and iron deposit: some of these drains were composed of the common horse-shoe tiles, laid without soles, and others with soles.

The drains through which water was continually running were chiefly open, having great quantities of the deposit at their mouths, and one drain formed of six-inch pipes, conveying much water, exhibited the iron copiously as a precipitate when the line was broken and a pipe removed, which exposed the water to the atmosphere; cess-pools communicating with the atmosphere at top, and into which some drains entered, were also lined with deposit. I examined, he adds, several drains serving as mains, and particularly at their point of junction with minor drains, and I found one of these drains about six feet in depth, and very well constructed, to be nearly closed with what appeared to be a pure specimen of the deposit, having the red colour of peroxide of iron, and of a pasty texture. This particular mass of deposit had occurred at the junction of a branch with the main, about thirty or forty yards from the higher end or origin of each drain, and where the run of water would necessarily be greatly less than as it approached the outfall; and I have found at Drayton Manor, and many other places where ferruginous matter abounds, that stoppage from its deposit is much more frequent towards the higher than
nearer the outfall end of a line of drain; and for the very obvious reason, that the flow of water there is greatly less both in quantity and velocity, and consequently of less force, than it is as it approaches the end of its course. This specimen was analyzed by Mr. Richard Phillips, of the Geological Museum, Craig's Court, London. Mr. Phillips at once told me it was peroxide of iron, but I wished it to be analyzed that I might know whether, and to what extent, the iron was pure or incorporated with other matter. The following is Mr. Phillips's report of its nature and of the manner of its production:

"Museum of Geology, 13th Dec. 1845.

"I have submitted the deposit occurring in the draining-pipes to analysis, and I find it to consist of, after drying,—

Silica and alumina, with a trace of lime .... 49·2
Peroxide of iron ......................... 27·8
Organic matter ........................ 23·0

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The large amount of peroxide of iron shown in the above analysis, appears to me to be in consequence of the iron existing originally in a lower state of oxidation, in which state it has been dissolved by carbonic acid, and formed by the decay of organic matter in the soil, and then carried away by the drainage water; when, by subsequent exposure to atmospheric air, it has been converted into insoluble peroxide. The other ingredients in the deposit would appear to have been carried down mechanically, in consequence of their existing in a very minute state of division."

It thus appeared from the analysis that only 27·8 per cent. of the deposit consisted of iron, and that the remainder, nearly three-fourths of the whole, consisted of foreign matter. This analysis powerfully fortified my hopes that the drains I was making might remain permanently open, if their mechanical structure were such as to admit water only, and no other earthy matters than such as might be chemically dissolved, in which case it was apparent that I should reduce the enemy to be contended with by nearly three-fourths of his strength, and direct against him, for expulsion, a more concentrated stream of water, by reason of the smaller dimensions of the conduit. Between November last and the present time, some miles of drains have been executed in the soils referred to, abounding with bog iron-ore, locally called "pox-stone," the same as I have met with in North Devon under the name of "black-ram," and in Somerset under the title of "iron-mould." In other parts it is called by its proper name. It occurs in masses, both large and small,
sometimes in beds. It is intensely hard, and interferes much with both the economy and despatch of digging the drains. It is the protoxide of iron of the chemists, and furnishes, by its fine dissemination in the soil, the matter dissolved by means of carbonic acid in the water which enters the drains, becoming ferruginous in the manner described by Mr. Phillips. The term iron, or rust of iron, would convey to the mind an idea that this ferruginous matter was heavy, and would quickly settle; but when it is considered that all substances chemically dissolved in water and precipitated, are infinitely fine, each atom is, in a practical sense, light, and easy of removal; and, in reality, this substance is seen to issue from the mouths of drains in the form of light, flocculent, floating little masses, which settle when the water is quiet, or are easily brought to rest by stones, grasses, &c.; and this has actually given rise to a notion with some people, that it was a vegetable substance, and grew in drains.

Up to the present time, not a trace of this ferruginous matter is to be discovered at the outfall of any one of the pipe-drains laid at Drayton Manor; there is not even a stain of its presence visible on the ends of any of those pipes which discharge into open ditches, and where it might be expected to exhibit itself; nor have I yet observed any deposit of the substance in the ditches; so that the result is very encouraging. The time, however, has been too short to permit us to indulge in absolute certainty as to their permanent action; yet I may mention one or two circumstances as confirmatory of the fact that earthly matter does not enter the pipes, and that therefore nothing has to be dealt with but the iron. There is no appearance of any sand or other earthy bodies having accompanied the water of drainage, which is brilliantly clear; and in one field where I had the opportunity of continuing a line of pipes through the field into a head of water which I could stop out, or allow to flow through the drain 290 yards long, at will, no sand was washed out by it, thus giving proof that none had entered the drain with the water of drainage. I do not feel to be thoroughly or sufficiently acquainted with the phenomena attending this drainage, for although my previous confidence in the non-transmission of earthly matter by the collared pipes has been strengthened, as well as the expectation that the flow of water in the confined channel would sweep out any fine rust of iron which might be deposited therein, I do not yet, however, understand the absence of the appearance
of iron deposit at the outfalls of these drains. Time and observation, assisted by an analysis of the issuing waters, which has already been commenced, and the drawing the attention of chemists generally to the subject, may, I hope, by enabling us to detect causes, teach us how to improve effects. The subsoil generally in Drayton Manor Park consists of gravel intermixed with fine and very heavy sand alternating with, or broken in places by, a marly clay very retentive of water. It contained much water, our test holes standing full in the winter, or within eighteen inches of the surface throughout. It was chiefly by the pickaxe that the trenches had to be opened, spades being of little use in the gravels. The sides fell in and closed so much that it was difficult, and in some parts impossible, to keep an entire line of drain open before the pipes were obliged to be laid, so that the worst parts had to be done by instalments, the pipes being laid and covered up as the work proceeded; for, if not so done, the spewing sand was forced up from the bottom and through the sides by the pressure of water. All was secure, however, when the collared pipes were laid and covered in. One drain, about 105 yards long, was laid in a quicksand, by using inch pipes completely sheathed in another larger pipe, and no packing or cover was employed. This drain, which is about six feet deep, has never exhibited, at its outfall, a grain of sand; the water is beautifully pellicid, and has maintained a discharge, varying however, with rain or drought, of about two gallons per minute. I conceive this method of sheathing pipes to be capable of forming a permanent drain through any species of quicksand or loose soil; packing may be a useful and even necessary adjunct in certain very fluid and fine media, but when a drain thus formed is carefully laid and filled in, my belief is that it will resist the entrance of all matter, except water. To use the apt expression of one of my workmen, "nothing else can get in when the water sighs into the drain so quietly."

A second cause of obstruction to drains described by Mr. Parkes, is the entrance into them of the roots of trees and plants. Probably no species of close under-drain yet constructed can be considered to be absolutely safe from roots, if laid within the range of their travels; and how far these often extend from the parent tree is well known to every agriculturist. The minutest orifice suffices to afford them entrance. Yet they seem capricious in their invasion. Mr. Parkes has
seen drains which have continued perfectly free in their action for years adjoining fences and plantations, whilst a drain at a greater distance has been choked by roots. In the two or three cases observed by him, he found that a single thread-like root alone had entered, and then worked its way up against the run of the water, increasing into a hairy mass, something like the brush of a fox, and growing in length sometimes to several yards, until it closed the drain as completely as if it had been stopped full of clay. In situations where drains must be laid near to trees, he advises the keeping as far off as circumstances permit, and the providing each row of pipes, if joining a main, with a cess-pool at their junction, in order that the discharge may be visible and examined occasionally, which would soon detect a stoppage if it occurred. But, he continues, it will be wise in all cases, if people will have hedge-row trees, that the drainer so plan his operations as to keep as wide of them and fences as possible; but better still, to get trees felled wherever they occasion a feeling of doubt as to their affecting the permanency of the drainage, or cause it, in respect of the direction or depth of the drains, to be other than complete. If trees, as in parks, are in the way of drains, I advise the sheathing of the pipes on approaching within twenty yards, and I frequently diverge from the line and pass round the tree to regain the true line of drainage.

Stoppages in drains may also be occasioned, although of very rare occurrence, by roots of plants. Mr. Parkes relates the following case as one of warning, and as calculated to rouse to vigilance of observation. A boggy piece of ground, very wet and spongy, had been sown with turnips. The drains were found in many places completely stopped with very fine roots in October. It was difficult, indeed impossible, to pronounce from what plant these roots proceeded. Mr. Parkes sent specimens of them to Professors Lindley and Daubeney, who were unable to decide upon the parent plant, to which, unfortunately, the roots had not been traced when the pipes were taken up. The drains were shallow, not exceeding 2 feet 6 inches deep anywhere. The boggy soil contained many sorts of weeds, as crowfoot, coltsfoot, rushes, and docks, of which there was abundant evidence when he was on the spot some weeks afterwards. The pipes contained much earth, which had got into them with the roots; and it appeared that several of the pipes were almost
stopped with soil alone; but it was also true that others, into which the roots had worked, were free of earth. From all the evidence that Mr. Parkes could collect on the spot, he was disposed to attribute the stoppage by roots to bad laying of the pipes by the farmer, and insufficient depth of drain in a very foul piece of land. He laid a drain deeply in the same soil, with pipes collar-jointed, and other drains, to test any difference in future action and phenomena.

Natural aids to Drainage. — Besides the porosity of soils, by which they receive and part with water more or less readily according to their openness or retentiveness, there are other adjuncts or means auxiliary to its reception and discharge. It has not occurred to me to excavate many clay-soils for drains, in which there are not perceptible what experienced and observant drainers aptly call water-veins. The clay is divided, as it were, into plates, masses opening or parting from each other like the leaves of a book, between which, thin as the vein is, an evident passage of water has taken place. These partings may have been originally occasioned by vertical cracks from the surface, which have never entirely closed again, and so served to conduct away some of the rain water to more porous and absorbent strata. It is a matter of fact, that in all clays in which these water veins occur in the greatest number, I have found drainage to be effected the most speedily, and I practically use the perception of their presence as some guide to the distance at which I determine to place the drains from each other.

But the most active and potent of the drainer's auxiliaries is the common mining earth or dew worm. The earliest written notice which I have seen of the utility of the earth-worm in drainage is to be found in Mr. Beart's article on draining,¹ in every word of whose remarks I concur. Earth-worms love moist but not wet soils; they will bore down to, but not into water; they multiply rapidly in land after drainage, and prefer a deeply dried soil.

On examining with Mr. Thomas Hammond, of Penshurst, Kent, part of a field which he had deeply drained, after long previous shallow drainage, we found that the worms had greatly increased in number, and that their bores descended quite to the level of the pipes. Many worm-bores are large enough to receive the little finger, and it is possible that one worm has several bores for his family and refuge holes from

rain. I have very recently found worms twisted up into knots, and berthed in a nidus formed by the side of the vertical bore, and in communication with it by a lateral hole about an inch long, forming in appearance a comfortable retreat.

My valued and much lamented friend, Mr. Henry Handley, informed me of a piece of land near the sea, in Lincolnshire, over which the sea had broken, and killed all the worms—the field remained sterile until the worms again inhabited it. He also showed me a piece of pasture land near to his house, in which worms were in such numbers that he thought their casts interfered too much with its produce, which induced him to have it rolled at night in order to destroy the worms. The result was that the fertility of the field greatly declined, nor was it restored until they had recruited their numbers, which was aided by collecting and transporting multitudes of worms from other fields.

The great depth into which worms will bore, and from which they push up fine fertile soil, and cast it on the surface, has been admirably traced by Mr. C. Darwin, of Down, Kent, who has shown that, in a few years, they have actually elevated the surface of fields by a layer of fine mould several inches thick, thus adding to the pabulum of grasses. His experiments were made at Mr. Wedgwood's, of Etruria, and are recorded in the "Gardener's Chronicle," of April 6, 1844. Mr. Darwin's researches are entitled to the strictest credibility. Here are some specimens of warp soil now undergoing drainage by me on an estate of Mr. William Marshall's, M.P., near Patrington, fourteen miles east of Hull, and opposite the well-known tract of land, reclaimed likewise from the Humber, called Sunk Island. When first examining this soil for drainage, I was struck with the astonishing number of fine vertical holes penetrating the warp to its full depth, in some places 8 to 10 feet. These holes were evidently not the work of earth-worms, being in a much smaller bore, and worms abound in that soil, and were at work in their own fashion, though no other living creature was discernible. Very many of these minute holes seem to be fully appropriated by the fine roots of plants which descend into them, and thus find easy access to moisture and air.

On further investigating into the origin of this net-work of holes, it was traceable beyond a doubt to the existence
and activity of myriads of small marine animals, having numerous legs, and minute eel-like looking fish working in the mud of recent deposition. The tidal stream from the Humber, which is conducted upon the warping grounds, and let out again with the retiring tide after the deposition of its solid matter, does not destroy the life of these creatures, nor close their cylindrical habitations. On the retirement of the water they are to be seen ceaselessly occupied in working up and down their holes further to maintain and elaborate them against the next invasion. The death of these amphibious animals no doubt occurs when the process of warping terminates, and the soil solidifies, but their holes remain entire, and open from top to bottom of the mass, serving to admit air and moisture, and to pass the water of rain in finely divided streamlets to the drains, and the earthworm finally establishes himself in a soil easily penetrated and most congenial to his mining habits. In the field of warp first begun to be drained on this estate, I have set out the drains at about 50 feet asunder, their depth varying from 4 to 6 feet, as outfall permits; but it is probable, as experience is gained of the draining faculty, that we may see fit to diminish the number of drains, and so increase their distance from each other in these soils. The alumina of the Humber warp is very fine, and very retentive of moisture. Water appeared at 18 inches below the surface after a month of powerful evaporation and drought, in May and June of this year, and copious streams were discharged from the deep drains. In its original state of wetness, but under circumstances of drought, this soil cracks widely and deeply like the stiffer clays, so that it seems to possess every facility for the most complete drainage, whilst its faculty for absorbing moisture from the air, and by capillary attraction from below, are of the highest order, which must vastly aid in conferring upon it the fertility well known to attach to warp lands.

But the quality of warp varies greatly, according as the deposit takes place in different parts of the same stream, and at greater or less distance from the warping river’s mouth. I cannot perhaps mention a more remarkable instance of the difference in the properties of warp, than what occurs at Bridgewater, in Somerset. The river Parrot is famed for the almost evergreen fatness of the pasturage bordering its banks, lands which were formed originally, it may be presumed, when that river was an estuary of the sea far inland.
Its deposit immediately in the neighbourhood of Bridgewater has occasioned a great manufacture of very superior bricks and earthenware; and there is one article of almost universal domestic use, called the bath-brick, for cleaning knives, &c., made at Bridgewater only; and it is singular that the sludge or mud from which these bricks are made is collected from the river Parrot's banks, within about a mile above and a mile below the town of Bridgewater. The banks of those particular two miles of the river alone afford the precipitate fit for the manufacture of the bath-brick. The deposit formed, whether more inland or more seaward, is found to be unfitted for the purpose. So, in the warped lands formed from the water of the Humber, whether passed immediately from that river, the Ouse, or the Trent, great difference in the quality of the deposit and the fertility of the soil in respect of the proportions of clay, sand, and salt is discernible and well known.

Great difference also exists as to the necessity of draining warped lands, arising from the depth of warp, the character of the subsoil on which the warp is run, and the particular composition of the warp itself in its proportions of clay and sand. Near to the mouth of the Humber, it strikes me that there is a much larger proportion of alumina (clay) deposited, in respect of silica (sand), than about Goole, Thorn, and other warping districts. There is no doubt, also, much more common salt in the composition the nearer to the Humber mouth.

The quantity of salt in which the wheat plant will flourish is curiously illustrated in the warp soils about Patrington, and would be scarcely credited unless seen. The whole surface of a large reclaimed warp-piece on Mr. Marshall's estate was planted with wheat for the first time in the autumn of 1844. When I saw it in the autumn of 1845, the surface of the ground was crystallized all over with salt, evidencing the enormous quantity which the mass of the bed must have contained; yet from this first crop, the tenant told me he had thrashed out twenty-four bushels per acre. The order of culture there, after warping, is to leave the land to the occupancy of what is called the sheep grass, which naturally skims it for three years, when that begins to die off. It is then ploughed up, and sown with rape allowed to go to seed. This plant is considered to remove the very injurious excess of salt, and great crops of it are obtained. Wheat follows, and after that any other crop to the farmer's liking,
ON DRAINING.

without regard to systematic rotation, may be produced, and without the aid of manure, for many years.

But the whole of this land is much too wet; it is too salt; and its powers will not be appreciable until after deep and complete under-draining. It appears, however, that the lands warped at a greater distance from the mouth of the river, must be skilfully treated in respect of under-drainage. A complete power of deep under-drainage should be established, to withdraw the water, and keep it down low beneath the surface when injurious, whilst there should be provided means of sustaining water nearer to the surface and to the roots of plants, when under the influence of such a dry season as was experienced in 1844.

In many of these warped lands means exist to fulfil this end, as water is raised out of the ditches by machinery when in excess, and the height of water in the ditches is maintainable by drawing it from the high land drains. A farmer, residing near to Hatfield Chase, informed me that he considered he saved crops of the value of £500l. in 1844 (when it will be remembered we had fourteen weeks of hot sun, without a drop of rain), by his command of water to charge his ditches. The warped lands are very commonly divided into fields of 10 acres, being squares of 220 yards, surrounded by open ditches, and it is considered that the water is thoroughly drawn out of the soil to the level maintained in the ditches; but this I much doubt, and am satisfied from my observation of these flat warped lands, both in wet and dry weather, that they would be astonishingly benefited by a system combining both sub-drainage and sub-irrigation; but it is possible that the farmer may have reason for not draining this soil more deeply or more completely, unless means are provided for sub-irrigation in droughty seasons.

There has been rather recently introduced by some drainers a practice of making what they term air-drains, with the view of providing for a ventilation of the soil, and also for promoting, as they think, a freer flow of water from drains. As regards the latter point, it is quite certain that such air-drains must be superfluous and unnecessary. The fact of water entering subterranean drains at all is quite decisive as to the universal presence of air in soil, and no one has shown or has attempted to show, so far as I know, its insufficiency. Water could no more issue from a drain laid in the earth, than it could flow from a tight barrel, if air did not press on the surface of the liquid within it. Every one knows how
small a vent-hole at the top of a cask suffices to enable us to withdraw a great stream from it at the bottom, and every one knows that the bulk of liquid discharged in a given time is in quantity precisely equal to the volume of air which enters in the same time. The fact of rain-water sinking through the soil is demonstrative of the permeability of that soil to air, as every drop of water which falls from the heavens must first displace an equal volume of air before it can enter the soil; the water would remain on the surface, and never sink, if, by reason of its superior gravity, it did not push aside the air in its descent, which it does until it meets with some subterranean level where the earth is saturated with the fluid, and the rain-water then comes to rest, having disturbed and displaced air throughout its whole downward course. And by this action we are led to observe one beautiful provision of nature for renewing the constituent air of the soil, and I regard it as an argument in favour of deep, as compared with shallow drainage, that a greater bulk of earth is thereby filled with air, and with frequently renewed air.

There are other equally beautiful processes incessantly active to maintain a full supply, and fresh supplies of air in the soil. The continual change of temperature in the soil, and in the atmosphere reposing upon it, has its effect; but probably the most potent cause is the unceasing appropriation by plants, or manures, or soil, of some one or other of the three gases of which the atmosphere is composed. A renewal of the particular atmospheric gas consumed, whether it be oxygen, nitrogen, or carbonic acid, must be nearly consensaneous with its use, and is effected by the well-known principle of the diffusion of gases, and without which neither plants nor animals could live.

I have spoken of cess-pools as useful and convenient breaks in lines of drains, particularly in the long run of a main, or where several lines of drains converge from two or more directions in one common central point to an outfall. The use of the cesspool in drainage is an old English practice; I have found it in several counties, both north, south, and midland: it is usually constructed in brick. The specimens now exhibited are made of large earthenware pipes nine inches in diameter, with a flat tile or foot on which to place them in the soil. This plan will be found advantageous and cheap, as the foreman drainer may fix his cess-pools without needing bricks and mortar and a bricklayer. The holes for
the receiving-pipes are burnt in these cess-pools of the proper dimensions, and the hole for the discharging or outfall-pipe is made a little lower than the holes of the receiving-pipes, so that a drip or fall from the former takes place, and the run of water from each pipe is observable. I have converted these cess-pools to another use, viz., that of enabling us to introduce water into the body of the earth, and apply it to what I have before termed sub-irrigation. All the drains of a flat field may be made to issue from a cess-pool, into which water from a higher level may be conducted. A cess-pool of the same kind is also to be fixed at the outfall end of that field, into which all the drains are conducted. Now, by stopping up the outfall-pipe, and letting water into the infall cess-pool, it is clear that all the pipes ramifying through a field will become filled with water, and that they will disseminate it gradually throughout the entire mass of earth above the level of the drain-pipes, and to any desirable height, as you will observe from the specimens before you, that an outlet-pipe can be formed in the discharging cess-pool at any required distance below the surface of the soil, or at the surface. In this manner water may be given to the roots of plants. I refer more particularly to the grasses; and when enough is given, the whole of the water may be removed at will, and a perfect drainage be established. The introduction of these cess-pools with pipes also enables us to fill the higher parts of a field with water, which, suddenly liberated, will scour out the lower drains, and prove their condition of openness. The cess-pool is also useful when placed close to an outfall into a stream or ditch, in which the water backs up with floods. It may then be furnished with a pipe and valve, here shown, which closes against the rising of the outfall water, and opens as the flood water falls, letting out the drainage water. By these simple means, the sedimentary flood water is prevented from entering the drain-pipes, which remain filled with the clear water of drainage. In case of need, the receiving and discharging pipes may be luted into the cess-pools with Jeffery's marine glue; but, in most cases, a running round with clay will suffice for the purpose, absolute tightness being rarely necessary.

These cess-pools, with the various pipes now exhibited, have been made for me by Mr. J. M. Hoskison, of Wilnecote, near Fazeley, Staffordshire. They are admirable specimens of manufacture for truth and smoothness.
It will be observed that I have not introduced to your notice any other kind of drain-tile than pipes, and because I consider them to have the preference over every other description of drain-tiles, and for the following reasons:—

1st, Because the pipe is an entire conduit in itself, stronger than any other form, and capable of being centred and connected by collars, or of having one pipe sheathed within another.

2nd, Because the pipe requires less substance of material for a given strength than any other form into which clay can be put.

3rd, Because the carriage is lighter both to the field, and in the field; a great convenience and economy to the farmer and the drainer.

4th, Because, from their form, when properly laid in the soil, pipes are subject to less derangement from external pressure, or the entrance of earth or vermin, than other forms of drain-tile heretofore in use.

Much has been said and written about the porosity of pipes as an useful property. I do not see any reason to suppose that the pipe possesses any greater or less degree of absorbent power than other porous or unglazed earthenware, most of which are more or less porous to water. When properly tested under a pressure of four feet of soil, I have found the absorbent power of various pipes, formed of various clays, equal to the passing of about \( \frac{1}{500} \) part of the quantity of water which enters the conduit through the crevice existing between each pair of pipes. By so much this property is useful, and I do consider that it assists in drying and giving firmness to the soil in immediate contact with the conduit.

Mr. Parkes exhibited some draining tools, which he recommended—"They are the result of much care and trial in comparison with others, and of cost to myself and the maker, Mr. Lyndon, of Birmingham;' and concluded his instructive lecture by observing that in clays, and other clean-cutting and firm-bottomed soils, he did not find collars to be at all necessary, but considered them to be essential in all sandy, loose, and soft strata.

*Journal of the R. A. S. E.,* vol. vii. part 1, 1846.
THOROUGH-DRAINING.

Art. XXVII.—THOROUGH-DRAINING.

By Mr. Grey, President of the Hexham Farmer’s Club.

[An Address to the Club, June 9, 1846.]

After some preliminary remarks, Mr. Grey went on to say,—So much of the land in this county lies on a retentive subsoil, causing in it a great degree of humidity and coldness, that the portion which is naturally so dry and open as not to be improved by draining, is the exception to the general rule. To obtain good crops from such land is always a matter of uncertainty. A wet spring delays the sowing to a late period; or if the weather be tempting for sowing, and storms of rain or snow should interrupt the operation—as was the case this year—such land has small chance to recover the injury it sustains during the remainder of the season. But admitting the seed-time to be good, and the crop to a certain period to be flourishing, a fortnight of wet and cold weather any time during the summer cuts down the fair prospect, and leaves a thin and unproductive crop for the harvest. Such was the case, many of you will remember, in the high and cold districts of this county four or five years ago; up to the end of June the crop was most promising; a succession of heavy rains then came on; the ground was saturated with wet; the corn became yellow, and by degrees thinner and thinner, till, ere harvest, the crop consisted more of thistles and weeds than grain. Against such contingencies thorough-draining is the only security; by means of it an earlier seed-time, as well as an earlier harvest, is obtained; the average produce of the land is greatly increased, in many cases it is doubled; and the expense of working it is immensely lessened. Every one accustomed to cultivate heavy and undrained soils knows the injury which his fallow sustains by one ploughing before it is sufficiently dry, or by a heavy fall of rain directly after ploughing, and how much labour is required to recover it from that injury, if it can be done at all, during that season. When, then, I hear tenants remark upon the expense of bringing tiles to drain a field, I tell them to think of the future labour which the dryness, and consequent friability of the soil after draining, will save them—more, perhaps, in one year of fallow than all the carting of tiles, with the certainty of a
much better crop to boot. So far I have alluded to corn crops, but in our days the root crops have grown into an importance almost greater than those of corn, especially on soils of inferior quality. It becomes, then, a great desideratum to substitute turnips for naked fallows in all possible cases; and this, thorough-draining enables us in a great measure to do. I have seen a field which, previous to draining, never was thought capable of growing turnips, produce a crop the year after being drained which was sold, for eating on the land, at 6l. per acre; and the produce of the barley crop in the succeeding year was double of what it had ever been known to grow before; thus returning the entire cost of draining in those two seasons. But on land less unfavourable, and on which turnips have hitherto been cultivated, though at great risk from wet seasons, the advantage of draining is found in its easier and earlier cultivation, in the greater certainty of its produce, the ease and comparatively small injury which attends the removal of the crop from the field, and the increased benefit derived both by the land and stock if consumed on the ground. Every one knows how much better sheep thrive on dry than damp land, and how much less waste of food is occasioned. But it is not to tillage lands only that the benefit of draining is confined. I know a rough ox pasture for which an allowance for draining was made by the landlord, but which did not finish the job, and a part is left yet undone by the tenant. The part which was first drained comes earlier, and affords a full bite to cattle three or four weeks sooner than the other, and is, besides, so much sweeter and more nutritious that they are constantly upon it, and never upon the other till necessity compels them. By abstracting the water, the coarse and aquatic plants are destroyed, and again succeeded by grasses of finer quality and earlier growth, by which means the value of the pasture is much increased. The beneficial effects of rain in promoting vegetation are too well known, and too obvious to require remark: every shower conveys a portion of ammonia from the atmosphere to the earth, and communicates a fertilizing property. It is only when the land is saturated with it, and when, instead of passing through, it remains in it till abstracted by evaporation, that it becomes pernicious. The most intense cold is produced by a process of evaporation; and if water, falling upon land with a retentive subsoil, is left to be removed by that means, which in winter is very slow, the earth is
starved, and the plants it contains frequently perish, or, as is the case with wheat, lose their hold, and are thrown out by frost. By draining thoroughly we make the rain our friend and not our enemy, we take all the benefit and avoid the injury. It is not, however, only during winter that superabundant moisture in the land is pernicious, its effects are equally injurious in the drought of summer: we see the strong soils, which in winter were saturated with water, in the drought of summer become hard, impervious, and unmanageable, cracked it may be with large fissures, but baked together so as to exclude all the beneficial influences of the atmosphere. The same effect is produced in hard frost: let any man attempt to push his walking-stick into such land at such a time, and he finds it bound in a coat of iron, while that which had been rendered dry and friable by draining is still loose and pervious. One obvious effect of water lodging in the soil, is the exclusion of air; but as the water is drawn off by draining, the air immediately takes its place, and, intermixing with the particles of the soil, communicates to it that divisibility and mellowness to which farmers give the term of "friability." It is from the admission of atmospheric air to a greater depth, charged as it always is with some degree of moisture, that dry and loamy land is found to resist drought better than wet and adhesive clays. [Mr. Grey then went into a curious and interesting dissertation on the principle of atmospheric pressure, showing its effects on all external objects, its tendency to insinuate air into the ground and occupy the place of water, and even aid in expelling it; and illustrated its effects as needful to the human body, by relating a circumstance which occurred to the celebrated travellers Humboldt and Bonpland, who, when taking observations at a great elevation on the Cordillera Mountains, found the air so rarefied as to make breathing painful, and at length to cause the blood to flow from their eyes and ears, the external pressure being no longer equal to counteract the internal impetus of the heart. Apologizing for the digression, Mr. Grey proceeded]. Having said thus much on the utility of draining, allow me now to make some remarks upon the mode of carrying it into effect. The first thing, and that is of essential importance in setting out drains, is to secure a clear outfall for the water which is to be discharged from them. I have seen much injury and loss sustained by allowing the drainage of a field to be emptied into an open ditch with little declivity, while by negligence in allow-
ing grass and weeds to obstruct its course, the ends of the drains were sanded up and rendered useless; it is much safer to incur the expense of conveying the water in a covered drain till a clear outlet can be found for it. Another thing to be especially avoided, is the laying of tile-drains through a hedge, that they may be emptied into a ditch on the opposite side. The roots of trees have a great tendency to insinuate themselves into the cavity of drains, and to run along them to a great extent—the root of the ash is especially pernicious in this way. I have seen drains which had been run across a hedge-row with ash-trees in it, which stopped running, and on taking up the tiles they were found to be filled with the roots of the trees, which were grown over with a hairy-looking vegetable substance, resembling a badger's tail, and had entirely stopped the circulation of water, and spoiled the drains for a considerable distance from the fence. But I would not only avoid placing drains in a hedge, I would also keep them in general, and as much as possible, off the headlands in tillage fields. It is, I see, a common practice to run the carry-drain along the headland; my objection to that is, that the headland is travelled upon by corn-carts and dung-carts, and is turned upon in ploughing, so that drains are in much greater danger of being broken in or disturbed, or so pressed into hollows that sand may filter into them, than when laid across the ends of the ridges two or three yards above the headland furrow. I would also recommend, in draining, that the drains of every field be laid down upon a plan when finished, so that no difficulty may afterwards be found, in case of stoppage or inefficiency, in going directly to the spot. Then, with regard to the depths of drains—a subject of much discussion and controversy—I am of opinion, and that opinion has not been formed without much observation, that we have wasted a good deal of money and great many tiles by laying them too near the surface. The tendency of water is downward; and the nearer its downward course approaches to the perpendicular, the quicker will be its escape. It follows, then, that it will find its way more quickly to a drain of three or four feet deep than two. And, in fact, in the case of drains only twenty inches or two feet deep and twenty feet apart, the water from the middle of the interval must have a course so nearly horizontal as to be very slow in its progress, and to expose the land to wetness for a considerable time. The theory of deep drains is this, that by
THOROUGH-DRAINING.

abstracting the water and admitting air instead, the soil, but especially the clay, contracts to the depth at which the water is drawn off, and, in contracting, many small fissures or veins are formed, which serve as channels for the water to reach the bottom of the drain. To leave theory, however, as we are all practical people here, I will tell you what I have myself seen: a field had been drained at the depth of two feet from one side to the other, still it did not produce the effect of drying the land so quickly as had been expected: the owner had a few drains cut here and there at a depth of four feet: after a heavy rain, I, along with others, went to examine the field: we found a small run of muddy water from some of the shallow drains, but a copious one of clear water from all the deeper ones, showing that, in its descent to them, it had not robbed the soil of any of its finest parts, as was the case in the shallow drains, and that it was escaping much faster from the land. You will find it also recorded, from most authentic information, in the Journals of the Agricultural Society, that the water drawn from an acre of land in an hour, drained at a depth of four feet, was one-third more than from another adjoining acre with two-feet drains, and that the run began sooner, after the fall of rain, in the deeper drains, and of course also ceased sooner, than in the shallow ones. My own opinion is, that in hardly any case should tiles be laid at a less depth than three feet, but that in many cases four feet would be preferable. The expense should be estimated more by the efficiency of the operation than the outlay of money; but, even in respect of expense, the balance is in favour of the deeper draining; for, if drains three feet deep and thirty feet apart are more efficacious than those of two feet deep and twenty feet apart, the former comes cheaper by the acre, as there is only one foot more of soil to remove in the deeper drains than in the shallower, against which is to be set the saving in the purchase and carting of one-third of the tiles. It is, of course, impossible that one rule can be applicable to all situations. Much must be left, in every case, to the kind of subsoil which is met with: in some places seams of sand are found intersecting beds of clay, and then probably one deep drain may lay a whole acre dry better than many shallow ones would. There is one description of subsoil common in this county, in which I think it may be advisable to make the drains frequent and shallow, rather than deep and more distant, because it is so firm and hard, that I believe no
cracking or contraction will take place in it, so as to allow water to descend; on which account the best way, probably, is just to dig through the soil, and lay the tile into a groove cut in the subsoil. This subsoil we call "moorband;" in other parts it is called "pan," and is a concretion of gravel and clay with oxide of iron, so hard that it is scarcely possible to break it up. One thing I have omitted to remark, and that is, that in making drains it is desirable that they should be done, as much as may be, in the spring or in dry weather. When bottomed out, care being always taken to lay the tiles or pipes level, and directly opposite each other, let them be covered just so much with clay, taken from the bottom of the drain, as to keep them safe, and then leave the drains open for as long a time as may be convenient for working the land, because the volume of air which in this way has access to the drain is so much greater than that which can pass through the tile or pipe, that the contraction of the soil or clay takes place more rapidly, and the drains come so much sooner into full action. Then, as to the tile or pipe which it is advisable to use: for a long time we used tiles of unnecessary size, and in many situations those tiles could not be used with safety without soles, which became very expensive. Of late years pipes have been substituted for tiles, and are, I think, in every respect deserving a preference; I prefer them because they are safer against stoppage, stronger, more durable, and more economical. The circular shape is that which in all sewers and carries of water is found to be least liable to be stopped up, because the current is always deepest and strongest in the centre, into which every substance that comes must fall and be carried off; whereas a flat bottom admits of deposits and accumulations which the shallow current cannot always remove. Pipes are less apt to be sanded up on this account than tiles, in flat ground; and on steep hill sides they are safer, as, when once fixed, the current cannot displace or undermine

1 Analysis of Moorband.

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<th>From Flodden Field.</th>
<th>From Milfield Plain.</th>
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<td>Oxide of iron</td>
<td>34</td>
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<td>Silex</td>
<td>74</td>
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<td>Alumina (clay)</td>
<td>6</td>
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<td>Oxide of iron</td>
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<td>Water and loss</td>
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<td>Total</td>
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They are stronger of necessity, by the equal pressure upon the circle, which any one may prove for himself. I lately broke several tiles with my hands at a tile-kiln, while I stood and jumped upon pipes of the same clay without effect; and they are more economical, because they are cheaper to purchase, and a cart carries a much greater number. It is objected to pipes that they may roll aside when laid in the drain, and the end of one may not be exactly opposite the end of the next; but then it may be objected that careless workmen may spoil any job; and, unquestionably, all kinds of draining require attention and nicety in the execution. Admitting this as an objection, however, I think it is fully obviated by the kind of pipe now made at Whittonstall and at other places in this district, which, while it preserves the circular form for the water, is attached to a flat bottom, which keeps its place in the drain as steadily as anything of the kind can do—a specimen of which I expected to have found here, but it has not made its way into the room. Such pipes, of various bores, can be made at from 16s. to 20s. a thousand.

I think, gentlemen, I have now noticed most of the points which are important in connection with this highly interesting subject—a subject which is now occupying much capital and giving employment to a multitude of hands in the agricultural districts, and which is destined, I believe, to render the produce of our soil much more certain than heretofore, and greatly to increase its average annual amount. There is yet one thing in connection with draining, and especially when it is accompanied by subsoil-ploughing, which perhaps you will allow me to advert to, and that is the depth to which plants will send their roots in search of nourishment, if not impeded by impervious subsoils, and by water, which is pernicious to them. I recollect to have seen in Bamburgh Castle some stalks of wheat which were placed there, I believe, by the late Lord Barrington, whose roots had penetrated to upwards of eight feet below the surface of the ground; they had been got, I think, by breaking in the edge of a quarry, near which the wheat was growing, and which had found means to penetrate its open soil. The extent to which the fern pushes its roots, far exceeding the height of its stem, may have been remarked by most of you on a steep bank, or by the side of a brook; we find the roots of trees, too, pushing outwards into the soil, to the great obstruction of the plough, as far as their tops rise into the air. If, then,
this be the natural tendency of plants, there can be no doubt that, in proportion as we draw off the stagnant water by deep-draining, and make the land permeable to atmospheric influence, and accessible to the roots of plants, in the like proportion shall we increase its productive powers; while, by lessening the evaporation, and ridding the earth of noxious vapours, we shall contribute materially to the warmth, dryness, and salubrity of our atmosphere. I now beg to thank you, gentlemen, for the very attentive hearing with which you have favoured me, in an address which may have appeared to you rather desultory; and if any one has objections to make to my statements, or explanations to ask for, I shall be most ready to attend to him.

A question was asked by Mr. Stephenson as to the size of pipes which Mr. Grey deemed sufficient to contain the water from drains thirty to thirty-three feet apart.

Mr. Grey:—I consider pipes of one inch diameter generally sufficient; more, indeed, than ever will be filled. Look at the quantity of water vented by a lead pipe of much smaller dimensions in your stable-yard. But it is an object to admit air, as well as to convey water, and therefore I am not strenuous for very small pipes: that is more a question of economy. If your drains are, say 300 yards long, begin with one-inch pipes for 100 yards, then take one inch and a quarter, and so go on increasing as you approach the outlet; and your carry-drain may be made of a single large pipe, or of three smaller ones, two side by side, and one above them, which makes a safe and excellent main drain; the top pipe, however, being seldom needed.

Mr. Smith inquired if Mr. Grey would recommend to put small stones over the pipes, or straw, or any other substance.

Mr. Grey said the object was to draw the water, not along the surface and down into the top of the drain, but by a downward fall through the soil into the bottom of the drain, when it would insinuate itself into the joints of the tiles or pipes; he therefore considered that the firmest stuff was best for the top of the pipe. He disliked to see straw carried out for that purpose, because it robbed the fold-yard and the dung-heap, and did, as he thought, no good. He had had occasion to drain a good deal of thin moorish land, where it was necessary to cut through a sharp yellow sand: he had laid heather, which is a very imperishable article, on the tiles in that case, to prevent the sand from being washed into them.
Another question was then asked as to the direction in which drains ought to be laid, whether directly upwards or in a slanting direction.

Mr. Grey replied, that he considered all drains ought to be laid perpendicularly and at right angles to the incline; for in that way the strata, as they crop out, are cut through, and the water they contain is immediately discharged into the drains; whereas, in the old way of laying the drains obliquely, they frequently ran along in beds of clay, drying only a yard or two in their immediate vicinity, but without abstracting the water which was proving injurious to the land.

Farmer's Magazine, September 1846.

Art. XXVIII.—ON DEEP-DRAINING.

By Mr. Mechi.

Gentlemen, on the subject of draining I have had a great deal to combat with—a great difference of opinion, and a great deal of prejudice, amounting, in some instances, to a disbelief of facts. I have had gentlemen who, upon seeing me cut the drains, and upon observing the opposite drains running, have said, "You will never make me believe the water can get through this strong soil." That is a very curious remark, but it has been made more than once. I don't think that you here would do so. I am sure you would not; but, gentlemen, deep-drainage must be the basis of agricultural improvement. If earth be the food of plants, the more you give them of it, the better they grow. It is a mistaken notion to suppose that the roots go down but a short distance; we have constant evidence that they will go down many feet, but not into undrained heavy cold subsoil. When roots come to stagnant water, or if heavy rains come, they are absolutely turned up like fish-hooks to avoid it. They have instinct, if they have not common sense. They search for food wherever they can find it, and I am quite sure, from the result of my practice, that deep-drainage has made a difference in one field of a quarter of wheat and a load of straw per acre in the past very dry season. I have two fields which some of you, gentlemen, saw last year, that were growing wheat this.
was drained with the mole-plough 18 inches, and well manured; the other was drained 5 feet with 1-inch pipes, 33 feet apart, a very strong brick clay. The wheat in one case was nearly 6 feet high; in the other it was little more than 4 feet. The difference in the quantity of corn was what I have stated—one quarter per acre and a load of straw. The shallow-drained field looked the best all the winter; having had the most manure. I said to my man, "This is only temporary; it will go to Halstead fair in the month of May."—"No," he said, "sir, this is the wheat for me;" and everybody said, "That was the wheat for them." When May came, the shallow-drained turned out yellow naturally enough, for the roots wanted to go down, they wanted to move, but they refuse to do that which neither you nor I would do—they refused to go down into stagnant air and stagnant water. What was the result? The wheat in the other field having the advantage of deep-drainage, became the better crop of the two. Which is the cheapest drainage? The deep drainage. It is cheaper than the shallow. I drained my clays actually 33 feet apart, 5 feet deep, with 1-inch pipes; the cost of this was 3l. 2s. 6d. per acre. I have reason to believe that the interest this will pay will amount to at least 50 or 60 per cent. on the investment annually. Well, gentlemen, then I ask should it not be done? I believe some of you saw the drainage last year, and I am happy to say that every drain runs freely—that the water all passes through the land, except in the particular case of a very heavy shower—for the pipes run like pumps. What is drainage to do? To carry off the water we see? That is a very small part of its operation. Water we have always considered our enemy; an abundance of water has always been considered our enemy on heavy land. Now I am prepared to prove that water is the very best friend we have; and that if our land be thoroughly and deeply drained, we never can have too much of it except at harvest. I am prepared to prove—and it is well known by chemists—that water is the richest manure we have. We know practically that irrigation is coveted by everybody for their meadows, and that it is exceedingly beneficial. What are the rains from heaven but the best of irrigation, providing we allow them to perforate the soil. They come down charged with ammonia, carbonic acid, and other gases, and disinfecting the subsoil, descend and form new chemical combinations. And there is another most particular use in the descent of water
through the soil, and that is, that it is the only carrier of heat downwards. Nothing can you get to carry heat downwards excepting water. It robs the air of its heat, the topsoil of its heat, and warms the subsoil. That is one of the most important operations of water. In summer the surface of the ground is often 130 degrees, the subsoil at the depth of 4 feet is about 46 degrees. But the water falling on well-drained land passes down to the drains, leaving behind it the heat it contained. That is a well-known scientific fact; and we all know, the warmer our subsoil is the better our crops grow. Well, then, gentlemen, what a sin and what a folly it is to make water-furrows open furrows on the top to carry it away, instead of making drains below—furrows which not only carry away the heavenly rains, but a great deal of the soluble parts of our manure that lie near the top. I know perfectly well that, on undrained land, if you put a top-dressing of soot, and there happens to come in the course of the day a very heavy “shot” of rain, as it is called, you have the mortification to find next morning that soot travelling down your ditches rather faster than you like to see it. But if the land be thoroughly drained and porous like a sponge, the particles of manure find their way down; the roots go in search of this manure, and up they bring it by capillary attraction. We all know that vegetation has great capillary power. We know it by the great trees. You observe a dry season; wherever you see a large tree in a field he drains the moisture around from the roots of his weaker neighbours, the corn. The consequence is, that your returns in the present season are not near so large as they proved to be the year before. Gentlemen, the subject of draining is a vital one to agriculture, and I have laboured hard to satisfy the minds of agriculturists, and to remove their prejudices. I have done 33 acres myself, 5 feet deep; it answers perfectly; and I therefore recommend you to do the same. I think, last year, some of you promised me you would try half an acre. I consider you are bound by your own interest, and by the interest you feel in this Society, to make the trial. I should state that the 5-feet drains are opened only 18 inches wide on the surface, and that there is no particular difficulty in reaching a depth of 5 feet with only an 18-inch opening at the top. The cost of that is, in honest clay, where no pickaxes are to be used, 6d. per rod workmen's labour. I have opened some drains in a field recently called a light sandy
field. I knew from the appearance of the crops that there was something wrong below. It was in vain I was told that it was a hot dry field; I knew it was a cold wet one. I began my drains and got down as far as four feet. Everything was dry. "There was no water," the man said. Very well, we got down another foot, and at the depth of five feet up spouted a beautiful spring; which is now running, and which will run no doubt for the next century. I cut another drain; in the last foot there was another spring. Now, if I had left off at four feet, where would be the spring rising up by capillary attraction, and not showing itself except in the case of bad crops? It is different from top-water draining so called. But you will find very often that in cutting 5-feet drains for top-waters, you will bleed many springs that have been your enemies unknown for years.

While speaking of draining, we will now allude to bog-draining. I have had some experience in that, and I will communicate it, because it may be useful to many gentlemen here who, I can say, in passing by, have land of a boggy nature—rushes growing on the top of a rich soil, but wet. Now, the only way to get rid of that water, is generally to cut into the hill above that sort of land. But mind, five feet are not enough here. You must go down at least eight or nine feet. You must make a hole first nine feet deep; and the chance is when you have made it, in the course of that or the following day, you will find the water rise in it until it stands within one or two feet of the surface. You will then have to make three or four such holes at various points, where it is proved from the appearance of vegetation that there is water. These holes will also most likely fill. Well, gentlemen, now we want to get rid of that water. To do this, you must cut a drain in the hill above these holes and below their level. And when you find that the water flows into your drains and that the holes do not hold any more water, you may then conclude safely that you have done the business as it ought to be. Gentlemen, there is some difficulty in laying pipes in these boiling sands, which they very often are. The only way to do it in difficult cases, is to have a skeleton arch, or some such protection; then lay a yard of pipes; put some straw in first, and then load them with earth to keep them from being forced out of their position by the water; then put fresh pipes down of similar length; go on making them secure, and
thus, at the successive stages, placing hay or straw under-
neath and earth above, I think you will render your work so
durable that you need not trouble yourselves about it for
many years to come. Boggy soil is like sponge—it has an
extraordinary tendency to draw up and to hold water. You
will find that shallow drainage in boggy ground is like
shallow drainage in sponge—the water will not leave the
sponge to pass into the drain, but will remain in the sponge
by capillary attraction. You find if you put a drain into a
bog at 10 or 11 feet depth, when the water has left that
bog and you have covered it, as you ought to do, with heavy
earth, you will find that the drain, instead of being 10
feet from the surface, will probably be at only 6 feet. The
bog dries as a sponge dries. A dry sponge is always more
shrunken and smaller than a wet one. That takes place in
boggy ground and in strong clays, but only in a smaller de-
gree, because it is the expansion of particles by stagnant
water which gives that tenacity to clay we so often see.
When you remove the water from the clay by a deep 5-
feet drain, you will find not only that the roots take pos-
session of the soil, but that the worms will go down and
bore ten thousand little holes, which will serve as pipes for
the water to the top. They are looking to the lower clay,
as if they were aware of the change of air and water.
The result is that stiff land, instead of being like brick loam
or putty, breaks up like a piece of shortcake. That is the
case with mine now.

Agricultural Gazette.

Art. XXIX.—ON DRAINING.

[Abridged from "Remarks on the Agriculture of Aberdeenshire."]

By Mr. Sullivan.

Draining is carried on during every season of the year,
and at all stages of the rotation; but the winter and early
spring months are those in which the operation is most
generally accomplished. Drains are occasionally executed
while the land is in stubble, and also, in some instances,
after the removal of the turnip-crop from the ground, just
previous to ploughing it up for the sowing of grain. It is, however, during the period in which a field is in grass, and immediately before breaking it up for oats, that most farmers in this quarter prefer to drain it, for the following, among other reasons; viz. that the stones employed in filling are then carted to the drains with less difficulty and labour to the horses, and less injury to the land; and that they can be broken and filled in more cleanly and expeditiously than when the ground is soft and loose on the surface; besides, when the field is in grass at the time of draining, suitable turf can very conveniently be obtained for covering the stones previously to putting in the earth.

**Main Drains.**—In beginning to drain a field or piece of land, the situation, direction, and dimensions of the main drains or leaders first demand the careful consideration of the farmer. Their number and position are of course regulated in a great degree by the nature of the surface; and their dimensions are determined chiefly by the extent of land whence they are intended to receive water, the degree of wetness, and other obvious circumstances. They are invariably made several inches deeper than the small or parallel drains, for the purpose of affording the water a sufficient fall from the latter, and thereby preventing the accumulation of sediment at the junction of the drains with their leader, which, it is obvious, would soon render them partially inoperative. Main drains, constructed in the manner to be presently described, are generally from 3 to 3½ feet in depth, from 15 to 18 inches in width at the bottom, and a proportionate breadth at the top. The depth just mentioned is considered quite sufficient for main drains, when the branch ones that fall into them are only from 30 to 33 inches deep; but, of course, the depth of the former must be increased in proportion to that of the latter. It is hardly necessary to state that the main-drains are always opened before the cutting of the smaller ones that are to be led into them is commenced, but that the latter are generally filled in before the former, the propriety and object of which must be known to every reader. The following is the usual mode of constructing main drains:—After the cutting and filling of the whole of the smaller drains are completed, and it has been observed that a sufficient and uniform fall is secured for the water, both into and from the main drain, a low wall is built with flat stones at each side of the bottom of the latter; openings being, of
course, left at the proper places for the parallel drains to enter. Their height is commonly 9 inches, the distance apart about 7 inches; and they are surmounted by strong flag-stones or "covers," any interstices between which are carefully filled up with small stones, to prevent the entrance of earthy matters. There is thus formed a conduit, or "eye," as it is here designated, of 7 inches in width by 9 in height, which is capable of voiding a considerable body of water. When the subsoil is composed of sand, or is in any degree soft, the bottom of the main-drain is generally paved with round stones, previous to the formation of the little side walls of the conduit, with the view of insuring the permanency of the work. Indeed, many intelligent agriculturists are of opinion that whatever may be the texture of the subsoil, the bottom of all mains should be so paved, as, however firm and secure it may be at the time, there is some reason to apprehend that the continual abrasion of the water would eventually undermine the sides, or otherwise endanger the safety of the drain. No doubt the cost is thereby increased; but, in the opinion of many skilful drainers, it is an exceedingly false economy to construct main drains in an imperfect or insecure manner, for the sake of saving a trifle of the expense. Efficiency and durability are the great points to be aimed at in their formation; and the judicious farmer will not hesitate to incur a little additional expense, in order to secure these desirable qualities; especially when aided, as he always should be, by his landlord. There are various other sorts of main drains besides that just described; but, as neither of them is so much approved of as it, it is deemed unnecessary to occupy valuable space with any further remarks on this part of our subject.

*Common Drains.*—The parallel or common drains are invariably made in the direction of the greatest ascent or slope of the ground, except where it is considered the declivity is so great that the velocity required by the water in descending would be likely to produce an injurious effect; in which case it is supposed by some to be necessary to direct them with a slight inclination across the slope, in order to diminish the force of the current of water in the drain. But it is, perhaps, needless to observe that such situations rarely stand in need of thorough-draining, at least not in such a degree as the low and almost flat grounds, which it is the farmer's first care to relieve of redundant moisture.
The intervals at which the drains are placed in the field, vary from 17 to 30 feet, according to the texture of the soil and subsoil. In the division of Buchan, which contains a greater proportion of clay than any other part of the county, it is in many cases found necessary, for effecting complete and efficient drainage, to have them so close to each other as 17 or 18 feet. When the ridges are 17 feet in width, it is the common practice to form a drain in each of the inter-furrows. In the other divisions of the county, however, the soil is not in general of a very adhesive character, and drains from 20 to 30 feet apart are found quite adequate to effect the object in view. They are often, but not invariably, made in the furrows; the proper direction and distance asunder being objects of greater importance.

Dimensions.—The dimensions of furrow-drains are in a great degree regulated by the kind of material intended to be employed in filling, and also by the manner of forming the channel for the passage of water. Stones are almost exclusively used for this purpose throughout Aberdeenshire; and there are two methods of putting them into the drains. Many farmers, agreeably to the Deanstone plan, break the stones to a small size, like those used in repairing the public roads; and put them promiscuously in to a certain depth. Several others, however, are of opinion that each drain should be furnished with an “eye” or open conduit in the bottom, similar to, but of smaller dimensions than, that of the main drains already described. Each of these modes of filling, and the cases in which the last-mentioned one becomes preferable to the other, shall be adverted to in a subsequent part of this paper. When it is intended to form an “eye,” or opening in the bottom of the drain of 3 inches in width by 4 in height, which are the usual dimensions, the drain requires to be about 18 inches wide at the top, and 12 at the bottom; but when broken stones are to be used, without a conduit in the bottom, the drains are formed so narrow as barely to afford room for the labourers to work with freedom. In this case, the width at the top is generally 15 inches, and that of the bottom 5.

Much difference of opinion exists among farmers in regard to the most proper depth of drains. There seems, however, to be a general and an increasing disposition to practise somewhat deeper draining than has hitherto been considered necessary or advisable. The usual depth of furrow-drains at
present is 32 inches; until very recently, a depth of 30 inches was the most common and the most generally approved of in Aberdeenshire; but the opinion is fast gaining ground among intelligent agriculturists, that by cutting the drains from 6 to 12 inches deeper, their efficiency in drying the soil would be very materially augmented; and that, therefore, the distance between them may be proportionably increased. When the subsoil-plough is intended to be afterwards used, the minimum depth to which stone-drains are cut is 32 inches below the surface of the ground. Both these important operations—viz., draining and sub-soiling—are deemed, by many experienced farmers in this district, to be necessary accompaniments to each other; for, when either is left undone, the maximum advantage cannot be derived from the accomplishment of the other.\footnote{Any farmer engaged in draining, may readily and fully convince himself, should he be sceptical, of the advantage of deep over shallow drains, by getting one cut some six or eight inches deeper than the rest, and observing, after the first heavy rain, or previous to its occurrence, if the ground happen to be very wet at the time, which draws the largest quantity of water.}

**Cutting.**—This part of the process of draining is very commonly performed by contract with one or more skilful workmen, at a stipulated rate of wages per hundred yards: these men being responsible for the work of the labourers employed by them. The filling in—especially when stones are employed, as it demands the greatest care and attention in its performance—is usually conducted under the immediate superintendence of the farmer or his steward, by the regular farm-servants, or labourers hired by the day, who, having no interest in hurrying over the operation, are more likely to execute it in a perfect and substantial manner than men engaged at piece-work.

With regard to the mode of opening the drains, the farmers in general are particularly solicitous that the drains, besides being of the specified dimensions, shall be straight and even along the bottom, that a sufficient and uniform fall be secured for the water, and that the sides be regularly and similarly sloped. Previous to the filling-in being commenced, or the contractor being paid for the cutting, all the drains are individually inspected by the farmer or his steward, in order to be satisfied that all parts of the work have been correctly executed, agreeably to the previous arrangement. Most of the landlords (all of whom in Aberdeenshire defray
a considerable proportion of the expense of draining) have a
man specially for the purpose of examining the drains in
course of formation on their respective estates, and seeing
that they are constructed in a correct and substantial man-
er. It is, perhaps, needless to observe in this place, that in
every case the opening of the drains is commenced at the
lower, and the filling at the higher level, in order that any
water which may happen to be present may thus be per-
mitted to escape, which not only insures a dry footing for
the labourers, but also serves to indicate any defects in the
work already accomplished.

Should the land about to be drained be in grass at the
time, the work is usually begun by stretching a line in the
proper direction, and marking off with a spade the breadth
of the drain at the top. The surface sods are then dug out,
and placed on one side; and in some instances they are cut
with care, in order that they may subsequently be available
for covering the stones before returning the earth. The
tools employed in draining are, two different sizes of spades,
a pickaxe, a footpick, and a narrow shovel or scoop for
throwing out the loose earth from the bottom of the drain.
The footpick, or "tramp-pick," as it is likewise termed, is a
most effective instrument for breaking up the indurated
subsoil, through which the spade alone could not easily be
made to penetrate, as also for loosening any stones that may
be met with.

Stone-Drains.—The stones employed in draining are pro-
cured from two sources, viz., the surface of the ground, and the
quarry. The small round stones annually gathered off the
grass-fields, as well as those brought to the surface by the
action of the tillage implements while preparing the land for
green crops, are carted into heaps at convenient situations, with
the intention of being subsequently employed (if necessary)
in draining. The fields, in most parts of the county, contain
a great number of such stones, and they are considered to
be peculiarly well adapted for draining; they also constitute an
economic material, since it is necessary, or proper at all
events, to collect and remove them off the ground; and they
require little breaking preparatory to being put into the
drains.

Mr. Sullivan adverts to an objection to filling drains with
stones broken to nearly the size of road metal, particularly
in lands abounding in ferruginous matter, the deposit from
which, sooner or later, completely obstructs the passage of
water, rendering the drain perfectly useless. This subject will be found treated of in a previous article (p. 84) by Mr. Parkes, who has indicated, as we believe, the only mode by which, in the present state of our knowledge, this very serious inconvenience can be obviated. It is with much deference that we observe, that we do not believe that the plan recommended by our talented author will be found effectual. He recommends that each drain should be furnished with a securely-formed "eye," or open conduit, in the bottom, which will afford a channel for the free passage of water, and not be "very liable to be rendered inoperative by the accumulation of deposit."

Proper size of Stones for Draining.—Many consider that it would be imprudent to reduce the stones to a smaller size than 4½ or 4 inches in diameter, from an apprehension that the water would not make its way with sufficient celerity through those of less dimensions. Others, however, break them so as to pass freely through a ring 3½ inches in diameter, and there are not a few who prefer them so small that the largest in the heaps may pass through a 3-inch ring. The propriety of using stones of a small size is every year becoming more and more generally recognised in practice; and, as the size is diminished, the quantity put into the drain is also lessened. On one estate, the proprietor of which defrays the whole of the expense of draining, except the carriage of the material used for filling, the drains were, in 1844, filled with 15 inches in depth of stones, broken so as to pass through a ring 4 inches in diameter; in 1845, all that were made were filled with 12 inches in depth of 3-inch stones; and the regulation since the beginning of the current year is, that only 9 inches in depth of stones, broken so small as to pass freely through a 2½-inch ring, shall be used. The drains, it may be proper to mention, are 32 inches in depth, 14 inches in width at the top, and 5 at the bottom. I may here observe that Mr. Smith considers 4 or 5 inches of broken stones to be quite sufficient.

The stones are most generally laid down in cart-loads at proper intervals along the sides of the drains, either prior to the cutting being commenced, or while it is being performed. It is found advantageous, particularly during winter, to have the stones on the spot previous to cutting the drains, as it is desirable to fill them in immediately after being opened, in order to guard against the falling-in of any portion of the sides, which not unfrequently happens during wet weather,
or after frost, and occasions much additional labour. Many farmers, prefer, however, to get the stones broken at the quarry in large heaps, or bens, whence they are carted to the drains when required; and this is unquestionably the more judicious practice. The small stones that have, from time to time been gathered off the fields, are commonly broken to the required size at the heaps into which they had at first been formed. In both these cases the broken stones are carted to the drains as required, and shovelled into them from the carts, care being taken not to break down any of the soil from the sides, or to allow any earthy matters to get in among the stones.

Mr. Sullivan describes an apparatus, which he says some of the Aberdeenshire farmers have found useful, for the double purpose of expediting the operation of filling the drains with broken stones, and of freeing the stones from all earthy matter. For this, we must refer to the essay.

The stones, after being made uniform on the surface, which is very easily effected when the mode of filling just described is adopted, are covered with turf of about 2 inches in thickness, cut from the contiguous surface, if the field is in grass at the time. Sometimes the first or top sods are reserved for this purpose. Heath, straw, and similar matters are also occasionally used when the land is in stubble or tillage. The covering of the stones with turf is a part of the process on which much attention is bestowed, as considerable damage may ensue to the drain from having it imperfectly performed.

In the construction of the other description of drain—namely, that furnished with an "eye," or square conduit—much care and attention must also be exercised. The eye is formed in nearly the same manner as the conduit of main drains already described; stones of suitable size are placed at both sides of the bottom, upon which others are laid across the drain, thus forming an opening, the ordinary dimensions of which are 3 inches in width by ¾ in height. In order to render this a substantial mode of draining, the side stones—or "cheeks," as they are designated—must be all of the same height, and be firmly laid upon the bottom, as the subsequent displacement of any of them would obstruct the passage of the water. The labourers accustomed to construct this kind of drain perform the work in a secure and expeditious manner. After the eye has been formed in the bottom of the drain, 5 or 6 inches in depth of broken stones are commonly, but not always, placed above the covers, and
these are again covered with turf, straw, or other suitable material.

Not a few of the farmers still adhere to the old practice, when returning the earth thrown out in excavating the drain, of placing the loose surface-soil next the covered stones, and keeping the more tenacious subsoil near the top. This is done with the view of facilitating the descent of rain-water into the drains; but many intelligent drainers are now opposed to the practice, and deny its propriety, as they deem it essential to the efficiency and durability of the drains to guard against the direct entrance of water from the top. It is considered preferable to force all the water to find its way into the drains by percolation through the subsoil; for, if permitted to enter through the loose earth above the stones, it must necessarily carry along with it a greater or less quantity of the soil, which will be deposited in the drain. The most approved practice, therefore, and that which is becoming general, is, after the stones or other materials used for filling have been properly covered with turf, to have a portion of the most tenacious of the subsoil well trampled with the feet, or beaten down with a wooden instrument adapted for the purpose. This consolidated stratum is commonly 2 inches in thickness. The remainder of the earth is then put in, sometimes with the plough, but generally by the spade; and a few turns of the harrows complete the process.

Turf-Drains.—In reclaiming some boggy lands in the district of Buchan, several drains were formed with sods cut from the surface, and which have continued in efficient operation during a period of thirty years. By this means, and at a comparatively trifling expense, several hundred acres of peat-moss have been completely and effectually dried, and, by liming and judicious tillage, have been brought into profitable cultivation. Sod or turf drains are resorted to with advantage in many quarters.

Wood-Drains.—In some districts where stones are scarce and wood cheap, the thinnings of plantations—larch and Scotch firs—are employed for filling the drains; and the manner in which this is effected is clearly and carefully described by Mr. Sullivan. The wood used for this purpose consists of the thinnings of plantations, i.e. the small trees commonly converted into paling. Larch is preferable, on account of its greater durability; but Scotch fir being the cheapest and most abundant kind in this quarter, is generally
used. The drains to be filled with wood are usually 32 inches in depth, 18 inches wide at the top, and about 6 inches at the bottom. It is essential to the efficiency and durability of wooden drains, that the sides be formed with a proper and regular slope from top to bottom. The small trees—or "spars," as they are designated—are prepared for being put into the drain, in the following manner: A portion of the butt or thick end of each is sawn off for placing transversely in the drain, about 6 inches above the bottom; the breadth of the drain at this part may be assumed at 9 inches, in which case the length of the cross-bars will require to be about 15 inches, so as to have 3 inches resting on each side. They are generally about 4 inches in diameter, and are placed in the drains at intervals of 4 feet apart; they are forced firmly into their proper position by a few blows of a heavy mallet, the workman taking care that they are all in the same plane or level. Any earth loosened from the sides in striking down the bars is, of course, thrown out as the work is proceeded with. After the butt-ends of the trees (which are divested of their branches in the wood) are severed, and placed transversely in the drains in the manner just described, the remainder of them are laid longitudinally above the bars, three being commonly placed side by side, and covered with the branches and twigs, or with turf, heath, &c., previous to putting in the earth cast out in opening the drains. It is obvious that this method of draining can be adopted with advantage only in situations where timber is convenient and cheap, and when the subsoil is sufficiently cohesive to afford a proper support to the transverse bars of wood; hence it is inadmissible in the case of boggy lands. The putting in of the wood is accomplished in a very expeditious manner: two persons saw off the butts, and another places them in their proper position in the drain, after which the longitudinal spars are laid on as closely as possible, with the top and butt-ends alternately in the same direction, so as to make them fit the better. There is thus formed beneath the wood a channel for the passage of water, of about 6 inches in width and the same in depth.

The cost of this mode of draining obviously depends much on the price of the wood employed. In most parts of this country, the spars used for the purpose are obtainable at from 1s. to 1s. 6d. per dozen; and it requires four dozen, averaging 20 feet in length, to do a hundred yards of drain. Drains thus constructed have been known to last for a very long period;
on one farm the writer has been assured that drains formed of wood, in the manner just described, have been in perfect operation for more than thirty years.

Gravel-Drains.—Coarse gravel is sometimes employed with much advantage in filling drains in bogs and swampy situations, where stones would sink into the soft and yielding bottom. A friend of the writer's drained several acres of mossy or spongy land, about six years ago, with coarse gravel, carted during frosty weather from a river in the neighbourhood; and the drains so filled are still in efficient operation. They were formed of considerable width, and filled nearly to the surface with the gravel; and the field in question was thereby rendered perfectly dry, and capable of being tilled in the same manner as the rest of the farm. The cost was very trifling. This material, when it can be conveniently procured, may also be used in draining short pieces of wet land at the bottom of fields; but it is unfit for a long length of drain, or where any considerable current of water is expected.

Expense and Profit of Draining.—Mr. Sullivan gives the details of the expense of thorough-draining a field of 12 acres; we pass these over to arrive at the conclusion, in which he compares the expense and the profit of the operation.

The entire expense of draining and subsoil ploughing this 12-acre field has amounted to no less a sum than £6l. 3s. 1d., or £7. 0s. 3½d. per acre.

After undergoing the usual course of tillage in summer fallowing, the land got a top-dressing of lime, and street-dung from Aberdeen, and was sown with wheat in the autumn of 1834. It is worthy of remark that this was the first time wheat was ever attempted to be grown in the field in question. The utility of draining cannot be better illustrated than by a comparison of the crops raised in this field prior and subsequent to the execution of that improvement. Subjoined is a statement of the actual produce and value of the crops from 1829 to 1833, inclusive:

<table>
<thead>
<tr>
<th>Year</th>
<th>Crops</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1829</td>
<td>turnips, a miserable crop, barely worth 2l. per acre</td>
<td>24</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1830</td>
<td>oats, 31 qr. 7 bush. (2 qr. 5½ bush. per ac.), at 25s. per qr.</td>
<td>39</td>
<td>16</td>
<td>10½</td>
</tr>
<tr>
<td>1831</td>
<td>first year's grass (depastured), valued at 27s 6d. per acre</td>
<td>16</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>1832</td>
<td>second year's grass (depastured), valued at 1l. per acre</td>
<td>12</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1833</td>
<td>oats, 24 qr. 7 bush. (2 qr. 6½ bush. per ac.), at 35s. per qr.</td>
<td>43</td>
<td>10</td>
<td>7½</td>
</tr>
</tbody>
</table>

Value of crops on twelve acres for the five years preceding the drainage ........................................... £135 17 6
ON DRAINING.

The following are the returns of the crops from 1835 to 1839, inclusive:

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>Quantity</th>
<th>Value per Acre</th>
<th>Total Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1835</td>
<td>Wheat</td>
<td>49 qr. 1 bush.</td>
<td>£122 16 3 per qr.</td>
<td>£6 16 3</td>
</tr>
<tr>
<td>1836</td>
<td>Grass (depastured)</td>
<td>£28 10 0 per acre</td>
<td>£19 4 0</td>
<td></td>
</tr>
<tr>
<td>1837</td>
<td>Oats</td>
<td>57 qr. 1 bush.</td>
<td>£71 8 1/2 per qr.</td>
<td>£67 16 0</td>
</tr>
<tr>
<td>1838</td>
<td>Turnips</td>
<td>£67 16 0 per acre</td>
<td>£67 16 0</td>
<td></td>
</tr>
</tbody>
</table>

Value of the crops for the five years succeeding the drainage: £309 14 4/2
Value of the crops for the five years preceding the drainage: £135 17 6

Increase in value of produce of twelve acres in six years: £173 16 10/2
Cost of draining and subsoil-ploughing: £96 3 1

Gain in course of six years: £77 13 9/2

One year's rent, and the expense of the following and manuring, should, perhaps, be deducted from this sum; but still it will be seen that the cost of draining and subsoil-ploughing the field referred to has been soon and most amply repaid; besides, that, while the productiveness of the soil has been greatly increased, the expense of cultivating it has been considerably diminished.

A farmer who had put down, in 1844, 1,761 yards, or 1 mile of main drains, and 14,895 yards, or 8,46 miles of small drains, at a cost (for cutting and filling) of from 16s. to 22s. for the former, and from 10s. to 13s. for the latter, per hundred yards, exclusive of carriages, and in 1845 nearly the same extent, states that the improvement in the land consequent on its drainage has been both immediate and very marked. The crops of every description, and more particularly turnips, have been considerably augmented in quantity and improved in quality, while the ground may now be ploughed or otherwise tilled in all states of the weather, except during hard frost. The value of the grass has also been greatly enhanced, the pasturage being more abundant, and the herbage more nutritious. He is of opinion that the cost of thorough-drainage is in most cases repaid in five or six years.

Mr. James Porter, the intelligent overseer of Logie-Elphinstone, the home-farm of Sir Robert D. H. Elphinstone, Bart., made an experiment last year, with a view to ascertain the
influence of draining on the first crop. The soil is naturally very poor, being a thin yellowish clay, resting on a subsoil of hard gravel and clay. The whole of the field, except half an acre, was thorough-drained with broken stones in the autumn of 1844, at a cost of 4l. per acre, exclusive of carriages. For the purpose of comparison, another half acre was measured off adjoining the undrained portion. The field was sown with Kildrummy oats on the 26th of March 1845, and the crop was reaped between the 14th and 21st of September. The following is a tabular statement of the result:

<table>
<thead>
<tr>
<th>Plots</th>
<th>Marketable oats on half acre</th>
<th>Weight per bush</th>
<th>Second quality of oats on half acre</th>
<th>Weight per bush</th>
<th>Shillocks or inferior grain</th>
<th>Weight per bush</th>
<th>Whole produce of the half acre, exclusive of shillocks</th>
<th>Weight of straw, cwt. qr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Drained</td>
<td>2 2 0</td>
<td>41</td>
<td>0 3 3</td>
<td>38</td>
<td>89</td>
<td></td>
<td>2 5 3</td>
<td>15 1</td>
</tr>
<tr>
<td>2. Undrained</td>
<td>1 5 1</td>
<td>39 4</td>
<td>0 2 1</td>
<td>37 4</td>
<td>69</td>
<td></td>
<td>1 7 2</td>
<td>12 0</td>
</tr>
<tr>
<td>Increase per half acre</td>
<td>0 4 3</td>
<td>0 1 2</td>
<td>20</td>
<td>0 6 1</td>
<td>3 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It thus appears, that even on the first crop after draining there was an increase of above 1 1/2 qr. of grain, and 6 1/2 cwt. of straw per acre, the value of which goes far to repay the expense of the operation.

Mr. Walker, Wester-Fintray, has drained extensively for some years past. All his drains are provided with open conduits, or "eyes," as the land abounds with ferruginous matter, and the cost varies from 4l. to 6l. 5s. per acre, according to circumstances. The most beneficial results have accrued from drainage on both his farms; one of the fields which was recently drained was last year in turnips, and the produce was valued at 6l. per imperial acre. When the same field was previously under this crop, it was barely worth 3l. per acre.

In the low-lying parts of Aberdeenshire, the expense of draining is not unfrequently repaid by the increased produce of the first three crops grown after the operation has been executed; but in general it is not expected to be fully returned until two courses of crops have been raised. There are some soils so naturally sterile as not entirely to repay
the cost of thorough-draining during the currency of a nineteen years' lease, if the increase of produce be alone taken into consideration; but several other advantages are also derivable from efficient drainage, to which, however, it is unnecessary to advert in this place.

Farmer's Magazine, Nov. 1846.

Art. XXX.—ON THE BEST METHOD OF DRAINING RUNNING SANDS.

By Mr. Linton.

[This is the subject of a Prize Essay, in which the mode of procedure in the particular circumstances is well and fully described. The writer gives an account of the results of twelve years' experience.]

During that period I have been engaged in draining a great variety of soils, but especially the running sand; the greatest part of which had been previously drained, but on account of the shallowness of the drains, which were not more than from 12 to 18 inches deep, their having been covered with perishable materials, and not having bottoms, which allowed the moles to do great mischief by their subterraneous burrowing, had become entirely choked up, and consequently useless.

The land in question has a very light grey, sandy surface. The subsoil is white sand, which varies in depth from 12 inches to 6 feet, beneath which lies, of a considerable thickness, a bed of marly clay. To attempt here to fix any stated depth at which drains should be laid is in my opinion absurd, as that is a question which can only be determined by ascertaining the depth at which the water lodges; which may be known by digging holes in different parts of the field previous to commencing the work, and as soon as the stratum which contains the water is cut through, it will at once be seen by both sand and water gushing into the opening, and undermining the earth around it. For the most part, when my drains are cut to the depth of about 18 inches, a small stratum of the quick running sand and water is found, and at about 18 or 20 inches deeper one containing a much larger quantity of water is cut into, which is about 3 inches
in thickness; beneath it lies the marly clay upon which we generally lay the tiles. But it sometimes happens that on the higher parts of the field the clay referred to cannot be reached, on account of the increased thickness of the sand. Still when this is the case, the sand beneath the stratum of water, on account of its elevation, is of a firmer and drier kind, upon which we can with confidence place the tiles, never having found them to fail when a rapid descent was avoided. To reach the clay in every place is not practicable. The average depth of the drains is about 3½ feet.

The manner in which the work is done is as follows:—The first object is to ascertain the depth at which the bottom water lodges. If deep, and the earth very porous, the drains are set out much farther apart than when it lies near the surface. Thus they are varied in their distance from each other in proportion as the water lies deep or otherwise; that is to say, when we can cut to a depth of 4 feet in that which is entirely porous, the drains are set 15 yards apart, and when we find the water to lie as deep as 6 feet, their relative distance is 20 yards. But when the clay lies near the surface, being only about 12 inches beneath it in some instances, they are set out only 8 yards apart.

Having ascertained the proper depth and relative distances of the drains, the outlet is next attended to, a point which is frequently too slightly regarded, and consequently often proves injurious, and sometimes entirely ruinous to the whole work. When this is accomplished, the drains are set out as above. The land, which is very undulating; is cut to a certain level depth throughout, so as to give a gradual and proper descent towards the outlet, and so deep as to only require two draws or spits to be taken out afterwards. The earth at the top being thus removed, the level is then used (as, from the porosity of the land, no water by which the descent might be taken runs so near the surface), and the greatest care is taken at this stage of the work to have all thoroughly true, and the descent given that is required, as the finishing depth and the fall are ruled by the top levelling, before the two spits referred to are taken out. To cut the drains deeper before using the level, would be to render the use of it almost impracticable.

All is now ready for completing the work, tiles and bottoms being laid by the side of the drain, and three men engaged in the work; two of the most experienced to cut the drain to its proper depth, the one following the other in
as short a space as possible, and the third immediately following with the bottoms and covering. The main drains are laid either with large-sized tiles and bottoms, or with two common ones, one upon the other, the lower one being reversed, and the upper placed upon its edges half the length of the tile backward, that the ends of the upper and lower tiles may not come together, which will break the joinings throughout the whole drain. If the latter plan be adopted, the minor drains are laid level with the edges of the reversed tile; if the former, about 2 inches descent is given at the entrance of the main drain.

All rapid falls are particularly avoided, or the drain will wash away in spite of all precaution, especially where a strong run of water occurs. Where a fall of one in a hundred cannot be avoided, it is necessary to beat clay into the bottom of the drain under the soles. In setting out the minor drains, the distance of each is regulated, as already pointed out, according to the openness of the land and the depth of the water. All long runs are also avoided, the length being no more than from 3 to 5 chains. I need scarcely say that the whole of the land is thrown level, so that there is neither ridge nor furrow to regard.

We shall now consider the most important and critical part of the work, which is the taking out of the bottom spit, and the laying of the tiles and bottoms; but most of all, the securing of the tiles from admitting the quick running sand. The two men who cut the drain to its proper depth, work as near to each other as possible, and the tile-layer quite up to the latter, or the drain would be immediately closed up by the sand running in from the sides, which would also let down the mass from the surface. In other words, when the first man has got a few feet from the end of the drain, the second commences taking out the bottom spit, and as soon as he has made way for the laying of three or four tiles, it is immediately done by the tile-layer; first laying the bottoms quite close to each other, and upon them the tiles, leaving as little crevice as possible, and immediately covering them with about 4 inches of the most tenacious soil that can be procured. Clay would be used, but on account of its being in large hard lumps, it cannot be made to bed sufficiently close to keep out the sand. Here I must notice, that it is essentially necessary that the drains be cut 3 or 4 inches wider at the bottom than the width of the tile, so as to admit this strong soil down the sides to the very bottom.
Much mischief is done by the sand getting in at the bottom part of the joinings of the tiles. Other materials have been used for keeping out the sand, but with bad effect. I prefer clay to anything else when it can be got sufficiently loose and malleable, so as to bed quite close and firm, and leave no crevice. Straw and all perishable materials are particularly avoided.

When the season is wet (although, from many considerations, a dry one should be chosen if possible), and when the drain is deep, great difficulty is found in keeping the sides from falling in before the tiles and first covering can be deposited. I have frequently found it necessary to fix planks to the falling sides, supported by cross-stays, to prevent accident, and keep the drain open until the work be completed.

After the clay or strong soil is well trodden in and thrust down the sides of the tiles with a common spade, the sand thrown out in making the drain is then filled in, and is firmly beat down by treading, and sometimes by running a broad-wheeled cart upon it, in which is put a sufficient weight, in order that the covering of the drain may become as firm as any other part of the field. This is done to prevent the water from descending or finding a channel to the tile in that direction, or it would be almost impossible to keep out the sand.

Sufficient has been said by different authors, especially in those Essays which are published in the Royal Agricultural Journal, as to the proper and natural course of the water—how it does and ought to enter the drain—without my entering at all into that part of the science of draining.

On account of the quantity of labour required in forming the drains, varying according as the land is wet and undulating, and again, the desideratum being rather permanent and well-executed work, than a large amount of it, I have had the work done, for the most part, by the day rather than by the piece. Notwithstanding, I have occasionally stipulated for the cutting of the two bottom spits, which together sink the drain about thirty inches, at the rate of 3½d. per 7 yards. The tools required are the common spade, shovel, draining-tool, and what is called the swan-necked scoop for cleaning out the bottom of the drain.

The pipe-tiles having been of late introduced into this neighbourhood, I have commenced using them. The drains are cut, and every other part of the work performed in the
same way as when the common tiles are used. But on account of the land having been but recently drained by them, my observations are not sufficiently matured to justify me in saying that they are in all respects equally good with the common tiles. I find it sometimes difficult to get them to fit close enough to each other, the ends not being quite straight, and some of them curved in the middle; therefore, it is necessary to apply clay to most of the joinings.

Of these running sands I have drained about 500 acres, and when the plan which has been stated here at large was adopted, which has generally been the case, the average cost per acre was about 5l. 5s.; that is to say, 1500 tiles, at 26s. per thousand; 3000 bottoms, at 11s. per thousand; cutting, 1l. 10s.; and incidental expenses, 3s.: total, 5l. 5s.

I shall now conclude these remarks by stating the result of these operations in draining, which indeed must be considered in conjunction with marling. The land in question was an enclosure of barren heath, and had been considered, and really was, previous to being drained and marled, worthless. It has now become profitable tillage-land, and is advantageously cultivated under the four-course system. But to attempt such a work without carrying out the two great parts of agricultural improvement which these soils invariably require, namely, draining and marling, is, I think, superficial and unwise, and is always attended with disappointment and loss.


Art. XXXI.—THE PRINCIPLES OF DRAINING.

By Mr. Hewitt Davis.

Experience had long shown to me the important difference between drains of 2½ and 4 feet in depth. Many years before Mr. Parkes had written on the subject, and so satisfactorily removed all doubts by his conclusive reasonings and experiments, I had found out that the deepest drains were the cheapest, most durable, and far more effectual in all soils: hence in all my practice I have long since abandoned putting in any in arable land at less than 4 feet. I have re-
peatedly had to redrain land that had been previously drained at shallow depths, and seen that the deeper drains run first, the longest, and discharged the greatest volume, and removed the cold damp from the surface, which the shallower had failed to do. The practice of shallow draining has arisen from the erroneous impression prevailing that their use is to take the surface water, and not to permit it to first soak down, whereas no rain water should pass off the ground, but all should be encouraged to go through it, and which, with proper tillage and drainage, it will do. Drains are intended to prevent the return of water upwards, and not to admit water from above. That draining is so little understood is hardly to be wondered at, when we consider that until Mr. Parkes's attention was directed to it, the practice had been generally confined to tenant farmers, and the advantages derived from extended experience and science were unknown. I confess, until I had read Mr. Parkes's essay on "The Temperature of Soils as affected by Drainage," I was at a loss to give satisfactory explanations for my practice, although I had come to the same conclusion that reading his works will, I think, at once bring every one. To his works I would refer all who are about to drain, for it is a lamentable fact that by far the greater portion of the money spent in draining is comparatively lost, and as yet few are aware of the full benefit to be gained. One of the most important benefits to be derived from drainage is a higher temperature in the spring of the surface-soil—a benefit of extreme importance in our climate, but which is not fully attained by drains of less than 4 feet deep, and scarcely felt at all when only \( \frac{1}{2} \) feet. If rain passes through the soil to the depth of 4 feet, the temperature of the soil, by the passage of the water, is considerably raised; whilst on the contrary, if drained only \( \frac{1}{2} \) feet down, the water from below is soaked upwards to the surface by capillary attraction, and will be continually passing off by evaporation—this rise of water, and the effect of evaporation producing extreme cold in the spring, appears too often unknown. I have drained all descriptions of soil, and as yet have never seen occasion to drain arable land less than 4 feet in depth, nor at distances less than 35 feet; of course the distance from 35 feet upwards will vary with the character of the soil, the lighter requiring fewer drains; but I take 4 feet to be the best depth for all soils, and the least expensive. I pay 9d. per rod for cutting and laying and
filling-in 4-feet drains; but labour in England varies considerably. There are draining tools, which, in the hands of men accustomed to them and to the work, enable them to earn 3s. or 3s. 6d. per day at this rate of pay per rod. There is no material equal to tiles or pipes. The labour of picking and breaking stones is nearly equivalent to the cost of tiles. Where fuel is moderate, 1½-inch tiles may be made at from 10s. to 18s. per 1000, the cost of coals being from 8s. to 28s. per ton; and about 750 are sufficient for an acre at 40-feet distances. If tiles are used, no stones should be put on them. I put a little heath or straw on the tiles to prevent their dislodgement by the fall of the earth in filling-in, or soil working in at the joints. At the prices I have given, draining costs from 65s. to 90s. per acre, including carriage of materials; I never use pipes or tiles less than 1½-inch bore. I think the use of stones alone is objectionable, and have lately heard great complaints where they have been used, and the draining cost from 8l. to 9l. per acre. All drains should be carried directly up the fall, never across. The object in view should be ever to give an even current with the greatest fall, and then there is every chance of the drain being permanent and always washing itself clean. A knowledge of geology will much assist in arranging the direction of the drains; cutting across the lines of strata or deposits let out the water that lies between them. Before draining, examine your land by sinking little wells 4 or 5 feet deep; and if you find a porous substratum that allows water to freely pass down, and you are not shown that water rises in winter, do not drain, for no benefit can accrue therefrom.

Agricultural Gazette, Dec. 19, 1846.
ART. XXXII.—INSTANCES OF THE COST OF DRAINING AN ACRE OF LAND,

The Drains being laid with Inch Pipes at various Depths and Distances asunder; the Pipes being assumed to cost Six Shillings per thousand, if manufactured upon an estate.

By Josiah Parkes, Consulting Engineer to the R. A. S. E.

<table>
<thead>
<tr>
<th>Character of soil.</th>
<th>Authority and place.</th>
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<tbody>
<tr>
<td>Uniform clay.</td>
<td>T. Hammond, tenant farmer, near Peasmarsh, Kent.</td>
</tr>
<tr>
<td>Ditto.</td>
<td>J. Thompson, Surrey.</td>
</tr>
<tr>
<td>Clay with some stones.</td>
<td>T. Hammond.</td>
</tr>
<tr>
<td>Clay super hard gravel subsoil.</td>
<td>H. Simmons, t.f., Hadlow, Kent.</td>
</tr>
<tr>
<td>Clay gravel bottom.</td>
<td>Kepping, Hadlow.</td>
</tr>
<tr>
<td>Clay gravel, sandy clay.</td>
<td>Ditto.</td>
</tr>
<tr>
<td>Clay with some boulders in subsoil.</td>
<td>Bartlett, t.f., near Burtleigh, Somerset.</td>
</tr>
<tr>
<td>Clay with some boulders in subsoil.</td>
<td>Ditto.</td>
</tr>
<tr>
<td>Clay with some boulders in subsoil.</td>
<td>Ditto.</td>
</tr>
<tr>
<td>Clay and grit loam.</td>
<td>Ditto.</td>
</tr>
<tr>
<td>Clay and grit loam.</td>
<td>Ditto.</td>
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### Tabular Data

<table>
<thead>
<tr>
<th>Length of Drains, per acre.</th>
<th>Feet.</th>
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<table>
<thead>
<tr>
<th>Distance between Drains.</th>
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<td>Feet.</td>
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<td>33</td>
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<td>33</td>
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<td>3 to 4</td>
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<td>5 to 6</td>
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<td>8</td>
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<td>10</td>
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<td>11</td>
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<tr>
<th>Cost of Drains, per rod per fur.</th>
<th>130</th>
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<tr>
<td>Feet.</td>
<td>130</td>
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<td>3</td>
<td>130</td>
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<td>3</td>
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<td>130</td>
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### Notes
- The pipes are assumed to cost 6 shillings per thousand, if manufactured on an estate.
- The cost of digging, getting, and housing, breaking the stone, and filling in, is 8 shillings per month.
DRAINING AN ACRE OF LAND.

Differing circumstances necessarily render it impossible to assign one cost as a universal rule in drainage. The instances of cost given in the Table comprehend a variety of soils and subsoils, the texture of which occasioned very different wages to be given for opening out the trenches. The pickaxe had to be resorted to in Nos. 6, 7, and 9; whereas Nos. 1, 2, 3, 4, 5, exhibit the usual charge in the district for excavating uniform, or, as you may well call them, honest, clays at the depths cited.

CHAPTER IV.

ON MANURES.

Art. XXXIII.—ON THE PRINCIPLES OF ARTIFICIAL MANURING.

By Baron Von Liebig.

If we compare the experience of farmers regarding the fertility of the soil and the quantity of its productions, we are surprised by a result which surpasses all others in general application and uniformity.

It has been observed, that in every part of the globe where agriculture is carried on, in all varieties of soil, and with the most different plants and modes of cultivation, the produce of a field on which the same or different plants have been cultivated during a certain number of years, decreases more or less in quantity, and that it again obtains its fertility by a supply of excrements of man and animals, which generally are called manure; that the produce of the fields can be increased by the same matters, and that the quantity of the crop is in direct proportion to the quantity of the manure.

In former times, scarcely any attempt was made to account for the cause of this curious property of the excrements of man and animals. Without taking into consideration the origin of the excrements, and the relation they bear to the food, it was not astonishing that their effect was ascribed to a remnant of vital power, which should qualify them to increase the vitality in plants. Ascribing their influence on the fertility of the fields to an incomprehensible occult cause, it was forgotten that every force has its material substratum; that with a lever, in a mathematical sense, which possesses
no extension and gravity, no effect can be produced, no burden raised.

Guided by experience, which is the fundamental basis of all inductive science, and which teaches us that for every effect there is a cause, that every quality—as, for instance, the fertility of a field, the nourishing quality of a vegetable, or the effect of a manure—is intimately connected with and occasioned by something which can be ascertained by weight and measure, modern science has succeeded in enlightening us on the cause of the fertility of the fields, and on the effects which are exercised on them by manure.

Chemistry has shown that these properties are produced by the composition of the fields; that their fitness for producing wheat or some other kind of plants bears a direct proportion to certain elements contained in the soil, which are absorbed by the plants. It has likewise shown that two fields, of unequal fertility, contain unequal quantities of these elements: or that a fertile soil contains them in a different form or state from another which is less fertile. If the elements are contained in the soils in sufficient quantities, it produces a rich crop: if it is defective in one of them only, this is shown very soon, by the impossibility of growing in it certain kinds of plants.

Moreover, it has been proved with certainty what relations these elements of the soil bear to the development of the plants. Chemical analysis has demonstrated that a certain class of these elements is contained in the seeds; others, in different proportions, in the leaves, roots, tubers, and stalks. They are mineral substances, and, as such, are indestructible by fire, and consequently remain as ashes after the incineration of the plants or of their parts. Many of these elements are soluble in pure water, others only in water containing carbonic acid, as rain water; all were absorbed from the soil by the roots of the plants in a dissolved condition. It has been shown that, if in a field those elements which remain after the incineration of the grain or seeds are present in an insufficient quantity, no wheat, no barley, no peas—in a word, none of those plants can be cultivated on that field, which are grown on account of their seeds. The plants which grow on such a field produce stalks and leaves; they blossom, but do not bear fruit. The same has been observed regarding the development of leaves, roots, and tubers, and the mineral elements which they leave behind after their incineration. If, in a soil in which turnips or potatoes are to
be cultivated, the elements of the ashes of these roots are wanting, the plants bring forth leaves, stalks, blossoms, and seeds; but the roots and tubercles are imperfect. Every one of the elements which the soil gives up to the plants is in a direct quantitive proportion to the production of the separate elements of the plants. Two fields, which, under otherwise equal circumstances, are unequally rich in mineral elements of the grain, produce unequal crops. One containing them in larger quantity produces more than another containing them in less. In the same manner, the capacity of a soil to produce tuberculous plants, or such which have many leaves, depends upon its amount of the elements of the soil which are found in the ashes of those plants.

It results from this with certainty, that the mineral substances which are furnished by the soil, and which are found again in the ashes of plants, are their true food; that they are the conditions of vegetable life.

It is evident, that from a field in which different plants are cultivated, we remove with the crop a certain quantity of these elements; in the seeds, those mineral parts which the soil had to provide for their development; and in the roots, tubercles, stalks, and leaves, those elements which are necessary for their production. However rich the field may be in these elements, there can be no doubt that, by several cultures, it becomes more and more impoverished; that for every plant a time must arrive when the soil will cease to furnish, in sufficient quantity, those elements which are necessary for a perfect growth. Even if such a field, during many subsequent years, produced twenty-five or thirty fold the amount of the seed—for instance, of wheat—experience shows that the crop gradually decreases, until at last the amount will be so small, that it approaches the plant in its wild state, and would not repay the cost of cultivation.

According to the unequal quantity in which the mineral elements of grain, tubercles, roots, seeds, and leaves, are contained in a soil, or according to the proportions in which they may have removed in the crop, the land may have ceased to be fertile for roots and tubercles, but it may yet produce good crops of wheat. Another may not produce wheat, but potatoes and turnips may thrive well in it. The mineral substances contained in a fertile soil, and serving as food to the plants, are taken up by them with the water, in which they are soluble. In a fertile field they are contained in a state which allows of their being absorbed by the plant, and
taken up by the roots. There are fields which are rich in these elements, without being fertile in an equal proportion; in the latter case, they are united with other elements into chemical compounds, which counteract the dissolving power of water. By the contemporaneous action of water and air—of the oxygen and carbonic acid of the atmosphere—these compounds are decomposed, and those of their constituent elements, which are soluble in water, but which had been insoluble by the chemical affinity of the other mineral substances, re-obtain the property of being absorbed by the roots of the plants.

The duration of the fertility of a field depends on the amount of the mineral aliments of plants contained in it; and its productive power for a given time is in a direct proportion to that part of its composition which possesses the capacity of being taken up by the plant. A number of the most important agricultural operations, especially the mechanical, exercise an influence on the fertility of the fields only thus far, that they remove the impediments which are opposed to the assimilation of the mineral food into the vegetable organism. By ploughing, for example, the surface of the fields is renewed and made accessible to air and moisture. The nutritious elements contained in the soil in a latent state acquire, by these operations, the properties necessary for their transmission into the plants. It is easy to conceive the useful influence which, in this respect, is exercised on the produce of the fields by the care and industry of the farmer. But all these labours and efforts do not increase the amount of mineral elements in the field; in rendering soluble in a given time a larger quantity of the insoluble substances, and obtaining by these means a richer crop, the time is merely hastened in which the soil becomes exhausted.

The experience of centuries has shown that, with the help of manure, of the excrements of animals and man, with which we supply those fields which have ceased to produce crops of grain, &c., serving as food for man and animals, in a sufficient quantity, the original fertility can again be restored; an exhausted field which scarcely yielded back the seed is made to produce a twenty and more fold crop, according to the proportion of the manure provided.

Regarding the mode of action of the manure, it has been observed, that all excrements do not exercise an equal influence on plants. The excrements of sheep and cattle, for instance, increase in most fields the crop of roots and herba-
ceous plants to a far greater degree than those of men and birds (guano). The latter act far more favourably on the production of the cerealia, especially if they are added to the animal excrements, and are given to the fields at the same time.

A field, for example, which has lost its fertility for potatoes and turnips, but on which peas and beans still thrive, becomes far more fertile by a supply of the excrements of horses and cows, for a new crop of potatoes and turnips, than by manuring it with the excrements of man or with guano.

The most accurate experiments and analyses have pointed out that the excrements of man and animals contain those substances, to the presence of which the fertility of the soil is due. The fertilizing power of manure can be determined by weight, as its effect is in a direct ratio to its amount in the mineral elements of the food of plants. The truth of the result of these chemical analyses must be evident to every one who inquires into the origin of excrements.

All the excrements of man and animals are derived from the plants of our fields; in the oats and hay which serve as food to the horses, in the roots which are consumed by a cow, there are a certain quantity of mineral ingredients. A horse, in consuming 15 lb. of hay, and 4½ lb. of oats per day, consumes 21 ounces of those substances which the hay and the oats took from the fields; he consumes annually 480 lb. of these constituent elements of the soil, but only a very small portion of them remains in his body. If a horse during one year increases 100 lb. in weight, this increase contains only 7 lb. of those mineral substances which were contained in the food. But what has become of the 473 lb. which we cannot detect in his body?

The analysis of the fluid and solid excrements which the horse gives out daily shows that the ingredients of the soil which do not remain in the body of the animal are contained in its excrements; it shows that in an adult animal, which from day to day does neither increase nor decrease in weight, the amount of the mineral ingredients of the excrements is equal in weight to the mineral ingredients of the food.

As with the horse, so it is with all animals. In all adult animals the excrements contain the ingredients of the soil according to the quantities and relative proportions in which they are contained in their food.

The mineral substances of the food which have remained
in the body of the animals, and served to increase their weight, are found again in the bones and excrements of man who consumes the flesh of these animals.

The excrements of man contain the elements of the soil, of bread or of grain, of vegetables and meat.

These discoveries explain, in a most simple and satisfactory manner, the fertilizing effect which manure produces on our fields.

It is now obvious why manure renders again fertile the exhausted fields; why by its means their productiveness can be augmented; why the latter is in a direct ratio to the quantity of manure administered.

The exhaustion of the soil by subsequent crops—its decrease in fertility—is produced by the gradual removal of the mineral elements, in a soluble state, which are necessary for the development of our cultivated plants. By a supply of manure they are again restored to that state suited to serve as nourishment to a new vegetation. If the supply of the removed elements of the soil, by means of manure, be sufficient; if the quantity taken away be restored, the original fertility re-appears; if the supply be greater, the produce increases; a defective supply gives a smaller produce.

It is now explained why the different kinds of manure exercise an unequal effect upon the fields.

The excrements of man, and the guano, containing especially the mineral ingredients of grain and meat, exercise far greater influence on the amount of produce in grain in a field in which these ingredients are wanting, even if those of the leaves and stalks are present in sufficient quantity, than the excrements of an animal which feeds on roots or green fodder. The excrements of the latter contain the mineral elements of the leaves, stalks, and roots, in prevailing quantity, and have a greater value for the production of roots and foliaceous plants than those of man or birds, which contain only a small quantity of those mineral substances which they require for their development.

If we compare, for instance, the composition of guano with the excrements of the cow—solid and fluid excrements in the same state of dryness—it is found, that in an equal weight the latter contain five to seven times more of the mineral ingredients of turnips and potatoes than the former. If, in a soil which is deprived of all these mineral substances, we wish to force a crop of turnips by means of guano, we require at least five times more of guano than dung of cattle.
The same thing happens, though *vice versa*, if we wish to produce a rich crop of grain by means of animal excrements; in this case, one part of guano and five parts of animal excrements produce the same effect as 13-15 parts of animal excrements.

To understand the proper meaning of these numerical proportions, it is sufficient to mention that 400 pounds of bones contain as much phosphoric acid as 1,000 pounds of wheat; these 400 pounds of bones can furnish sufficient phosphoric acid to 8 acres.

If we take the importation of bones into Great Britain in the last ten years to amount to one million of tons, enough phosphoric acid has been supplied to the fields for 25 millions of tons of wheat; but only a small proportion of the phosphoric acid of the bones is in a state to be assimilated by the plants, and applicable to the formation of the grain. The plants, in order to apply the other far greater part of that phosphoric acid to their formation, must find a certain quantity of alkaline bases besides the bone earth, which are not given to the plants in the bones, because they contain neither potash nor soda.

To have increased the fertility of the fields in the right proportion, 800,000 tons of potash ought to have been added to the one million of tons of bones, in a suitable form.

The same is the case with guano; 60 to 100 pounds of it are sufficient to furnish phosphoric acid to one acre of turnips; but the four to eight fold quantity is required to furnish the turnips with the necessary alkaline bases, and it is still doubtful whether they can be at all provided with the latter by means of the salts with alkaline bases which the guano contains.

At a time when the necessity of the mineral substances for the growth and development of the plants, and the direct relation which the effect of manure has to its amount of the same substances, had not been ascertained, a prominent value was ascribed to the organic matters which it contains. For a long time it was thought that the produce of a field of those substances, containing nitrogen, which serve as food for man and animals, stood in a direct proportion to the nitrogen contained in manure. It was believed that its commercial value or its value as manure might be expressed in per cents, by its proportion of nitrogen, but later and more convincing observations have induced me to contradict this opinion.
If the nitrogen and carbonic acid formed by the decay and decomposition of the vegetable ingredients of manure were the cause of its fertilizing power, this ought also to be seen if the mineral substances are excluded. Direct experiments have shown that the nitrogen of the excrements can be assimilated by the plants in the form of ammonia; but that ammonia, as well as carbonic acid, although it is indispensable for the development of all plants, can accelerate the growth of plants and increase the produce of a field of grain, roots, and tubercles, only if at the same time the mineral ingredients contained in the manure which is applied are in a state in which they are suited for assimilation. If the latter are excluded, carbonic acid and ammonia have no effect on vegetation.

On the other hand, experience has shown that on many fields the produce which is rich in carbon and ammonia can be increased to an extraordinary amount without any supply of such matters as furnish these substances.

On fields which are provided with a certain quantity of marl or slacked lime, or with bone-earth and gypsum—substances which cannot give up to the plants either carbon or nitrogen—rich crops are obtained, in many places, of grain, tubers, and roots, entirely in contradiction with the view which ascribes the effect of the manure to its amount of ingredients containing nitrogen or carbonic acid.

To explain this process, which is so opposite to the common opinion, the marl, the lime, the gypsum, the alkalies, and the bone earth were regarded as stimulants, which acted on the plants like spices on the food of man, of which it was believed that they increased the power of assimilation, and allowed the individuals to consume larger quantities of food.

This view is contradicted if we consider that stimulants mean such substances as do not serve for the nourishment of the organism or for the formation of organic elements, and can only increase the weight of the body if at the same time a certain increase of food is given. In supplying the fields with the above mentioned substances the weight of the plants became increased in all their separate parts, without their having been provided with the quantity of food which, according to theory, was necessary to this extraordinary increase, viz., with carbonic acid and ammonia.

Chemical analysis shows that these so called stimulants are either actual ingredients of manure, as gypsum, bone earth, and the active substances of the marl, or that they
are the means by which the mineral elements contained in the soil are resolved into a state adapted for being assimilated by the plants; this is generally effected by the application of slacked lime. They consequently exercise on the vital process of the plants not a mere stimulus like the spices, but are consumed for the development of the leaves, seeds, roots, &c.; they become constituent parts of them, as can be shown with certainty by chemical analyses.

The success which has followed the application of these substances to the fields, has explained, in a most striking manner, the origin of the carbon and nitrogen in the plants.

In the marl, in the bone earth, in the gypsum, in the nitrate of soda, no carbon is provided to the fields; and yet, in many cases, the same produce, in some even a higher one was obtained, than by the application of a manure containing carbon and nitrogen. As the soil after the crop does not contain less carbonaceous or nitrogenous substances, it is evident that these products which had been obtained without any carbonic or azotic manures, must have got the carbon and nitrogen of their leaves, roots, and stalks from the atmosphere; it follows, therefore, that the productiveness of the fields cannot be in proportion with a supply of carbonaceous and azotic substances, but that the fertility depends only on the supply of those ingredients which should be provided by the soil.

The soil does not only serve the purpose of fixing the plants and their roots; it participates in vegetable life through the absorption of certain of its elements. If these elements are present in sufficient quantity, and in appropriate proportions, the soil contains the conditions which render the plant capable of absorbing carbonic acid and ammonia from the air, which is an inexhaustible storehouse for them, and renders their elements capable of being assimilated by their organism.

The agriculturist must, therefore, confine himself to giving to the field the composition necessary to the development of the plants which he intends to grow; it must be his principal task to supply and restore all the elements required in the soil, and not only one, as is so frequently done; the ingredients of the air, carbonic acid and ammonia, the plants can, in most cases, procure without man’s interference: he must take care to give to his field that physical condition which renders possible and increases the assimilation of these in-
gredients by the plant; he must remove the impediments which diminish their effect.

The favourable influence which bone earth, gypsum, and nitrate of soda, exercise on the fields has induced many farmers to the belief that in applying them they can dispense with manure or with the other elements of the soil; it requires, however, only little attention to see the great error of this opinion. We observe that the effect of these substances is not equal on all fields; in one place the amount of produce is increased by the lime, by the bone earth, and by gypsum; in another country, or on other fields, these substances in no way favour vegetation. From this arises the contradictory views of farmers regarding these matters as manures. If one farmer thinks the liming of his fields quite indispensable for rendering them fertile, another declares that lime produces no effect at all.

The reason of this difference is very simple. The examination of a soil upon which lime has had no effect shows that it was already rich in this substance; it further shows that its effect extends only to those kinds of soil in which lime is wanting; or in which it is found in too small a quantity, or in a condition which is not suited to its assimilation by the plant. Lime especially serves for resolving the silicates of alumina (clay), and consequently it cannot fertilize soils in which clay is wanting—for instance, sandy soils. It must be apparent to every one, that on the calcareous and gypseous fields of France and England, one-half per cent. of gypsum or lime can have no influence at all on vegetation. This can be said with equal justice of bone ashes, and of every other mineral substance serving for the nourishment of plants.

If these substances exercise a favourable effect, some of the constituents of the soil or manure are restored which are indispensable to the nourishment of plants, and which have been wanting in the soil. If this be the case, the other bodies, equally necessary, must be present in sufficient quantity. On a field in which sulphate of lime has acted favourably, and in which clover had been cultivated as fallow without it, the crop was 2200 lb. of clover hay, in which 53 lb. of potash were removed. On the same field, after it had been gysped, 8,000 lb. of hay were produced, which contained 191 lb. of potash. If this potash had not been present in the soil, the gypsum would have had no effect—the crop would not have been increased.
On fields which are richly provided with all the other mineral ingredients, with the exception of gypsum, the latter is applied with the greatest success. But if gypsum is present in the soil, the same effects are produced by ashes and lime, as is the case in Flanders. On fields in which phosphate of lime is wanted; bone ashes increase the produce of grain, clover, or grass; and on argillaceous soil, lime produces a decided improvement. All these substances act only on those fields which are defective in them, and if the other elements of the soils are present: the latter cause the former to come into action, and vice versa. The farmers who thought that by using lime, gypsum, bone earth, &c., they might dispense with animal manure, very soon observed that their fields deteriorated. They observed that after a third or fourth successive manuring with those simple substances the produce decreased; that, as is the common expression, the soil became tired of the manure, that at last the field scarcely produced the seed.

It is evident from this, what is the action of the mineral elements in the soil. If, in fact, in the first years, the produce of the soil had increased by the application of bone-ashes, or by a single element of the manure—if this increase was dependent on the amount in the soil of the other mineral elements, a certain quantity of those was annually taken up by the plants and removed in the harvest; and a time must at last arrive in which it is exhausted by the repeated removal; the soil must become barren, because, of all removed elements, only one or the other, and not all of them in a right proportion, have been restored.

The right proportion of the supply is, however, the only true scientific basis of agriculture.

If we subject the fluid and solid excrements of men and animals to an exact analysis, and compare the elements of them according to their weight, some constant relations between these elements impress themselves upon the mind, the knowledge of which is of some importance.

If the excrements of an animal are collected with some care, and left to themselves for some days, their nitrogen appears to have been converted, more or less perfectly, into ammonia. In the fluid excrements, in the urine, the salts of the food, which are soluble in water, are found in the form of alkaline carbonates, or of sulphates, phosphates, and other salts, with alkaline bases. In the solid excrements or
faces, silica, if it was contained in the food, earthy carbo-
nates, and phosphates, are the principal ingredients.

The quantity of alkaline carbonates bears a certain pro-
portion to the amylum, sugar, pectine, or the gum of the
food. The urine of an animal which has been fed with
potatoes or turnips, is rich in alkaline carbonates. The
potatoes, however, consist principally of amylum; the chief
ingredients of the turnips are sugar and pectine. The urine
of a horse which has been fed with hay and oats is relatively
poor in alkalies, if compared with the former.

It is further shown that the ammonia, or the nitrogen of
the excrements, bears a certain proportion to the phosphates;
the azote increases or decreases with the quantity of the
phosphates, in a manner that both can serve as a measure
for each other, although not quite as an accurate one. It is
not quite accurate, because the gum and the amylum also
contain a certain, though small quantity of phosphate of
lime, as has been proved in my laboratory.

The ammonia of the excrements is of course derived from
the nitrogenous substances in the food; the phosphates are
likewise constituents of the latter. In the composition of
the food, an equally constant proportion exists between both.
A given weight of gluten or casein, in peas or in grain,
always corresponds with a certain weight of phosphates. If
the grain or the vegetable is rich in those azotic products of
vegetable life, it is also rich in phosphates. If it is deficient
in them, the quality of the latter decreases in an equal
ratio.

As the amount of nitrogen in manure is a measure for its
amount in phosphates, and as manure contains, besides these,
also the other ingredients of the soil which are required by
the grain or by the other vegetables for their development,
and taken up by them from the soil, it is easily conceived
what was the cause of the error in regarding the azote of the
manure as the principal cause of its efficacy. The reason
was, that the ammonia of the manure is always accompanied
by the mineral elements which affect its nourishing quali-
ties, because they render its assimilation into the organism
of the plant, and its transition into a nitrogenous constituent,
possible. Without phosphates, and without the other mineral
elements of the food of plants, the ammonia exercises no
influence whatever upon vegetable life.

If it has been shown that the fertility of the soil depends
on certain mineral substances; if the restoration of the fer-
tility of exhausted fields by means of the excrements of man and animals depends upon their proportions of these matters; if the effect of the manures accelerating the vegetation depends upon their proportions of ammonia, it is clear that we can only dispense with the latter when we provide all efficacious elements exactly in those proportions and in that form most proper for assimilation by the vegetable organism in which they are found in the most fertile soil or in the most efficacious manure.

According to our present knowledge of the effect of the constituent parts of manure, I feel convinced that it is indifferent to the plants from which source they are derived. The dissolved apatite (phosphate of lime) from Spain, the potash derived from the felspar, the ammonia from the gas-works, must exercise the same effects on vegetable life as the bone earth, the potash, or the ammonia, which we provide in nature.

We live in a time when this conclusion is to be subjected to a comprehensive and accurate trial; and if the result corresponds with the expectations which we are entitled to make, if the animal excrements can be replaced by their efficacious elements, a new era of agriculture must begin.

I invite the enlightened farmers of England to unite with me for that purpose, and to lend me their aid. Whatever may be the result of these experiments, it is necessary for the future prosperity of agriculture that they be made. They will enrich us with a number of valuable facts; we shall ascertain where we have wasted efficacious matters in the common course of farming; we shall acquire an exact knowledge of those substances which are necessary, and of those which are dispensable.

For a number of years, myself and many young talented chemists have been occupied with the analysis of those mineral substances which are constituent elements of our plants of culture, and with the examination of the excrements of man and animals, as well as of a great number of soils acknowledged as fertile. These labours have been laid before the scientific world long since, but only a very confined application has been made of them in agriculture.

The farmer is, by his position, not in the condition to procure and to command the efficacious elements necessary for the restoration and increase of the fertility of his fields in a right proportion and suitable form. For this purpose, science and industry must combine their aid.
I have been fortunate to remove the difficulties which are opposed to the application of a mere mixture of the elements of manure. If we employ the different elements of manure exactly in those proportions in which they are necessary, according to experience, for a rich crop of wheat, peas, turnips, potatoes, and if, at the same time, we leave them in their common state, they do not produce that effect which we might have expected; the cause of this is, that the different elements of manure possess a very unequal solubility; the ammonia evaporates, the soluble elements are carried off by the rain, and the effect is more in proportion with the amount of those ingredients of the manure which are less soluble.

I have found means to give to every soluble ingredient of manure, by its combination with others, any degree of solubility, without altering its effect on vegetation. I give, for instance, the alkalies in such a state as not to be more soluble than gypsum, which, as is well known, acts through many years, as long as a particle of it remains on the acre.

The mixture of the manure has been adapted to the mean quantity of the rain in this country; the manure which is used in summer has a greater degree of solubility than that used in winter. Experience must lead to further results; and in future the farmer will be able to calculate the amount of produce of his fields, if temperature, want of rain, &c., do not oppose its coming fairly into action.

I must, however, observe that the artificial manures in no way alter the mechanical condition of the fields, and they do not render a heavy soil more accessible to air and moisture. For such fields the porous stable manure will always have its great value: it can be given together with the artificial manure.

All manure which is to be used during the winter contains a quantity of ammonia corresponding with the amount of nitrogen in the grain crops which are to be grown. Experiments in which I am at present engaged will show whether in future times the cost of this manure can be greatly lessened by excluding half or the whole amount of ammonia.

1 Equal parts of carbonate of potash and carbonate of lime (chalk), melted together, will dissolve in 460 parts of water. Increase of chalk lessens, while a larger proportion of the other ingredient increases, the solubility.

E. N. H.

2 Dr. Krocker, in his laboratory, has determined, in the course of the last term, the ammonia present in moist soils of great varied physical properties. The results are still unpublished; but he remarked to me one
ON THE COMPOSITION AND USE

I believe that this can be accomplished for many plants—as for clover and all very foliaceous vegetables, and for peas and beans; but my trials are not so far advanced as to prove the fact with certainty.

Giessen University, 1845.

Art. XXXIV.—ON THE COMPOSITION AND USE OF ARTIFICIAL MANURES.

A Lecture by Professor Johnston.

Professor Johnston said, that what he had to do, was to explain the nature of what were called artificial manures, and to recommend their use. In regard to the nature of these manures he might state to them that they might be arranged into two different classes—such as consisted of mineral matter only, and those which were composed of organic matter. He believed most of them were aware that the mineral matter contained in the soil, and the mineral matter contained in plants, was composed of the same substances. There were a considerable number of different things of a mineral nature, which went to the composition of plants. These were the mineral substances contained in the mineral manures. Some of the manures applied to the land con-

day, that if the ammonia per-centage of the soil then in hand be estimated as constant through a depth of 1 foot, the ammonia in an acre was about 8000 lb.

Even in sand destitute of soluble mineral salts, and nearly so of organic matter, he found a per-centage that was startling. Indeed, the sum of his results is, that the ammonia is in nearer relation to the moisture than to anything else.

I found ammonia in the glaciers that come down from heights of 14,000 feet above the level of the sea—from near the summit of Mont Blanc. Even at that height the ammonia is still in quantity that may be weighed. Every rain and snow storm brings this ingredient to the earth. Every soil that can retain its moisture will also retain the ammonia that descended with it. Hence one cause of superiority of a soil containing much decayed vegetable matter or much humus. It enables it to hold moisture, as well as furnish a source of carbonic acid. A rod dipped in muriatic acid, and held near the surface of a handful of moist soil, will cause white fumes to rise, occasioned by a combination of the ammonia with the muriatic acid. A gentle breath directed along the surface of the earth experimented with will render the fumes more apparent.     

E. N. H.
sisted wholly of this mineral matter. Amongst these, gypsum was much used, which was entirely a mineral manure, consisting of sulphuric acid and lime, common sulphate of soda, and other substances. But there were mixtures of those substances, and those mixtures were now used very extensively. There was also a class of artificial manures, which contained what he might call combustible or organic matter, which could be consumed or burned. The manure used in fertilizing ground very frequently contained a portion of this organic matter, which was of great value in the growth of plants, and which he would by-and-by explain. Amongst those manures, so extensively used of late were, ox-bones, which were composed of the following substances,—

<table>
<thead>
<tr>
<th>Substance</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cartilage</td>
<td>33.3</td>
</tr>
<tr>
<td>Phosphate of lime</td>
<td>57.4</td>
</tr>
<tr>
<td>Phosphate of magnesia</td>
<td>2.0</td>
</tr>
<tr>
<td>Carbonate of lime</td>
<td>3.9</td>
</tr>
<tr>
<td>Soda, with a little common salt</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Now 30 per cent. of this matter burned, while the rest was not consumable. Rape-dust was extensively used as manure, and contained a large proportion of organic matter, for when it was burned it left a residuum of 8 or 10 per cent. of mineral matter. Another substance—guano—which was the droppings of birds, when burned, left a large proportion of mineral matter, and was a very useful manure, if applied in proper time, in proper quantities, and under right conditions. These substances were more or less natural manures; but now they had received, in consequence of the researches made—long and laboriously made—into the composition of plants, and soils, and minerals, a knowledge of what a given soil required to grow a given crop. They were, therefore, enabled to make artificial mixtures of what the soil required to grow a given crop, and he considered this most important in the present transition state of their agriculture. The farmer being by this means, to a certain extent, enabled to turn the old elements, which were formerly the opponents of his prosperity, into the most beneficial instruments for his service. The principle was this:—If they took a given plant of any sort and burned it, there remained behind a certain quantity of mineral matter—sometimes more and sometimes less, according to the nature of the plant. The principle upon which the manufacture of the substances to
be added to the soil for the purpose of giving it fertility pro-
cceeded, was, to compose such a mixture as would give back
or add to the soil in sufficient quantity the constituents of
the crop which it was intended to raise, and it depended on
a knowledge of the number of those substances, and the
proportion in which they existed in different plants, that this
could be effected. These returns to the soil of mixed manure
should contain the several substances carried off by the
crop. The straw carried off a great deal more of the
mineral matter from the soil than the grain; but, at the
same time, the substances that grain carried off were the
same as were carried off by the straw. So much in regard
to the nature of artificial manures, and the principle upon
which they were manufactured, and upon which their virtue
depended. Now, the next point was their recommendation
to use them. Many excellent old farmers told them there
was nothing like farm-yard dung, and many young farmers,
and those who had learned most, would say the same thing.
Now, all present knew that if they had plenty of well-pre-
pared farm-yard dung, not exhausted of the liquid, which, in
too many cases, was allowed to run to waste, and as he had
seen yesterday on a large farm in the neighbourhood, they
need not be afraid of growing excellent crops from that
alone. But if they were to look to the best husbandry in
the island, and to ask how it was that those men were most
prosperous, every one acquainted with the matter would
give them the same answer as he would give. Those men
farmed the highest and added the most manure to their
land. They had not been satisfied with returning to their
land what they had taken out of it, but they had uniformly
got manures from a distance, for the purpose of supplying
that additional quantity above what they could produce
themselves, for bringing their land into its highest state of
activity. He laid it down as a general rule, that, in order
to have their land in the highest state of fertility, they must
add to it more manure than they could make upon their
farms. The agriculture of Great Britain, although the most
advanced in the world, was nevertheless capable of being
promoted to a degree which it was very difficult to form any
conception of. This was to be effected after adopting
thorough-draining, subsoil-ploughing, and other mechanical
means for improving the soil, by more skilful manuring than
had been hitherto practised, which was essential to good
farming. He recommended this high mode of farming, not
only because it would be beneficial to the country, but because it would also be productive of greater profit to themselves. He wished to impress upon them that the improvement in the management of their farms which he recommended, was not based upon the good of the country alone, although that was a subject in which they were all interested, but on the consideration that ultimately it would be more profitable to themselves. But although he had explained the principles upon which the use of these substances were recommended generally, there were certain particular cases where the use of them all would not be necessary. After referring to the improvements which were going on in the northern part of the island on several estates (in one instance at the expense of 10l. per acre), and on lands which had never been cultivated, he said, although they were exhibiting extraordinary perseverance, industry, and skill, in improving the soil, it was only by the use of those manures that they would be able to make it produce the largest crops at the least possible expense. After some observations as to the capability of every kind of land to produce, with proper management, a profitable crop, and to the propriety of manure being applied only where it was wanted, he referred to an experiment made by the Rev. Mr. Huxtable, of Dorsetshire, in raising a crop of turnips on a soil composed almost entirely of chalk. He made a mixture of the substances which went to the composition of turnips, but instead of sowing it broadcast, or placing it along the top of the whole drill, he got children to go along with bags of this substance, and to place a little of it at the distance of every 12 inches, on which three or four seeds were placed, and the result was, that he got a crop of 20 tons an acre of magnificent turnips. In this experiment a curious circumstance was to be observed, namely, that wherever the seeds were put in where there was no manure put, the turnips got to the size of an egg, but no more. With such skilful treatment as this he believed their most barren soils might be made to pay all the expense of cultivation, and leave a profit besides. He then concluded by inviting those present to state the results of their experience for the purpose of enabling others to follow their example.

Mr. Fraser, of Reelig, with reference to Professor Johnston's theory of placing the manure close to the seed plant, asked—"Would it not be better to disperse the manure, so that the roots might be induced to seek for their food?
ON THE RATIONALE OF CERTAIN MANURES

Turnips, for example, go a very far way for their food; and if they exhaust all the manure that is immediately around them, how will they get that which is necessary still to sustain and to complete their growth?"  

Professor Johnston.—Children must be nourished and attended to as children; at first they must be helped to their food, but in course of time, if properly cared for, they will help themselves, gather flesh, bone, and muscle, and become strong men. Just so with plants. At first they must be helped to food by placing it near them; as they get strong they will put forth their feelers and take food from a greater distance, and thus nourish and sustain themselves, growing to maturity. My theory implies, that while food is to be placed immediately within the reach of the suckling, there must also be sufficient in its locality generally to supply it with increased nourishment to give it strength; and this theory practical men have abundantly demonstrated as sound. 

_Agricultural Gazette, Sept. 19, 1846._

Art. XXXV.—ON THE RATIONALE OF CERTAIN MANURES EMPLOYED IN AGRICULTURE.

By Professor Daubeny, of Oxford.

To afford a rational explanation of the mode in which the substances applied by the farmer to his land cause it to yield more abundant crops, cannot be regarded by him as a superfluous undertaking; more especially when it is recollected that an entire exemption from theory implies a state of mind almost incompatible with the earnest prosecution of any line of pursuit, that the practical farmer is in his own way often the most inveterate of theorists, and that, even if a correct theory did not assist, an erroneous one would be sure to mislead us. The proper province, therefore, of the man of science, who attempts to apply his theoretical knowledge to the advancement of agriculture, seems to me to be that of endeavouring to extract from the statements of practical farmers the ground-work of some rational theory with respect to the uses of the various substances which long experience has led men to employ in the improvement of the soil; thus enabling us to apply them, not, as at present, at
lhaplazard, but with some degree of discrimination, and with reference to the particular circumstances of each case.

Lime.—Now, amongst the whole list of bodies enumerated under the general, but rather vague, terms of manures, or fertilizers, there is, perhaps, none of more extensive use, and few more important in their effects upon the land, than quicklime; and I may, therefore, select it as the subject for a few remarks, in order to illustrate the position with which I set out, by showing that, if we could enlighten the farmer as to the manner in which it affects the land, we might save him much disappointment by explaining when it is likely to be useless, and when, perhaps, even detrimental in its effects.

I am aware, indeed, that I have selected a topic which some may regard as almost exhausted, for all who have consulted the recent treatise of Professor Johnston on agricultural chemistry, will admit that he has communicated in it a very able and correct account of the uses of lime in agriculture; nor, with this work before me, should I, concurring as I do in the general tenor of his remarks, have brought this subject before you on the present occasion, were it not for the sake of drawing attention to one in particular, amongst the various uses attributable to this substance, which seems to receive light from the principles that I ventured to lay down in the conclusion of a memoir on the rotation of crops, lately published in "The Philosophical Transactions."

In this memoir I endeavoured to elucidate the distinction that exists between that portion of the ingredients of a soil which is in a state to become available for the immediate purposes of the plant, owing to its being readily soluble in the water that penetrates the ground, and that which is not at present brought into a condition of such easy solubility, and consequently at the present moment does not contribute in any degree to the development of the vegetables that grow in it. The former portion I have distinguished as its active, and the latter as its passive ingredients; and I proposed to estimate the relative amount of each, by treating the soil, first with a definite quantity of water impregnated with carbonic acid gas, and afterwards with diluted muriatic acid, and to determine the several quantities taken up by the first and by the second of these re-agents. The former I conceived would be likely to represent the amount which was actually applicable to the uses of the plant, since it is to be presumed that what could not be extracted by a large quan-
tity of water holding carbonic acid in solution would not be taken up by the rain-water which might penetrate the substance of the soil, whilst that which was dissolved afterwards by muriatic acid was likely, in the course of years, to be brought naturally into a similar condition.

These positions I illustrated by showing that a soil exhausted by growing a series of crops without manure was in point of fact more deficient in those of their ingredients, which were in an active or immediately available condition, than another which had been more recently manured, although the passive ingredients present in the latter might not be sensibly greater in amount.

If these principles be admitted, we shall be naturally led to inquire whether certain of the operations in agriculture, which long experience has sanctioned, may not derive their advantage in part from accelerating that process of disintegration in the soil which renders it more amenable to the influence of atmospheric agents.

Thus, amongst the mechanical operations which may contribute to bring about this result, I might instance ploughing, and other means of pulverizing the soil, and of bringing a larger amount of surface into immediate contact with water, carbonic acid, &c.

Perhaps the discordant reports which are given us as to the effects of subsoiling upon different descriptions of land might be reconciled by considering whether the latter was in a condition to allow of its dormant ingredients being rendered available within a short period.

But, without dwelling farther upon this and other operations belonging to the same class, I will proceed to consider the chemical means by which the same end is, as I conceive, likewise brought about, and amongst the rest may allude to the practice of liming, which is now of much general use throughout the country.

Its effect in rendering the organic matters more soluble, or rather, as I should prefer to represent it, in promoting their decomposition, so as to render them better adapted for supplying both carbon and nitrogen to growing plants, has been already sufficiently explained by Professor Johnston, and by others. Its action upon the inorganic matter, though not altogether unnoticed, has perhaps been rather less attended to.

Yet, when we recollect that quicklime mixed with pounded granite speedily liberates the contained alkali, as was first
established by Professor Fuchs, of Munich, and has since been introduced as a practice of Mr. Prideaux, of Plymouth, and when we recollect, moreover, that many of the clays and claystones which compose the bulk of several rock formations in secondary and tertiary districts are derived from granite rocks, we cannot doubt that the action of quicklime upon the latter will be of an analogous description, and that a liberation of the alkali present in the rock will be one of the consequences of its application.

Nor is this a mere matter of theory; for I have myself found that twice as much alkali could be extracted from the soil of a portion of the Botanic Garden at Oxford, which had been exhausted by growing a number of successive crops of poppies for fourteen years without any manure having been employed, after it had been left in contact with slaked lime for a fortnight, than was obtainable from it alone; the solvent employed for taking up the alkaline salt being in both instances water impregnated with carbonic acid, allowed to trickle slowly through the respective samples of soil.

According to this view of its mode of application we can more readily understand why it should be applicable to argillaceous soils rather than to calcareous ones—not merely because it supplies the lime which most plants require for their organization, for this might be effected by carbonate of lime as well as by the pure earth, and indeed would scarcely be required where, as is often the case, the clay contains in itself a small per centage of calcareous matter, but because clays usually contain alkali, whilst limestones do not.

We may also explain why the frequent liming of a soil tends to produce exhaustion; for if the effect of this substance be to convert its dormant ingredients into its active ones, or to render their principles, which, from their state of combination, were but sparingly soluble, more immediately available for the uses of the plant, it is plain that every fresh application of it will tend to diminish more and more the amount of these ingredients, not only by what is actually taken up by the plants, but likewise what is gradually carried away by the rains that percolate the soil.

By too liberal a supply of lime, therefore, we seem to be undoing the wise provision of nature, which aims at counteracting the great solubility of the alkalies, by retaining them in a state of combination with the other earths from which they are slowly liberated; thus anticipating the ingenious expedient of an illustrious chemist of the present
day, who, in order to prevent the alkaline ingredients of his manure from being carried off before the crop has had time to take them up, combines them with carbonate of lime, and thus produces a more sparingly soluble combination.

Let us, indeed, for a moment stop to consider what would have been the consequence had this natural provision for economizing the resources of the soil been omitted; one of the most formidable of which would have been that, before the present stage of the world's existence, all the alkalies existing in the superficial strata of the earth must have found their way into the ocean, when, even supposing their presence in such excess had not proved destructive to the marine plants which take them up—supposing even their abundance to have stimulated the marine vegetation, and thus to have afforded an exuberant growth of algae adapted for manuring the tracts of land that lie contiguously to the sea—still the inland portions of our continents must have remained absolutely barren, from the impossibility of transporting, to any great distances from the coast, the produce of the sea, which, in the case supposed, could alone have returned to the land those soluble ingredients which the rains of preceding ages had carried away. These consequences are prevented by the state of combination in which the alkalies naturally exist in the soil, as they are thus brought into solution so sparingly, that the whole, or nearly the whole of them present in the water which the soil retains, is taken up by plants; whilst the latter, as they decay, render these principles back again to the soil, in a more available condition, indeed, but still in one which opposes some impediments to their being carried off speedily by water.

Hence the vast accumulation of alkalies locked up within the forests of most thinly peopled countries; hence the unrivalled fertility of virgin soil, enriched by the annual tribute paid to it by these forests at the period of the fall of the leaf—hence, too, the miasmata so apt to occur in new countries thus circumstanced, whenever the soil is disturbed by the processes of agriculture, and the decay of the vegetable debris accelerated by the free introduction of air and moisture.

I may here just allude to another interesting provision, by which the slow but continuous disengagement of alkalies from certain rocks of igneous origin seems to be secured.

I allude to the fact, that, whilst igneous rocks which have cooled rapidly appear to be in the condition of glass—that
is, to have their constituents brought into that state of intimate union which render them almost unattackable by ordinary acids, and of course, therefore, scarcely decomposable by atmospheric agents—the greater portion at least of submarine lavas, or of volcanic products which have cooled slowly under pressure, consists of an intimate mixture of glassy felspar with some member of the zeolitic family, the characteristic of which is its easy solubility in acids.

Nor is this property confined to submarine products, for Dufresnoy has shown that the modern lavas of Vesuvius are distinguished from those of the Monte Somma by being soluble in acids in the proportion of 4 to 1.

Nature, therefore, appears to have provided means for the slow disengagement of alkali, not only in the case of plutonic rocks, but also in those of more modern volcanic origin, by causing the materials of which they consist not in general to assume a vitreous condition, but to separate in the act of cooling into a certain number of definite combinations, some of which, at least, acids are capable of attacking, and which, consequently, would be liable to yield to the continued influence of atmospheric agents.

Sulphuric Acid.—Another chemical agent which seems to operate in promoting vegetation, somewhat upon the same principle as lime has been represented to do, is sulphuric acid. An example of its operation is appended in the now familiar process of treating bones with this acid, as the earthy phosphates are by this means brought into a soluble form, and are therefore rendered more fit to be assimilated by plants.

This, at least, I apprehend to be the true theory of the advantage derived from its use when mixed with bones; for, although the phosphoric acid is introduced to the soil as a superphosphate, still it is not as such that it enters into the structure of the plant; and it therefore follows, that it must have combined with its usual quantity of lime before it was taken up by the roots.

A case, however, of a more precisely parallel description is afforded by the practice, adopted in some parts of the continent, of sprinkling the soil with sulphuric acid.

Here, in the first instance, a certain amount of gypsum is generated, which acts beneficially upon certain crops, by supplying them with a material needed for their inorganic constitution.

This end, however, might be attained at a cheaper rate
by applying gypsum already formed; but, then, it is to be considered that sulphuric acid in the very act of producing this salt disintegrates the soil, releases its component parts from the cohesive attraction which before acted as an antagonist force to chemical affinity, and also, above all, converts the minute quantity of phosphate of lime present in most soils into a superphosphate, thus rendering it more soluble.

If we put together all these several advantages, it may be conceived that a dressing of sulphuric acid will often succeed better than one of gypsum would do, the superior cost of the article being compensated by the benefit accruing from its power of converting the dormant principles of the soil into those which are active, or directly available for its purposes.

Gypsum.—In alluding to the subject of gypsum, I cannot refrain from pointing out that it affords a striking illustration of the great uncertainty which still prevails with respect to the theoretical principles by which the practice of agriculture is at present guided.

We have here four distinguished authorities in the science of agriculture, namely, Sir Humphry Davy, Baron Liebig, Monsieur Boussingault, and Professor Johnston, of Durham, expressing as many distinct views with respect to the operation of this agent as a manure—Sir Humphry regarding it as advantageous by reason of both its constituents, that is, acting as sulphate of lime; Baron Liebig directly by neither one, but indirectly as fixing the ammonia of the atmosphere; Boussingault attributing its usefulness to the lime it contains, and Professor Johnston chiefly to its sulphuric acid.

I allude to this discrepancy of opinion rather in order to press upon the minds of agriculturists the importance of instituting inquiries for the purpose of ascertaining more precisely the *modus operandi* of this and other measures, than for the sake of obtruding any views of my own on the question more immediately before us—views which have not been tested by any specific train of experiment, and which are therefore the less worthy of being brought into competition with those of such distinguished philosophers.

Nevertheless, I may remark, that, of the four theories just mentioned, the one proposed by Boussingault seems to me the most destitute of probability. It offers no explanation whatsoever of the peculiar adaptation of gypsum for plants of the leguminous order, nor for the preference which practical men assign to its use over that of lime, where the
latter is so much more accessible, and consequently, beyond all comparison, more economical. The opinion is based upon a series of experiments, which tend to show that clover treated with gypsum not only contained more sulphate of lime than it had without it, but also a larger proportion of lime in other states of combination—a very natural consequence, in my opinion, supposing the absorption of the quantity of gypsum which was congenial to its organization had invigorated the system of the plant, and thus had enabled it to draw more largely from the soil than it otherwise could have done.

The converse hypothesis experienced by Professor Johnston seems hardly consistent with the fact that gypsum is better adapted for leguminous plants than for cereals, inasmuch as the latter, according to Boussingault, yield quite as much sulphur on analysis as the former.

With regard to the remaining hypothesis, propounded by Sir Humphry Davy and by Baron Liebig, it is probable that both the causes assigned by these two philosophers may have a share in the virtues which belong to gypsum as a manure.

All authorities concur in asserting that those crops which contain the largest amount of sulphate of lime in their composition are most benefited by the application of the substance in question; and, indeed, even the experiments of Boussingault, which are alleged in opposition to this theory, evince that clover treated with gypsum contained in its ashes more of this ingredient than it had done under other circumstances.

But there is one mode of applying gypsum much practised on the Continent, and also in the United States of America, which seems to imply a distinct mode of operation from the other. This is the practice of scattering gypsum in fine powder over the leaves of the crop when just rising above the ground, which is stated to invigorate the stem and leaves, and even to extend its beneficial influence to the roots themselves.

This circumstance would seem to point to some function of the substance employed in absorbing ammonia, and thus bringing this highly important substance into immediate contact with the parts which are most ready to assimilate it.

M. Boussingault objects to this view of the subject on grounds that appear to me exceedingly inconclusive. He
begins by calculating that the quantity of clover covering an acre of land had gained by the application of gypsum as much azote as it would have required 134 lb. of carbonate of ammonia to produce.

Now, the average quantity of rain which falls in Alsace could in no case convey to the gypsum in a year anything approaching to that quantity of carbonate of ammonia, so that it is impossible that the application of gypsum to the land could have generated the whole of that quantity. But who does not see that the gypsum, according to Baron Liebig's hypothesis, would not only absorb ammonia from the rain water, but also condense that which was exhaled from the ground, in consequence of the decomposition of animal matters; and it is the more surprising that this should have been overlooked by Boussingault, as he states just afterwards that gypsum exerts no truly beneficial influence upon artificial meadows, excepting when the soil to which it is applied contains an adequate proportion of azotised organic manure.

The practice, therefore, of sprinkling the clover leaves with gypsum may have its use in arresting the ammonia exhaled from the ground, as well as that which descends with the rain from the heavens, and in bringing both the one and the other into immediate contact with the absorbing surfaces of the plant.

According to this view of the subject, the uses of gypsum in agriculture will be partly general and partly special—general, in fixing ammonia, which all plants more or less require; special, in supplying sulphate of lime to those species which contain it in their organization, and therefore most serviceable to those, like the leguminse, which contain the largest proportion of this ingredient. When the substance alluded to is sprinkled over the leaves of the young crop, as is the case in France, it would seem that the first of these objects is the one principally attained; where it is mixed with the soil, the second.

The former mode may prove serviceable, whatever may be the composition of the soil itself; but the latter method of administration appears to presuppose that the soil was deficient in it, and, consequently, ought to be preceded by an actual analysis of its ingredients.

Farmer's Magazine, Nov. 1846.
Art. XXXVI.—ON THE THEORY AND PRACTICAL USE OF LIME.

By Mr. J. Towers.

About the time that Liebig's first work appeared, I, with others, only endeavoured to show that, in order to decompose surplus or crude vegetable matter, and liberate its elements, lime must not only attract the moisture, or free water of the herbage, but must disturb the chemical affinities of the elements which compose its tissue, so as to liberate the hydrogen and oxygen, causing them to re-combine as water, and to deposit the carbon in the form of black charcoal; in a word, that it must produce chemical combustion—without ignition indeed, but nevertheless true in its results.

But while the theory, so far as it went, may be certain, we must premise that the lime so to act must be pure and unslaked, or in that very condition wherein we find it when it absorbs and combines with water, in the act of slaking; otherwise it can never burn and consume the vegetable matters, even if applied to the extent of from four to eight hundred bushels per acre. Independently, therefore, of its mere destructive power, pure lime, that is to say, lime free from carbonic acid, whether fresh from the kiln, or slaked by air or water (i.e., in the condition of hydrate), must and does exert a chemical action peculiarly specific, and of vast importance to the agriculturist; and this I shall endeavour to render experimentally evident, after quoting one leading passage from the paper of Dr. Daubeny. It reads thus—

"Its effect in rendering the organic matters more soluble, or rather, as I should prefer to represent it, in promoting their decomposition so as to render them better adapted for supplying both carbon and nitrogen to growing plants, has been already sufficiently explained by Professor Johnston and by others. Yet when we recollect that quick-lime, mixed with pounded granite, speedily liberates the contained alkali, and that many of the clays and claystones which compose the bulk of several rock formations in secondary and tertiary districts are derived from granitic rocks, we cannot doubt that the action of quick-lime upon the latter will be of analogous description."

These qualities of lime, that is to say, its solvent power,
and that of liberating potash from rocks and clays, are very important; but they have little or no reference to the one which appears to be still more extraordinary.

Some years since, the theory of humus was broached; and for a time the cultivators of the ground were taught to consider it the all-in-all, the pabulum of nutrition, "the chief nourisher in life's feast;" or, in other and more homely terms, "the cooked food of plants." Soon, however, the zeal of its partizans was checked, and then it appeared that humus was a slowly formed product of vegetable decay, and that, so far from being a wholesome food, its predominance became a medium of barrenness and destruction. Peat bogs, flow-mosses, and, indeed, all submerged masses of vegetable matter, abound with humus; and these, so long as they remain in their natural condition, are worthless, and unproductive of good cereal or garden crops. Lime, duly applied in tillage, is the grand chemical remedy; it exerts a specific action not at all connected with any solvent power, and this has been clearly and unequivocally explained by Mr. Rowlandson of Liverpool. He has entered into a minute chemical detail of facts, and has shown, by irresistible evidence, that his theory of the remedial action of quick-lime is correct. Mr. Ruffin, of the United States, had paved the way for new researches into the agency of calcareous manures, and his able articles were copied into the pages of the British Farmer's Magazine of 1835.

Since the appearance of Rowlandson's article, I entered into several interesting experiments, a detail of which will substantiate the view taken by that gentleman of the chemical action of lime.

There are two or three substances which fairly represent humus. The first is, the dark-coloured mass that remains after long-protracted fermentation of the dung mixen, and long after it has attained the state of what is termed "spit-dung;" The second, the dark brown remains of the bottom of a very old wood pile. The third, completely reduced leaf-mould, or that peculiar modification of moor-soil which is occasionally found in some heath commons. All these substances can be procured for experiment, and will furnish proof of the singular agency which lime must exert upon vegetable remains when reduced to the condition of humus.

If to a solution of caustic potash, soda, and particularly of ammonia, a portion of either of the afore-named matters be
added, much colouring matter will be extracted, conferring a deep brown tint to the solution. Water alone, when heated to the boiling point, will extract a little of this colour, but to a comparatively trifling extent. From these facts, and by observing that the alkali employed loses causticity and some of its acid taste, chemists have concluded that humus contains an acid principle, to which the modern term "humic acid" has been applied; and if we admit that a combining power between alkalies and other substances in an opposite state of electricity is sufficient to establish the presence of an acid, we will not dispute the correctness of the term.

But if, in lieu of any of these pure alkalies, lime be employed, whether in powder or as strong lime-water, colour will be destroyed, and the supernatant liquid will become very pale. Thus, for example:—Take an ounce of any of the three substances named; mix with it a quarter of its weight of powdered quick-lime, and pour on the mass a pint of boiling rain-water. After stirring to effectually blend the whole, let the mixture repose for a time. At first the floating liquor will be turbid, but it will finally become clear, and nearly void of colour.

This experiment may justly be considered inconclusive, for the effect of the lime might be deemed negative. However, having prepared any of, or all, the brown liquids, that is to say, the soluble humate of potassa, of soda, and of ammonia, take a known measure of any one of these, more or less, and add to it either a small quantity of lime in powder, or so much strong lime-water as shall be required to produce the effect, which will speedily become sufficiently evident. In either case a precipitate will be produced, and the liquid will be nearly deprived of colour.

Here we perceive a positive or direct action of the lime, for it becomes evident that its affinity for the humic extractive or acid is so strong as to take it from its alkaline base, whether that base has been potash, soda, or ammonia.

The same phenomena will occur if common heath soil, bog, or turbary peat-moss be the subject of experiment. Mr. Rowlandson announced these results in the Journal of Agriculture, and I can vouch, by the evidence of repeated experiments, that his conclusions are faithful, so far, at least, as they can be attested by solutions of any of the humous substances obtainable in farm or horticultural establishments. Further confirmation may be obtained by testing that dark-coloured liquid from farm dunghills, which, throughout the
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kingdom, is so laudably and economically squandered by our sons of the soil. If lime be added to it in any form, the same precipitate will occur, with considerable reduction of colour; and thus we are enabled to sum up the qualities of quick-lime in the space of a few lines.

1. If applied to green vegetables, quite hot from the kiln, it will destroy the tissue and carbonize the substance, itself being brought into the state of mild lime or chalk.

2. As powdered or air-slaked lime, it will directly kill slugs and molluscan vermin, acting by its peculiar attraction for water.

3. As an alkali, it will neutralize acids of every description, and hence is peculiarly useful if dusted over trees infested with lichens.

4. Its affinity for humic acid is predominant, as we have seen; and, therefore, it becomes a specific remedy, wherever there is a redundancy of inert decayed vegetable remains.

5. According to high chemical authority, it is capable to liberate potassa from clay and granitic rocks, and to set it at liberty from its combination with flint as an insoluble silicate of potassa.

6. It is a mistake to suppose that quick-lime renders vegetable and animal remains soluble. These substances are partially soluble, as we have seen in the three alkalies; but the precipitate formed by the addition of lime is not soluble, or, at any rate, it is so far fixed that it will remain long quiescent in the ground, from which it can only be taken up in very small quantities and by slow degrees, according to the capacity of the vegetable for such food.

Lime, then, acts as an antidote of redundant humous matter, attracting and fixing its acid as an innocuous humate; and thus, upon the above principles, I hope that I have established unequivocally the importance of lime as a prime agent and corrective.

Farmer's Magazine, Nov. 1846.
Art. XXXVII.—ON LIME: ITS APPLICATION TO NEWLY BROKEN UP LAND.

By the Editor of the "Agricultural Gazette."

1. Newly broken up land, though it be not manured with lime, contains sufficient store of nutriment for some years' crops.

2. It is better for newly broken up land to remain unlimed for two or three years, except under special circumstances; for it is already sufficiently fertile, and the expense for some years is unnecessary; and the application would probably cause an excessive fertility, if one may use that expression, such as would injure grain crops by an excessive growth of straw. Now the special circumstances to which we allude, occur in cases (1) where light land on a ferruginous subsoil has remained long under stagnant water; the soil is then found to contain compounds of iron injurious to vegetation, which are decomposed by an application of caustic lime, and the elements of which, under the influence of that application, are induced to re-arrange themselves in forms no longer injurious. And (2) in cases where, as an effect of stagnant water, peat has been formed, which, when drained, leaves a soil destitute of the mineral elements necessary to fertility; lime and clay are then necessary applications.

The farmer, independently of all theory on this subject, will be perfectly safe in remembering that where lime has not hitherto been applied, and where the land contains an excess of vegetable matter, or has long been injured by stagnant water, or is destitute naturally of calcareous matter, lime, whatever the mode in which it acts, is sure to have a fertilizing influence. Apply lime, therefore, a year or two after breaking up your grass lands, and then maintain the fertility thus produced by growing each year on half the land crops for consumption on the land, by selling only grain and butcher-meat off your farm, and by bringing on to it oil-cake and other food for cattle, sheep, and pigs: you will thus enrich your manure, and increase its quantity.

Agricultural Gazette.
The specific effect of bone as food for the turnip-crop has long been known—long; indeed, before science was in a position to explain the cause of its peculiar effects, or to assign correctly to what portion of its constituents the benefits are chiefly due.

It was found, greatly to the surprise of many, that burnt bones, in which of course the organic parts had been destroyed, were equal, if not superior, in their effect to bones not so treated; and that when boiled, in which state the fat had been expelled, they were more productive than bones in a fresh state. It was thence supposed by those who jumped to conclusions too hastily, that the substances thus expelled were useless, at any rate for the turnip-crop, and they were apparently supported by the theory of a very eminent chemist, who, if we mistake not, laid it down as his opinion that the value of manures depended principally, if not entirely, on their inorganic ingredients—a doctrine altogether at variance with the previous generally received notions, that ammonia was the true fertilizing element, and that its amount afforded the measure of the value of manure. In medio tutissimus ibis—the truth, we take it, will be found to lie between the two extremes. We may justly regard the inorganic constituents as being the most important and essential portion of manure, affording to the plant what the skeleton does to the animal, the basis of support; and, as plants can obtain no other supply but through the soil, we may justly regard them as the most essential constituents.

The other elements are, to a great extent, supplied through
the atmosphere; and even nitrogen and its combinations may be thus furnished. The avenues through which this atmospheric supply is furnished, are the leaves of the plant; and their size afford a correct criterion, ceteris paribus, of the amount of nutriment derived from the aerial source. Thus beans and other pulse obtain more food from the atmosphere than cereal plants; roots, more than the former; and wheat, from the small size of the leaves, less than any. Thus only can we account for the striking fact, that if we give a good supply of inorganic elements only to the turnip-crop, we shall very probably have a plentiful crop; whilst, if these be absent, however rich the manure may otherwise be, the crop will be a failure. Not that we must therefore draw the conclusion, that the organic manures are of little or no importance to root-crops: they are of value, and particularly to the grain-crops which succeed.

The organic matter which composes about one-third the substance of bones is, however, so intimately combined with the earthy portion, and their disunion is accomplished with such difficulty, that the good effects of either are to a certain extent neutralized, at least so far as the first crop is considered; and we are consequently obliged to supply five or six times as much as the crop actually requires, and to render them available by means of pulverization. It is on this principle that the assistance of sulphuric acid is sought for and obtained: it serves, by its chemical affinities, to separate the component parts of the bones, and render them more soluble and available as food for plants. In the excellent and accurate experiments of Mr. Hannam, related in a former number of the Journal, it was clearly proved that fresh bones, when ground, were superior to boiled ones, from which the fat was extracted; and the latter were superior to burnt bones, from which the gelatine was also removed. This result was, however, far more striking when the bones were dissolved in sulphuric acid, a difference of nearly 2 tons of turnips being observed, whilst, with the bones merely ground, a difference of 17 cwt. only was exhibited. From the same experiment, we likewise learn that the beneficial effects derived from the earthy part of bones are 4½ times greater than that derived from the organic parts. I refer to the Journal for the particulars of these experiments, and to the previous number for other statements, from which, if we had no other evidence, we should be justified in drawing the conclusion, that 20s. laid out in bones and acid will go
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much further than 40s. expended in bones alone, so far as the turnip-crop is concerned.

These experiments, however, appear to have been made with the addition of a very considerable quantity of water, so as to apply the manure to the land in a liquid state, which, without denying its superiority, is yet attended with such difficulty, trouble, and inconvenience, that it is vain to expect that farmers generally would incur it. The expense of a proper cart for the application of this manure in a liquid state is very considerable, and sufficient to prevent its general adoption. And, although it was in this form that the public were first made acquainted with its valuable properties, yet its general adoption must be attributed to the additional discovery, that it can readily be applied in the state of compost, by means of the common drill. Having directed my attention to the preparation and employment of this valuable manure in the form of compost, I am in a position to state, that by its means one-half the usual expense in the purchase of bones may be saved.

We cannot, however, do better than take as our text, or rather the heads of our subject, the points to which the attention of competitors are drawn by the Council of the Royal Agricultural Society of England, which are—

2. Proportion of acid in a given weight of bones.
3. Proportion of water, if any, mixed with the acid.
4. Mode of mixing the bones with the acid, and of preparing the compost.
5. Effect of various quantities applied in combination or comparison with common bones and other known manures.

1. First, then, the state of the bones—with regard to which I have merely to observe, that they should be as fine as possible, but the ordinary state of bone-dust will answer the purpose very well. The dust is decidedly preferable to half-inch bones, for, whilst the increased weight of the former will compensate for its greater price, the points of contact being greatly increased by subdivision, the bones are more rapidly and more perfectly acted on by the acid, and require, in fact, a less quantity both of that and of water.

We next come to the second and more important point.

2. The proportion of sulphuric or muriatic acid to a given weight of bones.
Sulphuric acid is preferable to muriatic acid, for several reasons—it is stronger, cheaper, has greater specific gravity, and contains much less water. On mixing it with water, a much higher temperature is attained, which conduces to the dissolving process, particularly of the organic portion of the bones. In addition to these reasons, we find that in the trials which have been made, muriatic acid has been found somewhat inferior. I have, however, been rather surprised that there should not have been a more decided difference than proved to be the case in Mr. Hamam's experiments: and we can only account for this by bearing in mind that the lowest proportion of muriatic acid employed was one-half, which was perhaps sufficient to affect all the phosphate of lime contained in the bones; whereas, if one-half had been employed, as was tried with the sulphuric acid, the result might not have been so favourable for the muriatic acid. Besides this, probably the muriate of lime formed by the muriatic acid is more fertilizing and soluble than phosphate of lime formed by the sulphuric acid; and, from its great attraction for moisture, particularly advantageous in such a dry season as that of 1844. It is, therefore, by no means improbable that an equal quantity of bones, prepared separately with the two acids, and afterwards mixed together, might be more productive than bones prepared with either acid alone.

The proportion of sulphuric acid most desirable to employ is a very important point, inasmuch as it has been shown that sulphuric acid alone, or mixed with water, possesses very little fertilizing powers. This, probably, is owing to the circumstance of the soil generally containing a sufficiency of this element, and to the fact that phosphoric acid is so extremely essential, particularly in the early stages of the growth of the plant, that it will not prosper without it, whatever we may otherwise employ as manure. A neighbouring agriculturist, during the last year, tried to raise a crop of turnips with a good dressing of salt and soot, which contain no phosphoric acid, though plenty of ammonia and other fertilizing ingredients, but the result was a total failure. In a garden experiment, I may here observe, I found sulphuric acid and water succeed as well as bones in raising turnips, but the soil no doubt contained phosphoric acid, as well as alkalies, on which the acid could act favourably.

Before we authoritatively pronounce on the quantity of
acid necessary to be mixed with the bones, it will be better to inquire into the nature and properties of the substances we propose mixing together.

Sulphuric acid, or oil of vitriol, as it is more frequently termed, consists of the union of two parts by weight of sulphur with three of oxygen gas; and its strength depends on its purity and freedom from water, for which it has a remarkable affinity, so much so that, if exposed to the air, it will quickly absorb water from the atmosphere. Its relative weakness, therefore, is owing to the quantity of water mixed with it. In speaking of sulphuric acid, I must be understood to mean in its concentrated state, possessing a specific gravity of from 18.45 to 18.50. And it should be borne in mind, in purchasing the acid, that 50 lb. of the above is at least equal to 60 lb. of the specific gravity of 17.14, and therefore, if the weaker acid be used, its quantity must be increased in proportion to the diminution of its strength.

On applying the vitriolized bone to the tongue, we find that it tastes both sour and sweet. The sourness arises, probably, from the phosphoric acid, and the sweetness from the gelatine sugar, which is formed by the action of the acid on the gelatine, converting a substance very difficult of decomposition into one readily soluble, and which can be easily absorbed by plants. When concentrated acid is mixed with a quarter of its weight of water, the temperature of the mixture is raised to 300°, and boils away at a great rate. The action of this heat on the animal part of the bones renders it of a dark colour; but if a small quantity of acid only be employed, the mixture is white, from the carbonate of lime which then predominates. From an average taken from several analyses of bones of man and various animals, the following appears to be tolerably near the mean:

| Organic matter, consisting of gelatine, cartilage, and fat | 34 |
| Phosphates of lime and magnesia | 59 |
| Carbonate of lime | 7 |
| **Total** | **100** |

Or, in rough numbers, the organic matter may be regarded as forming one-third, and the earthy portions two-thirds. Of course, if the bones are very fresh, the former will be in larger proportion than one-third; thus Mr. Hannam gives
it as forty-five per cent. The above, however, may be considered as a fair average in the state usually employed by farmers.

Four bushels of bones, which may be considered to be a fair allowance for an acre, will weigh, in a fine state of bone-dust, about 180 lb. This quantity contains $12\frac{1}{2}$ lb. of carbonate of lime, consisting of carbonic acid, $5\frac{1}{2}$ parts, and lime, 7 parts, which will require 10 lb. of sulphuric acid to convert it into sulphate of lime or gypsum. This is the first result of the mixture, and is the cause of the very unpleasant fumes which are given off, and which consist, in fact, principally of carbonic acid disengaged from the carbonate of lime, in consequence of the superior affinity which lime has for sulphuric acid. This result takes place before the acid acts on the phosphates of the bones, and thus it is that when a small quantity of acid has been sprinkled over bone-dust, the good effect has been but moderate, the carbonate of lime alone has been acted on, and the phosphate of lime has remained undecomposed.

The quantity of phosphate of lime existing in the 4 bushels of bones, is about 106 lb., containing 47 lb. of lime, and 59 lb. of phosphoric acid. If we consider superphosphate of lime to contain a double portion of acid—a fact, however, not quite decided—then 33 lb. of sulphuric acid will be required, which, by uniting with half the lime, or $23\frac{1}{2}$ lb., forms gypsum, and leaves the other moiety of lime united with a double portion of phosphoric acid in a state of superphosphate. Thus, 43 lb. of acid will be required to effect these changes, leaving any additional quantity for other purposes.  

Phosphate of lime is a substance very difficult of solution, and thus, in a very dry season, the effects of bones are often very slight and imperfect. Superphosphate of lime, on the other hand, is extremely soluble, so much so that the vitriolized bones can be entirely dissolved or suspended in water, and thus applied. This at once explains the cause of the valuable properties of the preparation. The bones in

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1 I find that the average weight of bone-dust, as it comes from the mill, is 168 lb. per 4 bushels, although I have found it reach the weight stated in the text.—Author.

2 I do not mean to say that these are the precise changes which take place, but only an approximation to them. Probably, some portion of phosphoric acid may be left in a free state in the prepared mixture.
their natural state are extremely indigestible, the acid cooks them—converts them into a species of soup, which can readily be eaten and digested by the young turnips. The adamantine fetters with which the various elements composing bones are bound so compactly together are, by means of this new agent, burst asunder—the compact is broken, and each constituent element is left to pursue its own course, and to exercise its own natural affinities. The chemical changes which take place between the sulphuric acid and the organic portion of the bones are no doubt very complicated. Sugar is one result, and probably sulphate of ammonia is another; but I cannot venture to state what quantity of sulphuric acid may be necessary to effect these changes. If we presume that one-third is the proportion of sulphuric acid employed, then there will remain 17 lb. to act on the organic portion of the 4 bushels of bones, the remainder having been required by the earthly portion.

We find that manufacturing chemists, in the preparation of phosphorus from bones (now largely required for lucifer matches), first destroy the organic part of the bones by means of fire, and then mix the remainder with half its weight of sulphuric acid. Thus, if we suppose 180 lb. to be the quantity employed, by burning it will be reduced to 120 lb., requiring 60 lb. of acid to form superphosphate, which would be one-third the weight of the bones previous to burning. I suppose, however, that in this case an excess of acid is required to render the process complete, as one-half would otherwise appear to be more than the quantity demanded.

From these and other reasons, we may justly consider that the proportion of acid to the bones should never be less than one-third, nor more than one-half. The former, I think, is the most economical, but probably the precise quantity most desirable will be 42 per cent. of acid. I may, however, observe, that in an experiment during the last season, in which one portion of the land was manured with bones and acid in different proportions, that which had more bones and less acid proved to be somewhat better crop than where fewer bones and more acid were used; the expense being the same in both instances.

3. The proportion of water to be mixed with the acid will next receive our attention.

When one part by weight of water is mixed with four of acid, the temperature is raised to 300° Fahrenheit. It is,
therefore, very desirable that sufficient water should be used to produce this great heat, which facilitates the dissolving process; and the quantity above stated, or, if more convenient, the same measure of water as of acid, which will be rather more than half the weight, will be a very good proportion. More should not be used, as no useful purpose will be accomplished. In an experiment tried last year with different proportions of water, I could not detect any difference in the result. The water should be applied first by means of a watering-pot, so that it may be intimately combined with every portion of the bones. This is an important point, and greatly facilitates the dissolving process, which without it is very likely to be imperfectly accomplished.

Another reason for applying the water first is, that the bones becoming partially saturated, the acid, from its great affinity for it, rushes as it were into the pores of the bones in search of the water, and thus the bones become more rapidly and perfectly mixed with, and acted on by the acid. When no water is employed, and the bones are not entirely in the state of fine dust, as they never are, unless purposely sifted, the surfaces of the small pieces of bone become acted on by the acid, and a coat forms around them which seals up the interstices of the bones, and prevents the acid from penetrating. I have no doubt this is often the case likewise from careless or imperfect mixture, and the good effects of the manure are thus materially diminished.

4. Mode of mixing the bones with the acid, and of preparing the compost.

It has been recommended that a large heap of ashes or mould should be made with a hole or depression on the top, in which the bones are to be placed, the acid poured over them, and after some time the whole shovelled up and mixed together. Now, if we examine into the effects of this mode of procedure, we shall readily perceive the objection to which it is subject. The ashes, no doubt, contain a considerable portion of carbonate of lime besides other salts, for which sulphuric acid has a very strong affinity. Thus the bones are robbed of a large proportion of the acid, of which they ought to have exclusive possession. And even if common mould is used, or any other substance which has no particular chemical affinity for the acid, still this mould will mechanically absorb much of the acid, and thus deprive the bones of
it. I hold it, therefore, as a point of much importance, that the whole of the acid should be directly applied to the bones, and that no other substance should be allowed to intercept or abstract their mutual affinities.

A very convenient and cheap vessel for manufacturing the mixture is a sugar hogshead, having its holes stopped with plaster of Paris. It is very desirable to avoid if possible any measuring or weighing of the acid, as it is so very dangerous a substance to handle. Many serious accidents occurred to my knowledge during the last year, and it is very difficult to impress farm-servants with a sufficient degree of caution, or even to convince them that a liquid which appears so colourless will burn their skin and clothes. In emptying a carboy of acid, even into a tub, it is difficult to prevent a little slopping about and damaging the clothes of the attendants, as well as the basket, &c., which contains the carboy. To prevent these unpleasant consequences, I have adopted the following plan:—The carboy is placed on a stage or cask the same height as the sugar hogshead, into which is put the precise quantity of bone-dust we intend mixing with the carboy of acid. The water is now added with a watering-pot having a rose at the end, so as to disperse it thoroughly, and the carboy of acid is then emptied by means of a syphon. This syphon is formed of a piece of block-tin pipe, which can be bent into any form, about three-quarters of an inch in calibre, and four feet in length. A brass cock is soldered to the long end of the syphon, on which the rose of a watering-pot may be placed. The syphon is now filled with water, and its long end closed with the cock, and the small end with the hand or finger. The latter is then quickly inserted into the mouth of the carboy, the cock turned on, and the acid will continue to flow till the vessel is nearly empty, without any assistance, so that the attendant has no occasion to expose himself to the injuries and offensive fumes which almost immediately begin to escape. He may, however, approach the windward side of the tub, and give the mixture a little stirring; which should be continued for some little time afterwards, so that the mixture may be complete. A convenient utensil for this purpose is a fork

¹ I have not found that any considerable quantity of the acid passes through the bones into the heap of ashes or earth; and though Mr. Spooner's is the better plan, where his apparatus can be easily procured, I still think that the expedient I mentioned may be found sometimes convenient.—Ph. Pusey.
with two grains, long in the grain, bent at some distance from the grains nearly at right angles, and fixed in a wooden handle. On the same day a fresh lot of bones may be added, and the process repeated until the hogshead is nearly full. In two days afterwards the mixture may be shovelled into a heap, and either remain till wanted, or mixed at once with a certain portion of ashes. It should be shovelled over several times, and ashes added at each time of turning, which will thus render the mixture fine and dry enough to pass through an ordinary drill.

It must be evident that much of the value and economy of the manure depends on it being perfectly mixed, so that every particle of bone should be exposed to the action of the acid. In many cases I have no doubt this has not been sufficiently attended to, and the result has been either that more acid has been used than is really required, or that much of the advantageous effect has been lost.

By the method which I have here recommended, and which I have adopted after many trials, the mixture can be readily and accurately manufactured, and with perfect safety to the attendants.¹

5. Effect of various quantities applied in combination or comparison with common bones and other known manures.

My own experience of the advantages of sulphated bones commenced in the very dry summer of 1844. Wishing to try their effects, and thinking that it was highly desirable to apply them as a compost by means of a drill (though I had not heard of any instances in which they had been so used), I resolved to make the attempt. I intended to apply the bones at the rate of 3½ bushels per acre, and half their weight of acid; but from not making sufficient allowance for the dampness of the manure, it extended over a large portion of land, so that little more than 2 bushels per acre were used with about 16 bushels of ashes. On the same day (in the early part of July) other portions of the field were drilled with bone-dust at the rate of 16 bushels per acre, and some parts with South American guano. The bones and acid (Swedes) were the first to appear, and their tops grew most luxuriantly. The turnips suffered from not being hoed till

¹ In manufacturing a considerable quantity of the mixture to meet a large demand for the present season (1845), I have found much advantage from constructing various utensils of different shapes, so as to perfect the mixture without inconvenience to the attendants, as well as from other improvements in the manipulative process.—Author.
they were too forward, but the crop throughout the field (considering the late period of their being drilled, and other unfavourable circumstances) was a very fair one, about 14 tons to the acre. The bones and acid portion was fully equal to the rest, and indeed somewhat better than where 16 bushels of bones had been applied to the acre.

Every alternate ridge was carted off, and the remaining half fed off by old ewes with no other food, with the exception of a little inferior hay. The field was then sown with dredge (a mixture of beans, barley, and peas), and the crop was a very excellent one; that where the vitriolized bones had been used was at the least fully equal to any portion of the field, and indeed somewhat superior to that dressed with bones alone. Thus it will be seen that the manure answers perfectly well so far as the second crop is concerned; and there is now the prospect of a good clover crop.

The result of the preceding year having fully satisfied me as to the value and economy of vitriolized bones, I did not think it necessary to test their merits against other manures during the last season, particularly as other equally successful experiments had been tried and published.

But wishing to ascertain the most economical proportion of acid to be employed, I prepared two lots for a field of 6 acres. In one the bone-dust was at the rate of 4 bushels to the acre, and the acid one-third; and in the other the acid was half the weight of the bones; but the latter was diminished so as to reduce the cost of both lots to the same sum. The mixture in each instance extended over half an acre more than was intended, and was mixed with equal portions of ashes, viz., about 20 bushels to the acre.

The Swedes came up well, and though attacked by the fly soon got out of its way, and proved a very good crop. The average of the field, however, was very much reduced by the great quantity of hedgerow timber by which it was surrounded, and which spread its blighting influence a considerable distance. However much these trees might add to the beauty of the landscape, they certainly destroyed most effectually the beauty and uniformity of the turnip-crop, and reduced the average of the field several tons per acre. A good portion of the field appeared to average about 22 tons per acre, and the half where the larger quantity of bone-dust with one-third its weight of acid was used, proved superior to the other, though whether to be attributed to the difference in the manure, or to the fact of that
part of the field being somewhat drier, it is difficult to say.

The field was a clay loam on the London clay, and was partially drained.

I also supplied various agriculturists in my neighbourhood with vitriolized bones, prepared in the proportion of 4 bushels (180 lb.) of bone-dust, and 60 lb. of concentrated sulphuric acid, which I recommended to be applied to an acre when no other manure was employed. The result in nearly every instance has been decidedly favourable.

Mr. W. Gater, of Westend, employed it at the rate of 2 bushels of bones to the acre, in addition to a fair dressing of farm-yard dung. On a portion of the field the dung was used alone. The former was fit for the hoe several days before the latter, and on weighing portions of each in January last, there was a superiority of 5 tons to the acre in favour of that portion which had received the addition of sulphated bones.

Mr. J. W. Clark, of Timsbury, used the manure which I supplied him with in the same proportions also in addition to farm-yard dung; and the Swedes proved the best on his farm. The amount of vitriolized bones used per acre varied in different parts of the field, and the goodness of the crop precisely corresponded to the quantity applied.

Mr. J. Blundell, of Bursledon, also used it at the rate of 4 bushels of bones to the acre with 6 bushels, of ashes in competition with night-soil and ashes. On visiting his farm a few weeks afterwards, I noticed, at several fields' distance, the superiority of one portion of the field, which I found was that on which the vitriolized bones had been used. The dampness of the season, however, proved so favourable to the development of the other manure, that, on weighing them in December, the latter was found about half a ton per acre heavier; the expense, however, was nearly double. The weight of the crop was between 17 and 18 tons per acre. I have no doubt that if Mr. Blundell had applied 20 bushels of ashes to the acre, instead of 6, with the sulphated bones, the result would have been much more favourable. When we bear in mind the large amount of potash contained in the crop, it must be very evident that it is of importance to supply a good quantity of ashes which contain a fair proportion of potash; I would therefore recommend that 20 bushels of ashes per acre, at least, should always be employed.
Mr. Pocock, of Hickley, used the manure at the rate of 4 bushels per acre, and one-third acid, and was well pleased with the result, though he did not ascertain its amount.

Mr. Withers, of Luzborough, was another farmer to whom I furnished a quantity, prepared as before mentioned, and he reports very favourably of the result.

Mr. Fielder, of Sparsholt, was induced by my representation of its favourable effects to try the manure, and he found that on his light land on the chalk it answered admirably. Two bushels of vitriolized bones with ashes successfully rivalled a small portion of ground drilled at the rate of 60 bushels of bones to the acre for the purpose of experiment.

Although the vitriolized bone has proved very successful with white turnips, I believe that its peculiar excellences are most fully proved by Swedes. I wished to ascertain this by experiment; and accordingly, on the same day and on similar land, a clay loam, 3 acres were drilled with Laing Swedes, and 3 acres with Matson's white globes after tares. The Swedes proved decidedly superior both in the early and later stages, and though the roots, as might have been anticipated, were but of moderate size, in consequence of the very late time of drilling (early in August), yet on comparing a few rods without manure the difference was very striking: A small portion of the globes, drilled with ashes alone, also exhibited a similar inferiority.

It should be observed, however, that in this experiment the land was probably more suited for Swedes than white turnips; but, on the other hand, the lateness of the season was more unfavourable to the Swedes, besides which the crop previous to the globes had been manured with stable-dung, whilst the other field had received no dressing since 1843.

Supposing that these results are to be attributed to the greater suitability of the manure for Swede, and not owing to other causes, the result is certainly in keeping with the comparative analysis of the ashes of Swedes and white turnips, which tells us that the former contains 408 lb. of phosphoric acid, and the latter only 73 lb. in 100,000 lb. each.

It must be evident from this circumstance that white turnips do not require so large a quantity of bones, whether vitriolized or not, and it also corresponds with the well known facts that Swedes require a larger quantity of dung to supply the necessary phosphoric acid, and also that white
turnips on favourable land can be raised with ashes alone far more easily than Swedes.

I would therefore recommend in all cases with white turnips, that a less quantity of vitriolized bone be employed, and that guano, or some other manure possessing its properties, should be used in combination with it.

In May last, a portion of land consisting of 1½ acre was drilled with Matson's green top globes, and manured with 1 bushel of sulphated bones, 1 cwt. of African guano, and about 25 bushels of turf-ashes per acre. The crop was a very good one, exceeding 20 tons to the acre.

In several instances within my own knowledge where guano has been used with ashes, the crop has been destroyed by the pungency of the manure, probably owing to the ammonia which it contains. There is no danger of this taking place with vitriolized bones, and I have found, though seeds will not vegetate if entirely surrounded with them, they readily will if the manure is mixed with twice its weight of mould.

The last season has not been a favourable one for displaying the peculiar advantages of vitriolized bones, or rather, it has been from its wetness so favourable for common bones and every other description of manure, that an indifferent field of turnips has been the exception and not the rule. It is in a dry season when the fly is particularly rife and active, when crop after crop is destroyed by this entomological pest, that the advantages of ensuring a vigorous growth to young plants is properly appreciated. Amongst all the specifics or antidotes for the fly, there is none, I believe, equal to the employment of vitriolized bones. Hitherto, I have not met with or heard of a single instance in which it has failed to force the plants out of the way of the fly. It is in a dry season, too, that the advantages of early and vigorous growth are shown, when the plant may languish for weeks for want of rain with ordinary manures, and thus lose time that never afterwards can be compensated for.

In a garden experiment, tried on a small scale to show the effect of different preparations in forcing the young plant out of ground, I found the following results:—

1. Vitriolized bone applied in solution above the seed caused the plant to appear on the fourth day.
2. The same applied below the seed brought up the plant on the fifth day.
3. Vitriolized bones as compost brought up the plant on
the sixth day, both when applied above and below the seed.

4. Sulphuric acid and water below the seed caused the turnip to make its appearance on the sixth day.

5. Bone-dust below the seed brought up the plant on the seventh day, the same time as it appeared where no manure was employed.

In the above instances, with the exception of the fourth, the expense of the manure was the same in each case.

**General Conclusions.**

From the facts and reasons which we have detailed and urged in our preceding essay, as well as from information supplied by previous experimenters, we may deduce the following conclusions:

1. That superphosphate of lime is the essential manure for turnips, and particularly for Swedes. That with it alone a good crop can be raised; but without it the turnip will not thrive, however rich the manure may otherwise be.

2. In preparing the mixture, the bones should be in as fine a state as possible.

3. That sulphuric acid, from its greater strength and cheapness, is preferable to muriatic acid.

4. That water, in the proportion of one-half the weight of the acid, should be first sprinkled over the bones.

5. The proportion of sulphuric acid most economical to employ should not be less than one-third, nor more than one-half the weight of the bones, and that probably the medium between these two quantities is most advantageous.

6. That the mixture can be applied either diluted with a considerable quantity of water by the aid of a water-cart, or with ashes by means of an ordinary drill. That though the former may be more speedy in its effects, the latter can be more conveniently applied, and has the advantage of admitting the addition of a large quantity of ashes.

7. That vitriolized bones may be used either alone or with other manures, and that when the latter are at hand, it is more advantageous to use the former in combination with them. For instance, if there are 30 acres to be prepared, and only sufficient dung to dress 15 acres, it is better to give a half-dressing of dung over the whole of the turnip break, and make up the deficiency by means of sulphated bones. Thus the plant will be forced in its early and supported in
its later growth. For the same reason vitriolized bones may
be advantageously combined with guano.

8. That vitriolized bones are equally advantageous to the
second year’s crop, when the turnips are either wholly or
partially fed off with sheep.

9. That while the economy of this manure is thus proved
by practice, it can be as readily explained by theory, e. g.,
—The tops of Swedes are known to possess double the phos-
phoric acid contained in the bulbs. Thus the superphos-
phate of lime in the manure causes the rapid development of
the leaves—one of its peculiar properties. The leaves being
thus early and largely developed, are enabled to extract a
considerable portion of nourishment from the atmosphere,
much more, indeed, than where the leaves are small and
backward. The difference between the amount of food
derived from the atmosphere by a forward and flourishing
crop, and that obtained by a backward and dwarfish crop, is
so much absolute gain to the farmer, or rather to the land.
It costs nothing on the one hand, but yields considerably to
the land if the crop is fed off on the other. A manure that
would thus force on the turnip in the early stages of its
growth, was long felt to be a desideratum by agriculturists.
This want has now been supplied; and even if this were the
only recommendation sulphated bones possessed, its discovery
and introduction would still be a boon.

Lastly. The value of vitriolized bone may now be con-
sidered to be fully and fairly established. Its claims rest
not on the assertions of a few experimenters. It has been
tried during the last season by hundreds with success, and in
the next it will be tried by thousands. It affords, in fact, a
triumphant answer to the question—What has science
done for agriculture?

Southampton, 27th Feb. 1846.

** The preparation of bones for turnips, as described by Mr. Pusey
(being heated with ashes), and other substances, has been long practised
with success; and this preparation causes a softening of the substance so
much that the smaller parts become immediately proper for the food of
plants.—J. Kimberley.

Art. XXXIX.—ON MANURES WHOSE CHIEF FERTILIZING SUBSTANCE IS PHOSPHATE OF LIME.

By the Editor of the "Farmer's Almanac."

Some years have now elapsed since the writer of this, in an essay on the use of crushed bones, ventured to refer to the probable value as a fertilizer of the native phosphorite of lime. In 1844, Dr. Danbeny made some experiments with regard to its power as a manure for turnips, and obtained the following weights of turnip roots per acre:—¹

<table>
<thead>
<tr>
<th>Manures</th>
<th>Weight</th>
<th>Produce.</th>
</tr>
</thead>
<tbody>
<tr>
<td>From the soil, simple, in lb.</td>
<td>14-298</td>
<td></td>
</tr>
<tr>
<td>Bone shavings, 10 cwt.</td>
<td>19-239</td>
<td></td>
</tr>
<tr>
<td>Chemical Manure Co.'s guano, 260 lb.</td>
<td>26-058</td>
<td></td>
</tr>
<tr>
<td>Spanish phosphorite, 12 cwt.</td>
<td>28-639</td>
<td></td>
</tr>
<tr>
<td>Sulphuric acid with ditto, 12 cwt.</td>
<td>30-869</td>
<td></td>
</tr>
<tr>
<td>S. American guano, 260 lb.</td>
<td>31-114</td>
<td></td>
</tr>
<tr>
<td>Bones with sulphuric acid, 11 cwt.</td>
<td>31-893</td>
<td></td>
</tr>
<tr>
<td>Graham's Animal Comp., 260 lb.</td>
<td>32-109</td>
<td></td>
</tr>
<tr>
<td>Sulph. of ammonia, 1 cwt.</td>
<td>32-670</td>
<td></td>
</tr>
<tr>
<td>Bones, finely powdered, 12 cwt.</td>
<td>36-185</td>
<td></td>
</tr>
<tr>
<td>Potter's guano, 260 lb.</td>
<td>37-201</td>
<td></td>
</tr>
<tr>
<td>Stable dung, 22 tons</td>
<td>39-476</td>
<td></td>
</tr>
</tbody>
</table>

In some experiments of Sir H. Verney's,² the fertilizers were applied in 1844 to a turnip crop. The experiment, however, failed, from the seeds not germinating. On the succeeding crop of Chevalier barley (sown at the rate of 1½ bushel), the following were the manures applied, and the results produced per acre:—

<table>
<thead>
<tr>
<th>Manures</th>
<th>Weight</th>
<th>Produce.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil simple</td>
<td>—</td>
<td>3 6 2</td>
</tr>
<tr>
<td>Unburnt bones</td>
<td>1 7</td>
<td>5 0 0</td>
</tr>
<tr>
<td>Burnt bones</td>
<td>0 18</td>
<td>5 3 2</td>
</tr>
<tr>
<td>Pigeon's dung</td>
<td>0 18</td>
<td>7 5 0</td>
</tr>
<tr>
<td>Spanish phosphorite and sulphuric acid</td>
<td>0 18</td>
<td>5 3 2</td>
</tr>
<tr>
<td>Superphosphate of lime</td>
<td>1 5³⁄₄</td>
<td>5 6 3</td>
</tr>
<tr>
<td>Stable dung</td>
<td>20 0</td>
<td>8 2 0</td>
</tr>
</tbody>
</table>

² Ibid. p. 331.
From some recent and valuable experiments of Mr. Pusey and Mr. Brooks, of Hatford, \(^1\) it is probable, as we have long since elsewhere suggested, that by finely dividing bones by putrefaction, and mixing them with gypsum powder, an effect may be produced upon turnips similar to that of using the superphosphate of lime. Mr. Pusey says, "I mixed eight bushels of crushed bones with sixteen bushels of our brick-coloured peat-ashes. In a few days, the heap began to heat violently, and the heat lasted for ten days: the whole was reduced to a fine reddish-grey powder. On trying this compost by the side of superphosphate, with a crop of turnips, the effect was precisely the same: the ashes cost only fourpence for two bushels—the acid would have cost five times as much. The superphosphate of lime appears to answer very well for wheat. Mr. P. Leigh obtained the following results per acre:---\(^2\)

<table>
<thead>
<tr>
<th>Manures</th>
<th>Cost.</th>
<th>Produce in Bushels.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil, simple</td>
<td>£ s. d.</td>
<td>29</td>
</tr>
<tr>
<td>Rape-dust, 5 cwt.</td>
<td>1 12 6</td>
<td>38</td>
</tr>
<tr>
<td>Urate, 6 cwt.</td>
<td>1 12 6</td>
<td>38</td>
</tr>
<tr>
<td>Dung, 30 loads</td>
<td>4 10 0</td>
<td>40</td>
</tr>
<tr>
<td>Guano, 3(\frac{1}{2}) cwt.</td>
<td>2 4 0</td>
<td>40</td>
</tr>
<tr>
<td>Superphosphate, 6 cwt.</td>
<td>2 4 9</td>
<td>53</td>
</tr>
</tbody>
</table>

It is noticeable that oil-cake, which is found so enriching to the dung of live stock, abounds with phosphate of lime. In the ashes of the gold-of-pleasure cake (constituting 6·89 per cent. of the cake), of English linseed-cake (constituting 7·25 per cent.), and of American linseed-cake (constituting 6·35 per cent.), were found by Mr. Fromberg.—\(^3\)

<table>
<thead>
<tr>
<th></th>
<th>Gold of Pleasure.</th>
<th>English Cake.</th>
<th>American Cake.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alkaline salts</td>
<td>30·43</td>
<td>31·55</td>
<td>38·20</td>
</tr>
<tr>
<td>Phosphates of lime and magnesia</td>
<td>40·56</td>
<td>47·67</td>
<td>56·26</td>
</tr>
<tr>
<td>Lime</td>
<td>3·46</td>
<td>4·88</td>
<td>1·24</td>
</tr>
<tr>
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<td>1·51</td>
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<td>4·04</td>
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<td>Sand</td>
<td>10·84</td>
<td>3·86</td>
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</tr>
</tbody>
</table>

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\(^2\) Ibid. vol. v. p. 605.  
\(^3\) Trans. High. Soc., 1846, p. 203.
The constant withdrawal of the phosphate of lime from pastures by hay and by live stock, and the total neglect of any means of returning a supply to the soil, are well worthy of the farmer's attention. We have already given the analysis of rye-grass, in which it exists in very considerable proportions: and as regards live stock, "If we consider," says Professor Johnston, "that an animal of 20 to 25 stone weight contains about 50 lb. of bone, the important constituents of which it derives from the soil, it will be easily understood how the rearing of growing stock for successive generations should impoverish the soil of the materials of bones, and how the application of bones as a manure should increase its productiveness in those grasses from which the animal derives the materials of which its bones are composed."

The experiments which we have made with crushed bones, and with gypsum, as a top-dressing for old, worn out pasturage, are confirmed by those of Mr. Fleming, of Barochan, in Renfrewshire, who says, "I have had very satisfactory results from top-dressing meadows and grass on my new moor property, with dissolved bones, and guano, and salt. The produce has been doubled at the trifling expense of 16s. per acre."

Mr. Stewart, of Hillside, in Dumfriesshire, adds, when speaking of some experiment on similar land with bones and lime, "The effect is mostly in favour of the bones, both in the quantity and in the quality of the pasture and hay. It is the inferior varieties of guano (provided the price is commensurate with the small amount of the salts of ammonia, and the large proportion of water they contain) that is the best adapted for those pasture lands that require an additional supply of the phosphate of lime.

Most of those of commerce have been analyzed by Professor J. F. Johnston. He found in these, per cent.—

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1 Farmer's Almanac, 1847, p. 25.
3 Ibid. p. 314.
4 Ag. Gaz., vol. iii. p. 244.
EXPERIMENTS WITH SPECIFIC MANURES. 183

<table>
<thead>
<tr>
<th>Kinds.</th>
<th>Water.</th>
<th>Ammoniacal matter.</th>
<th>Earthy phosphates</th>
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<td>,, dark</td>
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<td>,,</td>
<td>25-49</td>
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<td>Patagonian, light</td>
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<td>20</td>
<td>24 to 32</td>
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<tr>
<td>,, dark</td>
<td>20-55</td>
<td>25</td>
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</tbody>
</table>

Farmer's Almanac, 1847.

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ART. XI. — EXPERIMENTS WITH SPECIFIC MANURES.

BY MR. ALEX. JAMES MAIN, WHITEHALL, LASWADE.

[Mr. Main closes an interesting account of his experiments, which appear to have been very carefully and ably conducted, with the following General Remarks and Conclusions.]

General Remarks.

On reviewing the results obtained from the experiments recorded in the succeeding tables, some important facts present themselves, well worthy of a more particular description. This I shall proceed to give as succinctly as possible. And, first, I would remark the fact, proved in the tables, that one manure may be successful in one locality and not in another, and vice versa.

*Suflate of soda* has proved itself, on this farm, a valuable top-dressing on oats; *sulphate of ammonia* the reverse. In other experiments on the same crop, conducted in other places, and reported in the "Transactions of the Highland and Agricultural Society," the effects of the two substances were completely reversed. Sulphate of ammonia was the

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1 The valuable and instructive tables referred to here and in succeeding parts of this article, are in the vol. of the *Trans. High. Soc.* from which this extract is taken.—Ed. F. F.
successful, sulphate of soda the unsuccessful application—I speak here of the substances in the individual application—in mixture, both are successful, and in varying degrees. On grass, the two succeed well together, in conjunction with common salt and pigeon dung; on oats, the most successful mixture with sulphate of ammonia, is guano, nitrate of soda, and animal charcoal; and sulphate of soda succeeds best with night-soil, saltpetre-refuse, and animal-charcoal; on wheat, sulphate of ammonia succeeds well with nitrate of soda, applied with which substance, sulphate of soda fails; with the former, however, animal-charcoal was conjoined, with the latter, it was not, and hence, probably, the success of the one and the failure of the other; on the potato-crop, sulphate of soda succeeds, while sulphate of ammonia fails; the experiments in this case, however, are destitute of authority, from their erratic character;—on the whole, both substances are good in mixture. The facts connected with these substances are demonstrative of the good results attending widely-extended experiments; and from them also the lesson may be learned that, before largely using any manure, it ought to be carefully experimented on.

Saltpetre-refuse has proved itself a most excellent top-dressing, both in the individual and mixed applications. Nor is it destitute of merit when applied with other substances as a manure to root-crops; on all, it has exercised a most beneficial influence. As a grain producer, its value is great in respect of quantity, but it is inferior as regards quality. And in respect of grain, it is surpassed in the wheat-crop by night-soil; besides that, comparing its produce in straw with its produce in grain, and both with the produce obtained from other specifics, it fails in producing a quantity of the latter corresponding with the amount of the former. In mixture, however, this failing is corrected, though the amount of produce in grain does not equal, in every case, its own produce, individually applied; as a set-off to this, it is improved in quality. On the whole, this is a valuable manure.

My experiments in night-soil are most satisfactory, and fully justify the conclusion, that it is a good manure. Probably, in other experiments undertaken this year, the effects of this manure will be sufficiently brought out; if so, then a just appreciation of its value may be formed; if not, I submit that, from the good effects of it recorded in my experiments, its merits demand a more extended inquiry. I
am aware that in England this manure has been long used and appreciated, but it is of very recent introduction into Scotland; and the merit of being the first to introduce it, so far as I am aware, belongs to Messrs. Mack and Rutharford, of Leith. The facts, however, are conclusive, and night-soil, if judiciously prepared, will, I am convinced, attain to as much celebrity as guano. Every effort should be made to secure it in abundance; particularly, it should be impressed upon the authorities of cities and large towns, the desirableness and propriety of attending to its collection. This done, not only would a great national good be secured, but a large increase of revenue would result to the cities and towns themselves. Glancing at its effects, it is found to be rich in the production of grain, both in quantity and quality. As a producer of straw, it is inferior to many of the other applications; but, on the other hand, its economical results are superior. In mixture, its value is considerably enhanced, nor are its essential qualities diminished; its production of grain, in the case of oats, is greatly increased, its quality little inferior; and its produce in straw, though still inferior to other substances, is largely augmented. In wheat, these remarks, in respect to mixtures with this substance, do not hold good. The produce, mixed with saltpetre-refuse and gypsum, is inferior to that from its individual application. I attribute this, however, in a great measure, to the presence of gypsum. That substance has not at all answered my expectations in any of my experiments. And, again, this failure is the result of only one application in mixture, and therefore does not afford sufficient data for a decision. But, be that as it may, the fact that it is, in every essential particular, a most valuable top-dressing for wheat, is unquestionable. Compared with guano, night-soil has not been so successful in its application to root-crops, nor, on the whole, has it entirely failed; a sufficient guarantee, that in respect to these crops, it is an improveable manure. This latter conclusion is strengthened by the fact that, allied to other substances, and applied to the turnip-crop mentioned in tables G and H, it in the one surpasses farm-yard manure in two applications, and nearly equals it in a third; and in the other table, while it surpasses farm-manure, it also excels the produce from guano itself—the mixtures with both substances being equal in kind and quantity. For the mixtures most beneficial in combination with night-soil, I must refer to the tables, merely remarking, that in the instance of its
surpassing guano applied to the turnip-crop, it was in alliance with dissolved bones and animal-charcoal.

Guano, as compared with night-soil, is inferior in the grain, and superior in the root-crops. Its merits and demerits, however, are so well known that I need not enter on their detail. This far, however, I may remark, that in case of the privation of this article, we have, in the case of grain-crops, equally good substitutes in saltpetre-refuse and night-soil; and in respect of root-crops, I have no doubt that bones and night-soil will be made to equal it. Referring to table D, a curious effect is found to follow: in the first place, guano, saltpetre, and night-soil, in combination, and in the next, the same substances with another added. The mixture of the three substances is a complete failure; with the addition of another substance, however, in each of three applications they succeed. In the first of these three applications, animal-charcoal is added; in the second, sulphate of magnesia; in the third, nitrate of soda. The first is superior in straw and grain, but inferior to the other two in weight of grain; the second is superior to the third in grain, but inferior in straw and weight of grain; and the third is inferior to both the others in grain, but again surpasses both in weight. All, however, are very superior to the three substances in combination, and applied without the addition. The cause of the failure in the application of the three substances, I cannot sufficiently explain: that it is to be attributed to the combination of guano and night-soil, is not strictly consistent with the effects of the two combined in other experiments; and yet the fact, that the addition of another substance is sufficient to obviate the bad effects of the mixtures, seems to point in that direction. Probably, therefore, the fact may be, that two ammoniacal excrements operate injuriously on each other, and that they require an amount of corrective power equal, on the one hand, to saltpetre-refuse and sulphate of magnesia, animal-charcoal and saltpetre-refuse, or nitrate of soda and saltpetre-refuse; and, on the other, to one-quarter of bones dissolved in sulphuric acid. I take the facts as I find them, and these demonstrate that guano and night-soil do not operate well together, except when an equivalent amount of corrective power is applied along with them, or, which is to the same purpose, that these substances, equally divided, of which the two named are a portion, do not produce beneficial effects. I do not hazard an opinion in elucidation of this subject, my
EXPERIMENTS WITH SPECIFIC MANURES.

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chemical knowledge being insufficient for the purpose; but the fact is interesting, at least to myself, and may be so to others more experienced, if it do not come under that class of facts which derive their interest solely from the ignorance of their discoverer. This conclusion, however, is clear, that guano and night-soil mixed, and in combination with other substances, is an excellent top-dressing for barley, and I have no doubt equally so for other grain-crops; and that the two substances mixed and applied to turnips, with bones dissolved in sulphuric acid, effects a vast saving in the first cost, secures a larger crop, and is more satisfactory in economical results, than a much larger quantity of dissolved bones applied alone.

Nitrate of soda individually applied, has not produced equally favourable results in this locality as in others. Probably its high price may have assisted in producing this unfavourable result, as certainly the appearance of the crop, when growing, did not indicate any failure in the manure itself. In mixture, it has been of great utility, and, no doubt, is worthy of considerable attention.

The experiment recorded in Table I, is an interesting proof of the fact, that farm manure combined with guano affords the largest amount of vegetative and economical results, when applied in the proportion of fifteen carts-load of the former to 3 cwt. of the latter. It would be interesting and instructive to enlarge on this experiment, and by the application of various quantities of guano, respectively applied to 10, 15, 20, and 25 tons or cubic yards of farm manure, ascertain correctly, and beyond possibility of doubt, at what rate applied these manures would be most productive. The same remarks apply to the experiment on potatoes. Night-soil might also be conjoined in the experiment by itself, and with other substances, and the results might elucidate facts of some importance.

I attach some importance to the experiment with bones on the turnip crop, exhibited in Table II. Bones, as a manure, are most important articles in agricultural economy, and they are most deservedly so. No experiment, therefore, tending to enlighten as to their improvement can be unimportant, especially if, from their improvement, they can be economized. Dissolving bones in sulphuric acid has tended greatly to advance this great object, namely, the improvement and economy of bones as a manure. The facts, however, elicited by these experiments tend to prove it still further possible
to economize and improve them. A reference to Table H will clearly illustrate the fact. I leave to persons more versed in chemical lore than myself to illustrate this point; but this I observe, that the larger the amount of the ammoniacal substance introduced into the mixture, the greater is the saving in bones, and in proportion is the crop increased.

Of the effects of mixed manures there can be no doubt. In every experiment undertaken to illustrate the properties of the specific manures, the results from mixtures bear a prominent part. In those I have undertaken, this remark also holds good; and there can be no question, but that in this way the large proportion of our foreign manures should be used. No doubt, some trouble may be necessary to discover the best mixtures, but this done, the results will more than repay the cost. In the absence of mixtures, many of our best manures, at least our best used in this way, are lost sight of, and thereby we deny ourselves the benefit to be derived from their use. Nor, because a manure fails as an individual application, is it a reason for arguing its failure in mixture. This fact is distinctly proved in the succeeding Tables.

Nor is this all, our best individual applications can be improved by combination, either applied to grain or root crops. Have we an individual substance excelling in the produce of straw, by a judicious mixture of this substance with one or more substances excelling in the produce of grain and in the weight of it, the properties of all may be improved, and the farmer more amply remunerated than by adhering to any individual substance. A word of practical improvement. Not mine alone, but many other experiments have clearly elucidated most important facts; these should be promptly acted on. Much good is lost by inactivity in the application of truths derived from careful experiment. This should not be; for though some labour, and possibly experience, may be necessary to demonstrate their practical usefulness, the public and private interests to be subserved should, at all times, be a sufficient stimulus to the prosecution of inquiry. Let farmers collate and reduce to practice the facts to be gleaned from experiments already recorded, and they will reap benefit in their own profit, and promote the national good.
Conclusions.

1st, Every description of crop requires an ingredient essential to its production, and without it such crop cannot be raised in perfection.

2d, If a soil does not contain in itself what is essential to the growth of the plant upon it, it must be supplied through the medium of one or other of the specific manures.

3d, The essential substance necessary to be added to the soil, may be discovered by consulting the nature and properties of the plant to be raised.

4th, Nitrate and ammoniacal substances excel in the production of straw, grass, or potatoes, and turnip tops, without an equivalent production of grain or bulbs; so these substances should not be applied alone, but in combination with others containing phosphates. This is illustrated by the fact that salt-petre refuse and nitrate of soda, applied with guano or prepared night-soil and animal charcoal, improve their individual production, either in quantity or weight, or in both.

5th, Salts which are sulphates produce grain in larger proportions to their straw, than other salts which are nitrate or ammoniacal.

6th, Bone manure, though dissolved in sulphuric acid, may be greatly enhanced in value by the addition of ammoniacal substances; hence it is inferred, that substances capable of imparting additional luxuriance to the foliage of plants, largely administer to their necessities, and, combined with phosphates, are highly advantageous.

7th, Sulphuric acid is eminently beneficial to the potato crop, and, in the experiment on that crop recorded in the Tables, has proved itself a preventative of the disease called "curl," having produced a healthy crop, when, from the same seed, and otherwise treated in the same manner, the other plants of the field were much infected with that disease.

I am aware that some of these conclusions are mere repetitions of ascertained facts, but truth is never injured by repetition. Perhaps I should have added to the list of my conclusions this one, that farm manure and guano, combined in the proportion of 15 tons of the former to 3 cwt. of the latter, is the proportion in which I have found these substances to succeed best; and as regards farm manure and night-soil, the best proportion is, 25 tons of the former to 1½ cwt. of the latter. This last result, however, may be
EXPERIMENTS ON THE CONTINUED EFFECTS OF SPECIFIC MANURES.

By Mr. A. F. Gardner, Barrochan, Renfrewshire.

The conclusions to be drawn from these crops for three years are,—1st, That moss and guano are able to supply the place of farm-yard manure in a greater degree than any other substance that has yet been tried here; and from the experience of the last four years it has been found that a mixture of dung and guano, in the proportion of from 10 to 14 tons of the former to 3 to 5 cwt. of the latter, will raise a larger crop, in the first instance, than from 30 to 40 tons of dung alone, and leave the land in as good, if not better, condition for the after crops, at about one-half the expense of the dung. 2d, That burnt bones are equal, if not superior, to fresh bones, for raising crops to which bones are applicable as a manure; and that bones will (if applied to green crops on land in which their constituents are deficient,) keep up the fertility of such land in a high degree for the after crops. Bone-dust was applied nine years ago as manure for a turnip crop, in a field of medium soil, and this field was treched this season and sown with oats. The land where the bones had been put gave 7 bushels oats, and 50 stones more straw, than that land to which farm-yard manure had been applied at the same time to the turnip crop, besides the grain having been 2 lb. per bushel heavier; and, during the time this field lay in grass, the portion manured with the bones could be pointed out from the rest by a darker colour and greater luxuriance of pasture. 3d, That sulphate of soda, applied to green crops, does not seem to have any influence upon crops after the second year of its application.

Trans. of the High. and Agric. Soc. of Scotland, Jul 1846.
EFFECTS OF SPECIFIC MANURES.

Art. XLII.—EXPERIMENTS ON THE CONTINUED EFFECTS OF SPECIFIC MANURES.

DRAWN UP BY MR. A. MURRAY, NETHERMILL OF CRUDEN.

From the results of three years' experiments of the rotation, Mr. Murray says the following conclusions may be drawn:

1st, Farm-yard manure with guano, seem to give the greatest bulk of crop, and a heavier crop than a full manuring of either alone.

2d, Farm-yard manure with bone-dust, or bone-dust and sulphuric acid, produce heavier crops of turnips and oats than a full manuring of either alone.

3d, Notwithstanding the weight of hay crop, after the bone-dust, or bone-dust and sulphuric acid, appears about equal to that raised by the other applications, still they uniformly produce the best sole of rye-grass and white clover. This may be accounted for in two ways. 1st, Much more phosphates are added to the soil by a full manuring of bone-dust, or bone-dust and sulphuric acid, than from farm-yard manure or guano. The same result holds good with mixtures of these. 2d, The texture of the soil is much firmer in the turnip crop after bone-dust, or bone-dust and sulphuric acid, than after farm-yard manure or guano. Now, experiment and experience have proved, of late years, that the texture of the soil has much influence in the growth of clover.

4th, The addition of sulphuric acid to bone-dust, appears to accelerate the growth of vegetables. This is an important circumstance for wet cold clay soils. I find, that a less quantity of sulphuric acid along with bone-dust, than that used by the Turrif experiments—say, 6 lb. instead of 25 lb. to the bushel, has all the advantages of early action, and is free from the objections to so large a proportion.

5th, With regard to farm-yard manure, or peat and saline manures, they fall behind the other applications after the first year. This may arise from the saline manures being easily dissolved, and thereby early appropriated by the plants.
ART. XLIII.—ON GUANO, AND ITS COMPARATIVE MERITS.

By Professor Johnston.

[At the meeting of the Yorkshire Agricultural Society, held August 5, two highly interesting and instructive lectures were given by Professor Johnston on manures. The one delivered at the public breakfast elicited many valuable observations from several members of the society giving the results of their experience in the use of different kinds of manure. To elicit such a discussion was the professed object of the address.]

With regard to guano, it was well known it was derived from a description of sea-fowl which lived on fish, and which was produced in great abundance. If they fed some fowls on the ordinary food, and others on fish, they would find that the manure of the latter was more valuable than that of the former. There was another fact with regard to the manure of birds generally. It was well known that the excrements of animals, of cows, horses, sheep, &c., consisted of solids and liquids. In the solids were found the phosphates; from the liquids ammonia was obtained, or at least the nitrogen which formed ammonia on fermentation. Now, in the excrements of the sea-fowl and other birds, the liquids and the solids were ejected together, and consequently it was more valuable. This was an important point. Hitherto only the solid excrements of animals had been really attended to; but they did not contain all that the farmer wanted; they did not contain the ammonia and saline qualities which the liquids carried off. It was not necessary that he should say much on the theoretical advantages of guano, nor was it of much importance to them; but they would find, from the market-value of its main constituents, in what its advantages really consisted. Ammonia was the principal fertilizing ingredient, and the price of that was from 30s. to 4l. per ton. In guano there was 55 per cent. of ammonia, and a large proportion of phosphate of lime. These two articles constituted the great proportion of guano, as well as the most valuable in the market. He had already told them that the sea-fowl ejected in one excrement both ammonia and the phosphates; whilst in animal excrements, the phosphate was contained in the solid and the ammonia in liquid. He would draw attention to some of the varieties of guano which had recently come into the market, in order that they might compare them with those which had already come into use. These varieties had been
brought from Sakdunha Bay and Patagonia. The former variety contained 70 or 80 per cent. of phosphorus, and was very rich, and the Patagonian guano was as good as the better qualities of Ichaboe guano. It was a subject of congratulation, that on the coast of Patagonia there was a very large supply of guano, and he hoped that the guano from all parts of the world would last the farmers as long as they would require it; and that by the time this manure failed they would be able to dispense with it. He thought it a most gratifying circumstance that Providence had thus interfered to cause knowledge in these matters to flow in the right channel. When guano failed, still the use of artificial manures would not stop. He anticipated that artificial manures would then be prepared, if not by manufacturers, at least by the farmers themselves, many of whom would be able to prepare them. Their business at present, however, was with guano as they found it. Three or 4 cwt. of guano was equal to 20 or 30 tons of farm-yard manure. He had stated its theoretical value, and if the time would have permitted him to explain all the things the plant requires, he could have shown them that this guano, to a great extent, supplies all the demands of the crop. The result of his inquiries in the country had shown that it was better husbandry to use guano and farm-yard manure in due proportions; or, if they did not do that, to use guano the first year and farm-yard manure the next. But in his opinion the safest way, in all cases, would be to use the proper proportion of dung and guano, as larger crops, generally speaking, had been obtained in this manner. He thought it was not the best, or the most economical method to use guano in a dissolved or liquid state. He then alluded to the great analogy which exists between guano and bones, explaining, however, that guano acts more quickly than bones. He next noticed some experiments which had been made in Ross-shire, Scotland, with guano. A gentleman named Ross, who resides in that county, which contains some as good land, and as good farmers, as in Yorkshire, wrote to his grieve or bailiff to apply guano to the land in the ratio of 4 cwt. to the acre. The grieve thinking his employer must be wrong, applied the guano in three several proportions. To one part he applied 4 cwt., to another 8 cwt., and to a third 16 cwt. The consequence was, that on the land where 4 cwt. were applied beautiful crops appeared, whilst the contrary was the case with the other portions, especially with regard to that portion to
which the 16 cwt. of guano had been applied. Then came the crop of wheat; for wheat was taken after the turnips. When the wheat was growing where the 16 cwt. had been applied, the straw was dark coloured, the corn was small in the ear, and when thrashed it was absolutely black. Where 8 cwt. had been applied the sample was a little better, although the straw had a peculiar dark colour. Where 4 cwt. had been applied the sample of wheat was beautiful, and that wheat brought into the market 6d. per bushel more than the wheat taken from the land on which 8 cwt. had been placed, and the wheat taken from the land where the 16 cwt. had been applied could scarcely be sold at all. He mentioned another case which had been brought under his notice ten days ago, to show the effects of guano in promoting the growth of the crops. He then drew their attention to the effects produced on the farm of Mr. Fleming, of Renfrewshire, and gave the result of the money value of three crops, grown in 1842, 1843, 1844, of turnips, oats, and rye, after the application of guano. The crops where guano was applied left a profit, after paying every expense for rent and interest on the capital, of 30l. 16s.; where farm-yard manure was applied, at the rate of 25 tons for turnips, there remained a profit of 14l. 16s., leaving a difference in the profit in favour of the grower, by the application of guano, of 16l. In the one case 3 cwt. of guano was used, and in the other 25 tons of dung. The learned professor was here asked what value he put on the manure, to which he replied 8l. 15s. He mentioned a few other cases of a similar kind, the result being that more profit was to be obtained from the use of half farm-yard manure and half guano than when they used farm-yard manure only, or when mixed with bones. The question would hereafter be, whether they would look to the after effects of guano, or whether they would not rather look to its immediate effects, or whether they would not apply it in smaller quantities from year to year, rather than larger quantities every four years. He believed it would be found more beneficial to apply it to each successive crop, to apply it to the seed, and then to apply a top-dressing when the plants made their appearance above the ground. After trying this plan, he thought it would be the most profitable they could adopt.

In the course of his remarks, the learned professor alluded to the following table, which was placed over the chimney-piece in large characters:—
ON GUANO, AND ITS COMPARATIVE MERITS. 195

Composition of different kinds of Guano.

<table>
<thead>
<tr>
<th></th>
<th>Levenside.</th>
<th>Star of the best.</th>
<th>Ichaboe.</th>
<th>Bolivian</th>
<th>Chinchas</th>
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<td>1:58</td>
<td>2:02</td>
<td></td>
</tr>
<tr>
<td>and common salt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>and magnesia</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Earthy matter</td>
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<td>12:00</td>
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<td>100:00</td>
<td>100:00</td>
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Mr. Lister Maw, of Tetley, near Crowle, rose to make a few observations to the company. He produced several turnips, which he said had been grown on his farm for fold-yard manure. And not only was that particular land in a high state of cultivation, but he had succeeded in bringing other farms, step by step, into an equal state of cultivation, so that they had in fact trebled their produce. He had made some observations last year at Beverley, and he then stated that he had opportunities, which very few in this country had, of making himself acquainted with the manner in which the Incas of Peru carried on their operations. Now, with respect to the relative value of guano, he believed that the Peruvian guano would be found to be the best. And, however much he might respect chemical knowledge as applied to agriculture, and however much they might be indebted (as they undoubtedly were) to such men as the learned professor, he still thought that the chemical affinities and compounds which were going on in nature were not exactly ascertained in the chemical analysis of the laboratory of the chemist. The peculiarity of Peruvian guano was, that it contained no moisture. It was a great peculiarity of that country that no rain fell on the western coast. And the guano of Peru being preserved in a dry state was much better than that of any other country. He believed the same remarks might apply to pigeon manure, and that because it was kept in a dry state in the pigeon cot. Mr. Maw showed, by a drawing, the manner of applying guano by the Incas. Another fact to which he alluded
was, that at the time the Incas applied the guano to their soil, they had no domestic animals. The llama was the only animal they had; and therefore they could not raise farm-yard manure. And, as a proof that even if they had such manure, they could not convey it to the land, Mr. Maw referred to his own experience in travelling in Peru, and to the time occupied by him in moving from one part of the mountains to another. He referred to the turnips which he produced as evidence against Professor Johnston, that 5 or 6 cwt. of guano was not equal to 50 tons of manure. He showed that the fold-yard manure was so rich that the fangs had gone out to seek for food, and he thought they had too much. Mr. Maw concluded by stating some interesting details respecting the great growth of turnips without the aid of guano or artificial manures. If the farmers would only raise sufficient fold-yard manure for themselves, which he thought they might do, they would have little occasion for guano. But if not, they might put their hands into their pockets as long as they could for the purpose of raising their crops. He had himself this year large quantities of turnips, rape, wheat, &c., and he had not used an ounce of guano. He had led upwards of a thousand loads of fold-yard manure to his fields, and he had now a thousand loads in hand, which he doubted not he could make good use of in competition with guano.

H. S. Thompson, Esq., said he quite agreed with Mr. Maw, that farm-yard manure was a very excellent thing. The great object of guano was not, he conceived, to dispense with the use of farm-yard manure, but to enable them to carry out the cultivation of a wider breadth of land than could be adequately cultivated without it. With respect to the advantages of guano on present and subsequent crops, he thought there were two things necessary to be considered. The first was the nature of the season, and the next the proper quantity of guano to be applied. By Professor Johnston they had been furnished with instances in which the application of a very large quantity of guano had been detrimental at least to the first crop, while the application of a smaller quantity had been highly beneficial. If more guano were put on than could be taken up by the first crop, of course there would be a portion left for the succeeding crops. If they had a very dry season, and the plant did not appear to derive the whole benefit which guano was capable of supplying, it was manifest that much of its fructifying
ON GUANO, AND ITS COMPARATIVE MERITS. 197

properties would be left to the succeeding crops. If the nature of the season were taken into account, in conjunction with the quantity of guano to be applied, it was very probable that many of the apparent differences of opinion as to the quantity of guano to be applied, and the different effects produced, might be reconciled.

Farmer's Magazine, September 1846.

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Art. XLIV.—EFFECTS OF GUANO IN GROWING CABBAGES.

By Mr. A. F. Gardner.

The soil upon which they were grown is about 2 acres of improved moss land, trenched with the spade in 1842, and the subsoil brought to the surface. It was cropped with potatoes in 1843, manured with 12 tons farm-yard manure, and 3 cwt. guano per acre, and produced a crop of upwards of 15 tons per acre. It was again dug this spring with the trenching-grape, when 2 cwt. of guano per acre was sown by the hand, broadcast, and harrowed in. After which, in the beginning of April, the cabbages (Drumhead) were dibbled in upon about an acre, and the other portion sown with mangel-wurzel, the land being cleaned and worked in the usual manner. These crops have grown most luxuriantly, the cabbages giving a crop of upwards of 60 tons per acre, most of them averaging from 20 to 40 lb. a piece. The mangel-wurzel is now (Nov.) still growing, but has been estimated by good judges to be 40 tons and upwards per acre of clean roots, many of them averaging 10 to 12 lb. a-piece.

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Art. XLV.—ON THE USE OF CHARCOAL AS A FERTILIZER.

By Cuthbert W. Johnson, Esq., F.R.S.

I hardly deem it necessary to prove to any one the value of charcoal as a valuable manure; and if it was necessary
to obviate the suspicion that there is any difference in the effect produced by the use of charcoal-ashes and the impure variety of these ashes afforded by peat, I am readily supplied with the means of doing so by a recent report by Mr. Peter Mackenzie, of West Plean, near Stirling.\(^1\) He tells us that he has been for some years past trying experiments with peat, charred peat, and peat-ashes, as a substitute for stable manure, and for many kinds of crop grown by farmers and gardeners. He remarks,—"In the spring of last year, I collected a quantity of peat for various purposes, and part of it was intended to be charred or burned. It was not so well prepared for burning as I wished, a good deal of moisture being in it; however, a good fire was made of wood to begin with, and as the peat dried it was drawn to the fire, and in this way was kept burning for two weeks. It required little watching, only once or twice in twelve hours. The partially dried peat was drawn to the fire, because it was intended to have a quantity of charred peat and ashes mixed together, and in order to obtain both, the fire was kept in a smothered state to char the peat (let the farmer mark the distinction). It commonly burst through in some parts, and there supplied the ashes. When we had a quantity to begin with, the unburnt peat, and the charred, with the ashes, were all well mixed together; at least one-half of the mass was unburnt peat." This mixture was applied about the beginning of May, to a light sandy soil, for a crop of Swedish turnips. The quantity used was at least at the rate of 200 bushels per acre. "We tried it," continues Mr. Mackenzie, "against well-made stable-manure in a state like mould, cut well with the spade, which was applied at the rate of about 20 tons to the acre, and spread into drills, like the peaty mixture. The plants grew well in both cases. We tried to ascertain the amount of produce per acre from each manure, as late as the middle of January 1846; for, from the mildness of the season, the turnips till then appeared to be in a growing state, each plant having had about two square feet of surface to grow upon. The surface was kept flat, and the ground chiefly worked with the Dutch hoe. The weight of bulbs fit for use manured with the peaty mixture was upwards of 40 tons per acre; while those produced from stable-dung weighed only about 30 tons. One row of peas was also manured with the peaty composition,

\(^1\) Quar. Jour. of Agric., 1846, p. 467.
and yielded as great a crop as those manured with the stable-manure." Such a preparation of charcoal, although mixed with other substances, the farmer will find very valuable in a variety of ways. It would constitute an excellent foundation for dung-heaps or sheep-folds, since charcoal very extensively absorbs the gaseous matters of putrefaction; and, when used in considerable proportions, would also imbibe all the drainage matters of the sheep, or other live stock. It answers well, also, for a covering for dunghills; but to this end, again let me remind the farmer, that he must only carbonize or char his peat or turf; he must, to accomplish this, by covering the burning heap with earth or green turf, retard, regulate, and reduce the extent of the combustion as much as possible. It is to the presence of a considerable portion of carbon in the ashes of a land pared and burnt, that the advantages of this now nearly exploded operation may be attributed. The ashes of a pared and burnt chalk soil from Kent contained four to five per cent. of carbon, that of a light Leicestershire soil contained six per cent., and that of a stiff clay soil from Mount's Bay, in Cornwall, contained eight per cent. of carbon.

The evidence, then, is abundant in favour of charcoal as a fertilizer. At such a period as this, too, when starvation appears to threaten, if it has not already visited, a large portion of the population of Ireland, it seems a most opportune and desirable period for the extensive and immediate preparation of charcoal from the abounding bogs of the sister kingdom. Let, then, the attempt be promptly made; let every owner of bog or peat land make some effort in this way; and, in so doing, such real friends of their country may rely that they will thus not only serve very materially their at present unwillingly idle neighbours, without burdening themselves, but that they will moreover enrich their own estates, while they promote the comfort and the improved cultivation of the land of their birth.

Farmer's Magazine, Nov. 1846.
Analysis of the water of the ocean shows us, that in it are contained all the inorganic ingredients which our crops take away from the soil—that it is, in fact, a liquid soil, from which myriads of vegetables receive the materials for their perfect development. Along our coasts, the plants nourished by the mineral and saline matters, dissolved in the waters of the sea, have long been employed by the farmer as applications to the soil, and in many parts of the kingdom are regarded as his sheet anchor—thus, in some small degree, restoring to our fields the substances lost by the faulty arrangements of our farm-yards and cities. My attention was lately drawn to the sea-weeds of our coasts, from being engaged in the analysis of the well-known substance kelp, produced by their incineration, and which is now exciting considerable interest, as a source of the valuable metallic-looking substance iodine, at present so extensively employed in medicine. So far as I am aware, no complete analysis of our Irish kelp has yet been laid before the public. It will, therefore, be of interest that the composition of this valuable and accessible source of the materials required to render our fields productive should be made known.

The mode of preparing kelp, as generally practised on our coasts, is so well known, that I need not allude to it further than to state that the sample submitted to me for analysis was prepared on the shores of the Lough of Strangford, where, I understand, by the use of iron bottoms for the kilns, and by the careful management of the weed, an article of superior quality is produced. It may also be observed, that when the object of the kelp-burner is to prepare a kelp rich in iodine, only some particular species of the Fucus family should be employed; but when it is required merely for agricultural purposes, all the numerous species, both of drift and shore weed, may be used with advantage.

The sea-weeds, as cast on our shores, or cut from the rocks, contain a very large amount of water—thus, the fresh.
leaves (Frond) of the Bladdered Wrack (Fucus vesiculosus), and of the tangle (Laminaria digitata), which are found in so great abundance on our coasts, when dried at 212 degrees, and incinerated, yielded

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Organic matter</th>
<th>Ash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladdered Wrack</td>
<td>68.8</td>
<td>26.2</td>
<td>5.0</td>
</tr>
<tr>
<td>Tangle</td>
<td>18.1</td>
<td>13.1</td>
<td>5.8</td>
</tr>
</tbody>
</table>

Of the stalks of the tangle, which are considered so valuable by the kelp-burners on the north-east coast, two samples gave as follows:

<table>
<thead>
<tr>
<th></th>
<th>No. 1</th>
<th>No. 2</th>
</tr>
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<tbody>
<tr>
<td>Water</td>
<td>84.00</td>
<td>83.10</td>
</tr>
<tr>
<td>Organic combustible matter</td>
<td>10.40</td>
<td>11.06</td>
</tr>
<tr>
<td>Incombustible matter, or ash</td>
<td>5.60</td>
<td>5.84</td>
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</tbody>
</table>

Mean of ash afforded by leaves and stalks together, 5.5 per cent., or a ton of the weed, as taken from the sea, would yield about 123 lb. of incombustible mineral matter or kelp. The inquiry now presents itself, how far the ash is capable of supplying our fields with the mineral and saline matters removed by cultivation.

As kelp is a substance remarkably complex in its composition, and contains a number of ingredients with which our farmers are not familiar, and the enumeration of which would only serve to perplex them, I consider that it will be sufficient to state the proportion of those ingredients which possess an agricultural value. From the great variety of weeds employed in its manufacture, the composition of kelp must be expected to vary considerably. The specimen from which I obtained the following results was received from a member of our society, A. H. Montgomery, Esq. of Tyrella, County Down, and was prepared on the shore of Strangford Lough, near Greyabbey:

<table>
<thead>
<tr>
<th></th>
<th>100 lb. of this kelp contained</th>
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<tbody>
<tr>
<td>Potash</td>
<td>8.22, or 184(^1/2) lb. per ton.</td>
</tr>
<tr>
<td>Soda</td>
<td>25.82, or 578(^1/4) lb. per ton.</td>
</tr>
<tr>
<td>Lime</td>
<td>5.17</td>
</tr>
<tr>
<td>Magnesia</td>
<td>8.17</td>
</tr>
<tr>
<td>Sulphuric acid (vitriol)</td>
<td>20.17</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>5.43</td>
</tr>
<tr>
<td>Chlorine, one of the ingredients of common salt</td>
<td>11.70</td>
</tr>
<tr>
<td>Silicic acid</td>
<td>2.71</td>
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</table>

The analysis just given shows that in kelp we have a rich
supply of the inorganic ingredients required by our crops, while the large amount of salts of potash and soda which enters into its composition, point it out as peculiarly adapted for the nourishment of our potato and turnip crops. The sample examined, from containing but a small amount of soluble silica, would not be so well adapted for the growth of the corn crops, except in situations where a sufficient supply of soluble silicates were already present in the soil; but, in general, the kelp of our coasts contains a much greater amount of silicates, from the common practice of fusing a quantity of sand with the melted ash—a practice which, for the sake of increasing the weight, is carried to a shameful extent by the kelp-burners. As kelp affords us, as I have shown, a convenient source of the most important elements of plants, and in a convenient portable form, so that we can readily carry it into the interior of the country, and apply it in situations where its action would be still more beneficial than in the neighbourhood of the sea, it is, I conceive, of importance that some experiments should be instituted with this substance, by such of my hearers as possess the opportunity. From several experiments, with different samples of kelp, I find that a hundredweight of that manufactured on our coasts usually contains between 50 to 70 lb. of salts soluble in water, which would afford the plant, from its formation, a ready prepared supply of nutritious materials, while the alkaline silicates and salts of lime, magnesia, &c., would continue to exercise a beneficial influence upon the fertility of the field, even beyond the present season.

The average produce of potatoes, in many districts in the north of Ireland, I have ascertained by careful inquiry, does not exceed 350 bushels, or 19,600 lb. per Irish acre, an amount of tubers which analysis shows us to contain about 190 lb. of matter extracted from the soil. The chief constituent of the potato tuber is potash, an expensive article with the manure dealer, 92 lb. of which is taken away from our fields with every 350 bushels of potatoes that we send to market. Now, half a ton of kelp, of the same character as the sample examined, contains, as we have seen, about 92 1/4 lb. of that alkali; so, by applying that quantity of it to a portion of ground in which we have produced 350 bushels of potatoes, we not only maintain its fertility, so far as it depends upon the presence of that substance in the soil; but also give it a supply of other matter which will be useful to the succeeding crops of the rotation; for the amount of soda
given to the soil in half a ton of kelp is much greater than is required for the development of the potato crop, 350 bushels of potatoes requiring only $54\frac{1}{2}$ lb. of soda, while the kelp contains 289 lb.

*Agricultural Gazette*, Oct. 10, 1846.

**Art. XLVII.—ON MANURING FOR HOPS.**

By J. C. Nesbit, F.G.S., M.C.S.L., &c.

[AFTER having given a series of elaborate analyses of the mineral ingredients of the hop, Mr. Nesbit concludes his essay with the following observations on the constituents of manures required for the cultivation of this plant, according to the results of the preceding analyses.

To show the large amount of common manures necessary to supply the potash to an acre of hops, he observes, that]

The average quantity of potash contained in guano is 3 lb. per cwt.

The straw of wheat contains on an average 5 per cent. of ashes, and every 100 lb. of the ashes contain about 13 lb. of potash.

Farm-yard dung contains on an average 7 per cent. of mineral ingredients. These contain about $3\frac{1}{2}$ per cent. of potash.

The following table, which gives us the weights of different manures necessary to furnish 17 lb. of potash to an acre of land, will make it probable that the large quantity of potash taken out of the land by the hop, is the main reason for the necessity of manuring this plant so highly.

*Quantity of guano, farm-yard dung, or wheat straw, necessary to furnish the 17 lb. of potash taken from the soil by the acre of Farnham hops.*

<table>
<thead>
<tr>
<th>Hops, leaves, and bine of one acre of hops, containing</th>
<th>Guano.</th>
<th>Wheat straw.</th>
<th>Farm-yard dung</th>
</tr>
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<tbody>
<tr>
<td>500 lb. hops,</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>146\frac{1}{2} lb. leaves,</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>289 lb. bine.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>935\frac{1}{2} lb.</td>
<td>7 cwt.</td>
<td>23 cwt.</td>
<td>61 cwt.</td>
</tr>
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</table>
It is evident, from the foregoing table, that though 2 cwt. of guano are amply sufficient to supply the acre of hops with its phosphates, yet that it requires 7 cwt. to supply the potash. Consequently the 5 cwt. of guano might have been replaced by a cheaper manure destitute of phosphates, but containing 12½ lb. of potash.

Hitherto I have spoken as if the hops, leaves, and bine of the acre of Farnhams were of the usual or average weight. But this was not the case. Owing to the unkindly weather, the yield was very deficient. It is no uncommon thing in some districts to grow a ton of hops an acre. We will suppose a farmer to grow a ton of hops per acre, and that the mineral ingredients of the hop are in the same proportion as in those which were analyzed.

We will suppose that the bine and leaves were double in quantity, but containing the same per cent. of inorganic matter as the others. This would give us 64 lb. removed per acre by the golding hop, while the grape hop would remove about 75 lb. per ton, though perhaps 64 lb. might be taken as the average.

The following table will then show us the weight of guano, wheat straw, or farm-yard dung, per acre, necessary to be put on the land, to replace the potash withdrawn by the hops, bine, and leaves:

| Quantity of guano, wheat straw, or farm-yard dung, annually necessary to replace the 64 lb. of potash taken from an acre of land by a ton of hops, with bine and leaves corresponding. |
|---|---|---|
| 311 lb. of hops, leaves, and bine of an acre of hops, containing 2240 lb. of hops, 293 lb. of leaves, 578 lb. of bine. | Guano. | Wheat straw. | Farm-yard dung. |
| ton. cwt. | tons. cwt. | tons. cwt. |
| 1 5 | 4 7 | 11 13 |

Now, as the whole of the above methods of furnishing the necessary amount of potash are enormously expensive, we are necessitated to look to other and cheaper sources for this valuable substance.

Several salts of potash are well known in commerce, and likewise to the agriculturist. Nitrate of potash, or salt-petre, is one, and common pearlash is another.
ON MANURING FOR HOPS.

Saltpetre contains about 47 per cent. of potash, and pearlash about 68 per cent. By calculation, therefore, we find that 64 lb. of potash taken from the land by a crop of hops would be replaced by 136 lb. of saltpetre, at a cost of about £2s., or by 94 lb. of pearlash, at a cost of about £3s.

The weights of saltpetre or pearlash given above would supply the deficiency of potash, supposing the whole crop, including bine, leaves, and hops, were removed from the land. But if the bine and leaves be allowed to rot on the ground, about one-sixth less than the preceding amounts would be sufficient. The impropriety, therefore, of removing the bine, &c., from the land, as is too often the case, is very apparent.

One of the most important points to be deduced from these analyses is the preparation, at a reasonable expense, of a manure which shall contain all the necessary mineral ingredients for the growth of the hop. Being engaged in the analyses of various other samples of the hop, I am now unwilling to offer, as perfect, any manure for the hop, until the comparison of different varieties shall have shown that the hops in divers localities agree in the per-centlage of their various constituents.

It will be seen by reference to the analyses, that, besides potash, the hops contain phosphoric acid, lime, magnesia, common salt, and silica. About 3 cwt. of guano would supply the necessary amount of phosphates. The chloride of sodium would be amply supplied by 1 cwt. of common salt. Lime and magnesia are doubtless found in sufficient quantities in the land; or if not, they can easily be supplied. The silica, perhaps, may be found in sufficient quantities in the land, though it might be better to supply both silica and potash together, in the shape of silicate of potash. This compound, however, is not at present an article of commerce, but there is a probability that it will soon be manufactured on a large scale. The sulphuric acid can be supplied by gypsum.

Either of the following mixtures might be worth trial for promoting the growth of the hop:—

Manure for an Acre of Hops,\(^1\)

\[ \begin{array}{c|c|c|c|c|}
  \text{s.} & \text{d.} & \text{cwt. guano} & \text{at 8} & \text{per cwt.} & \text{£} \\ 
  \hline
  3 & 4 & 8 & 0 & 0 & 1 \\
  1 & 0 & 1 & 0 & 0 & 0 \\
  \frac{1}{2} & 0 & \frac{1}{2} & 6 & 0 & 0 \\
  \frac{1}{2} & 0 & \frac{1}{2} & 6 & 0 & 0 \\
  \hline
  \text{Cost per acre} & \text{—} & \text{—} & \frac{1}{2} & 6 & \frac{1}{2} \\
\end{array} \]

\(1\) Cost per acre. £3 5 6
Art. XLVIII.—APPLICATION OF MANURE.

THE CROPS TO WHICH FARM-YARD MANURE CAN BE MOST BENEFICIALLY APPLIED, WITH THE BEST TIMES AND MODES OF APPLICATION.

[Darlington Farmers' Club.]

Mr. Walton, who introduced the subject, said, Farm-yard manure is very frequently applied to the fallow land for the benefit of the wheat, but not always successfully; and some have even gone so far as to say that it has done harm to the wheat crop. I have no doubt but that farm-yard manure is generally beneficial to the wheat crop; but one of the main questions is, how and when to apply it to the greatest advantage? In these times, when we have portable manures, generally miscalled by the name of artificial manures, which act not only as a stimulant, but which really continue to benefit the succeeding crops, we are set quite at liberty to apply the farm-yard and home-manufactured manure to the purpose for which it is best suited, provided that we know how we may apply it most beneficially. My impression is, that when disappointment arises from the results of its application, that it may not have been applied in the most judicious manner. I have known the wheat crop fail when
the manure has, as I fancy, been applied too late in the autumn, or just previous to the land receiving the seed furrow ploughing. By this mode, it appears to me that the manure does not get sufficiently mixed with the soil, so as to benefit the wheat crop to the extent it might have done. In such a case, it seems that the plants at first seize hold of, and luxuriate in, portions of the manure near the surface; but afterwards, when the roots strike down to a greater depth, and spread to a greater breadth in the soil, then the plants turn sickly on the roots coming in contact with the soil, which is not intermixed or impregnated with the manure, and at harvest it turns out a poor light crop. Now, I think it a better method to apply the manure to fallow land for wheat as early as possible, say in the spring; or early part of the summer; in order that it may get thoroughly mixed with soil, and by this means the crop will receive a regular supply from the manure all through its growth. By adopting this method, I do not know but that farm-yard manure may be as beneficially applied to the wheat crop as in any other way. In applying farm-yard manure to grass land, I conceive that it should be pretty well rotten; but I should rather apply the artificial or portable manures, which would more easily get access to the roots of the grass.

Mr. Pearson rather differed from Mr. W. as to the best time for applying farm-yard manure to the fallow land; for he thought that the land should not have more than two ploughings after the manure was applied, previous to sowing the wheat; but he was not quite sure that it was best to apply it to the fallow for the wheat crop in every case; for, in some instances, it might answer better to apply it to the clover lea, where it was to plough in for a crop of oats. On a clay land farm, he thought it bad policy to use the farm-yard manure for turnips, as he had found the superphosphate of lime answer quite as well, if not better, for this crop on such land, and thus the farm-yard manure was available for the other crops.

Mr. Phillips, Professor of Chemistry, said, that if the ammonia were fixed in the manure previous to applying, it would lessen the danger (either in an early or a late application of farm-yard manure to the fallow) of the ammonia escaping by evaporation (volatilization), or of being washed out by the rains; and, considering that it could be so easily and so cheaply done, it ought never to be neglected, 1 lb. of diluted vitriol, the cost of which was about one penny, being
sufficient to fix the ammonia in a cubic yard of dung. He also believed Mr. Pearson to be quite right in his remarks as to the superphosphate of lime answering well on clay soils for the turnip crop; for potash, which was so requisite a constituent to the growth of the turnip, was generally present in much greater abundance in the clay soils than in the better descriptions of turnip soils. But it must be borne in mind that, although the superphosphate of lime answers well as a manure for the turnip crop upon clay land, yet it will be requisite occasionally to apply, during the rotation of cropping, other descriptions of manure, otherwise the land would be impoverished, because the superphosphate of lime does not contain all the necessary ingredients to constitute the food of every kind of crop.

Mr. Dixon, the Secretary, having experienced, in a droughty season or two, ill effects from excessive evaporation, when manure was applied in the early part of summer, and exposed to the sun in working the land through the season, advocated the late application of manure to the fallows for wheat.

Mr. Pilkington, upon the whole, did so too; he adverted to the impropriety of applying manure in the early part of summer on fallows, before they were thoroughly cleared of root weeds.

*Agricultural Gazette*, August 29, 1846.

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**Art. XLIX.—Liquid Manure—Mode of Application.**

*By Mr. W. C. Jolly.*

The following account by Mr. W. C. Jolly, land-agent in Scotland, of the application of liquid manure, upon a farm in the neighbourhood of Glasgow, belonging to Mr. Harvey, is highly important; it has been in operation for two years. The liquid employed is the waste from the byres and stables, and from a distillery, collected and pumped up by the same process as I understand this company mean to use, over a stand-pipe, and carried out nearly 2 miles in a direct line through the fields, 3 to 4 miles of pipes altogether. Mr. Harvey keeps from 400 to 500 cows, and has a distillery on
the premises; it is all collected in a well; the steam-engine there is for the purposes of the distillery, which pumps this up over the stand-pipe. It also contains human manure to a very small extent. It is taken out in cast-iron pipes, 3 inches in diameter, through the fields, and there are cocks at different parts, and a hose is applied, which goes from any part, and is then distributed by tin pipes added on, so many of them about 6 feet 6 inches in length, and the others about 3 feet in length. There is no labour, but a single man or boy to watch it or distribute it over; they may do it by jet. He does not use a jet. Some of the land is in ridges, and some of his fields are flat; and it has a much better effect when the land is flat; on a ridge it is apt to run into the furrows. It is found to distribute it very equally over the land; and though it is run on at every 3 feet or 3½ feet, you would not know the difference of the crop, unless they miss a bit, and then it is marked. I should say that the distribution of manure in that way is by no means so offensive as by applications of common farm-yard manure. I saw the tanks full and empty, and particularly wished to examine whether there was any deposit; they have never required to be cleaned out, except at first. They put up an agitator to take it all, supposing the substance deposited to be the best of it; they found out by experience that it was by no means the richest part, and they have ceased to use the agitator, by which means the first tank it flows into requires occasionally cleaning out. He farms various qualities of land; and he has applied it to all sorts of crops, and with universally good results. On pasture-land it has had the most beautiful effect; the cattle seem to like the parts dressed with it; they graze it much more greedily; if a part is missed, the cattle will leave that. I should say that land that formerly he could not cut more than once, he will cut this year three times. It is common rye-grass. This year he has applied it to oats, after they were braided; most of the people thought it would have destroyed them; I went back afterwards, in five or six weeks, and the effects were wonderful; I should say double the amount of the crop upon the part dressed with it, compared to the part that was not; and so distinctly marked, that at half a mile distance you could see the parts missed; the field is cold clay land. I estimate the crop at double what it would have been without it. I could not say how many quarters, with any accuracy, at that stage of the crop. From the dressing...
he is in the habit of giving per acre, he has a much greater result than from any quantity of farm-yard manure I have seen applied. He has 300 acres, which is now nearly all in fine condition from that application; and I should think, from the supply, that he has equal to twice 300 acres; he has more than he requires, so much so that after this year he will not require any solid manure; he is selling it. He put up this apparatus two years ago, and he is so thoroughly convinced of the advantage of it, that he recommends it very strongly.

Agricultural Gazette, Oct. 10, 1846.

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ART. L.—LIQUID MANURE: MODE AND EXPENSE OF DELIVERING IT OVER THE LAND.

[From Evidence laid before the Select Committee on Metropolitan Sewage.]

BY MR. CHADWICK.

The following evidence laid before the Select Committee on Metropolitan Sewage, by Mr. Chadwick, is highly important in reference to the applicability of the plan of the Company:—

"In the summer of 1842, I was staying with a friend, Mr. Thomson, of Clitheroe, where Dr. Lyon Playfair was also staying. Mr. Thomson has extensive printworks, where he employs about 1000 persons, and from the works has much liquid manure. Mr. Henry Thomson pumped up the sewage-water from a well or shaft into a tank made at the top of a field, about 80 feet above the rest of the farm. He found that, under that 80-feet pressure, by means of the hose, with the labour of two men (one to remove the hose, and another to direct the nozzle), they could distribute about 2000 gallons of liquid manure in an hour. The important result was this, that it was to be accomplished by the labour of two men; and suppose we give 2½d. or 3d. an hour, that delivery of the 2000 gallons was accomplished for 6d." The expense of delivery of the same quantity by water-cart was, I think, about 5s.; the expense of loading and spreading stable-dung was about 11s. That was about the relative mechanical cost; 6d. for the delivery by the hose, 5s. by the
water-cart, 11s. or 12s. in the distribution of stable-manure: an equivalent quantity, and that close to the farm. Then, there was this great advantage in favour of the hose (though you cannot give an estimate in money-value as the relative amounts), that, in the distribution by the water-carts, there is the poaching of the land by the weight of the cart and horse, and probably the damage of which would be more than 5s. and of course still greater damage in the case of the cartage of the heavier produce of stable-manure. With the hose, the experiment appeared to be complete, with the addition of a very important fact, that you could, by the hose, get on the land at any time; but with the water-cart, or in spreading solid manure, of course, you are restricted by the state of the weather as to its application at certain periods. So far as they could try, I think these 2000 gallons of sewer-water were found equal to about 3 cwt. of guano, and about 15 tons of stable-manure. But there was another important point which was established beyond a doubt, which was, that the friction through the hose, for a considerable length, was much less than we anticipated; for instance, we used half a mile of hose, and carrying it on the surface, over furrows, and through a ditch, and over a hedge, I think at the end of 800 yards it gave out a jet something, as near as I could judge, of 40 feet (nearly half the height due to the pressure). These experiments appeared to establish the fact, that the hose, in many circumstances, for the delivery of a given quantity of water, even considering it as a means for the distribution of simple water, would have been cheaper than the water-meadow itself; and you have the advantage also with that, of being able to apply the liquid-manure to arable cultivation. With the water-meadow, you only apply it to grass-land. Putting the interest on the machinery and capital together, we could not put down the fair expense of this delivery by the hose at much more than 1s. an acre, that is for 2000 gallons."

_Agricultural Gazette, Oct. 10, 1846._
Art. LI.—ON THE RELATIVE VALUE OF MANURES.

By Mr. Karkeek.

[At the annual meeting of the Probus Club, various tabular statements were exhibited in the room, containing analyses of soils and manures, and the results of experiments instituted with different manures by various members of the club. The following paper, founded on these experiments, was read by Mr. Karkeek.]

He first suggested that when the produce of two unlike manures in the same experiment does not differ more than a ton or so per acre, their effect should be considered as equal. Among the many experiments entrusted to his revising, there were none that he could find so deserving of their attention as those made with bones and sulphuric acid. The first experiment to which he would direct their attention, with this new fertilizer, was made by J. H. Tremayne, Esq., of Heligan. Three acres of strong loamy clay-slate soil were appropriated for it. The seed was Skirving’s variety, sown in the latter part of May 1845, in drills of 27 inches apart. Each of the manures was mixed with 14 bushels of wood and coal ashes per acre, which was drilled in with the seed. The following statement shows the different manures applied, the cost per acre, and the produce per acre:—

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>24 bushels bone-dust</td>
<td>72s.</td>
<td>30½ tons</td>
</tr>
<tr>
<td>2.</td>
<td>8 bushels of bone-dust and 100 lb. of sulphuric acid</td>
<td>36</td>
<td>28</td>
</tr>
<tr>
<td>3.</td>
<td>20 cart-loads of good farm-yard manure</td>
<td>60</td>
<td>28</td>
</tr>
</tbody>
</table>

The Swedes grown by the vitriolized bones were the earliest in leaf, and fitted to hoe sooner than the other plants. Ultimately there was no great difference in the weight of bulbs; but the difference in the expense per acre was very considerable, the bone-dust and dung costing more than the amount stated, as the extra expenses of carting and spreading the dung were not taken into the account. Mr. Karkeek said, it should be observed that the crops in this experiment, compared with those afterwards mentioned, might appear large; but it should be remembered that the turnip crop of 1845 was one of the largest, and the one of 1846, perhaps, one of the smallest, since the general introduction of artificial manures into the county. The propor-
tion of bones and acid used per acre in Mr. Tremayne's experiment is unusually large; the quantity now recommended is 4 bushels of fine bone-dust, weighing about 180 lb. to 80 lb. of concentrated sulphuric acid, the common oil of vitriol of the shops not being sufficiently strong for the purpose. The following experiment was made on Treverbyn estate in Probus, by Mr. J. Kendall, on a barley arish (stubble), the soil of a light loamy character, resting on brown arenaceous slate, and valued at 25s. per acre.

<table>
<thead>
<tr>
<th>No.</th>
<th>Manure per acre</th>
<th>Cost.</th>
<th>Produce.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>12 bushels of bone-dust and 2 cwt. of sulphuric acid</td>
<td>60s.</td>
<td>20 tons.</td>
</tr>
<tr>
<td>2.</td>
<td>20 bushels of bone-dust and 1 cart-load of wood-ashes</td>
<td>68</td>
<td>18½</td>
</tr>
<tr>
<td>3.</td>
<td>Dry superphosphate</td>
<td>64</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>3 cart-loads of wood-ashes and 3 cart-loads of field-ashes</td>
<td>33</td>
<td>8</td>
</tr>
</tbody>
</table>

The object Mr. Kendall had in view in making the experiment was to test bones in three different ways at about the same expense. The superphosphate took the lead at the commencement, and continued it throughout. The rapidity of growth is seen in every experiment made with superphosphate, which is of essential importance; for the turnip is a plant which exposes a large surface of leaf to the atmosphere, and on this depends its power of obtaining organic matters from the atmosphere. The next experiment is a trial of Ichaboe guano against the dry superphosphate, by Mr. C. Parks, at Newlyn, on a wheaten arish, the soil of a deep loamy character, resting on arenaceous slate, and valued at 25s. per acre. The extent of land was 5 acres.

<table>
<thead>
<tr>
<th>No.</th>
<th>Manure per acre</th>
<th>Cost.</th>
<th>Produce.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>2½ cwt. of Ichaboe guano</td>
<td>22s. 6d.</td>
<td>13½ tons.</td>
</tr>
<tr>
<td>2.</td>
<td>2½ cwt. of superphosphate</td>
<td>22 6</td>
<td>16½</td>
</tr>
</tbody>
</table>

He had several experiments of this character before him, and in every instance the superphosphate proved to be a very cheap manure, and rapid in its fertilizing properties. J. S. Enys, Esq., of Enys, tried the superphosphate on a piece of sparry soil, resting on coarse argillaceous slate, near Carclew downs, valued at 10s. 6d. per acre. On 27 rows, measuring 29,403 square feet, manured with 2 cwt. of Ichaboe guano, the weight of turnips without tops was 8 tons per acre; whilst on 22 rows, measuring 24,948 square feet, manured with 2 cwt. of superphosphate, the weight of bulbs averaged
11 tons per acre. The Rev. T. Phillpotts, of Feock, instituted some very extensive experiments with different manures for turnips, and the result confirms the experiments previously mentioned, as he obtained as heavy a crop with 4 cwt. of superphosphate and \( \frac{1}{2} \) cwt. of Potter's artificial guano mixed, at an expense of 46s. per acre, as with 32 bushels of bone-dust, at a cost of 96s., or with 32 bushels of bone-dust and \( \frac{1}{2} \) cwt. of Potter's guano, at a cost of 102s., or with 28 loads of rich butchers' dung, at a cost of 168s. per acre. The next experiment was instituted at Trewithen, by Mr. Trelhewy, with four different kinds of manures for turnips, on an old ley pasture of a loamy character, resting on arenaceous slate, valued at 30s. per acre:—

<table>
<thead>
<tr>
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<th>Manure per acre</th>
<th>Cost.</th>
<th>Produce.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ichaboe guano</td>
<td>36s.</td>
<td>23( \frac{1}{2} ) tons.</td>
</tr>
<tr>
<td>2.</td>
<td>Liebig's patent manure</td>
<td>35</td>
<td>24</td>
</tr>
<tr>
<td>3.</td>
<td>Dry superphosphate</td>
<td>45</td>
<td>23( \frac{1}{2} )</td>
</tr>
<tr>
<td>4.</td>
<td>Bone-dust</td>
<td>72</td>
<td>20( \frac{1}{2} )</td>
</tr>
</tbody>
</table>

The most interesting part of this experiment is the effect of "Liebig's turnip manure," which produced the largest crop at the smallest expense. This manure pushed the turnip plant more rapidly forward than either of the others; but it will be seen that the same effect does not always attend its operations; for, in the very next experiment, made by the same party on Carnwinick estate, and in a different kind of soil, it had quite a contrary effect. This was on a plot of ground of six acres, purposely reclaimed from the wastes adjoining Trelyon common, by stubbing, beating, and burning; as is usually practised in cultivating the gorse wastes in this county. The soil is of a coarse character, resting on argillaceous slate:—

<table>
<thead>
<tr>
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<th>Cost.</th>
<th>Produce.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Liebig's turnip manure</td>
<td>35s.</td>
<td>12( \frac{1}{2} ) tons.</td>
</tr>
<tr>
<td>2.</td>
<td>Saldanha Bay guano, No. 1</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>3.</td>
<td>Superphosphate of lime</td>
<td>45</td>
<td>20( \frac{1}{2} )</td>
</tr>
<tr>
<td>4.</td>
<td>Bone-dust</td>
<td>72</td>
<td>26( \frac{3}{4} )</td>
</tr>
<tr>
<td>5.</td>
<td>Ichaboe guano</td>
<td>38</td>
<td>20( \frac{1}{2} )</td>
</tr>
<tr>
<td>6.</td>
<td>Saldanha Bay guano, No. 2</td>
<td>38</td>
<td>26( \frac{1}{2} )</td>
</tr>
</tbody>
</table>

In remarking upon this experiment, Mr. Karkeek said, the first thing that attracts the attention is the small produce from Liebig's manure, compared with its effect in the former experiment; for, in this case, it appeared to have acted the worst of the lot. He then proceeded to account for the
contrary action of the manure on the two soils, by stating
that the meadow at Trewithen, having been highly manured
for the last seven years with farm-yard dung; might be
considered as fairly rich in carbonized and nitrogenized
matter, besides a tolerable amount of alkaline phosphates
and silicates; but the Carnwincick soil could not afford much
of these matters; for, excepting the ashes left from the
burning of the furze root, &c., there was probably very little
else, saving the inorganic or mineral elements which the
soil itself afforded. He knew nothing of the composition of
Professor Liebig’s manure; he believed it to be entirely a
mineral one; but the next experiment would perhaps throw
some light on the subject of its failure at Carnwincick. This
was made on a very extensive scale by J. D. Gilbert, Esq.,
Trelissick, on a wheaten arish of 10 acres, lying on coarse
argillaceous slate, abounding in quartz (provincially spar-
stones), the soil of which was extremely poor, having been
very considerably injured by bad farming previous to its
coming into Mr. Gilbert’s possession. It was valued at 12s.
per acre; and in preparing the land for a turnip crop of
“Scotch yellows,” it was ploughed 7 inches deep, and the
seed and manure drilled in 27 inches apart.

<table>
<thead>
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<th>Cost</th>
<th>Produce</th>
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<tbody>
<tr>
<td>1.</td>
<td>Bone-dust</td>
<td>72s</td>
<td>10 tons</td>
</tr>
<tr>
<td>2.</td>
<td>Fish refuse 1 (one load of fish offal with 11 loads of earth)</td>
<td>—</td>
<td>11 1/4</td>
</tr>
<tr>
<td>3.</td>
<td>Farm-yard dung</td>
<td>100</td>
<td>10 1/4</td>
</tr>
<tr>
<td>4.</td>
<td>3 cwt. of Liebig’s patent manure</td>
<td>35</td>
<td>6</td>
</tr>
<tr>
<td>5.</td>
<td>3 cwt. ditto, with 200 lb. of Ichaboe guano</td>
<td>50</td>
<td>11 1/2</td>
</tr>
<tr>
<td>6.</td>
<td>400 lb. of Ichaboe guano</td>
<td>32</td>
<td>15</td>
</tr>
<tr>
<td>7.</td>
<td>21 bushels of bone-dust and 100 lb. of nitrate of soda</td>
<td>91</td>
<td>20 1/4</td>
</tr>
<tr>
<td>8.</td>
<td>21 bushels of bones and 100 lb. of nitrate of potash</td>
<td>98</td>
<td>20 1/4</td>
</tr>
</tbody>
</table>

The produce in each case, excepting the two last, was ex-
ceedingly light, but the experiment is an interesting one, as
testing the effect of eight different manures on a poor ex-
hausted soil. In this instance Liebig’s manure, compared
with the guano, No. 6, at about the same cost per acre,
yielded only two-fifths of the weight of turnips; and in the
trial No. 5, where 200 lb. of Ichaboe guano were added to
Liebig’s manure, the weight of turnips compared with No. 4,

1 The recent fish refuse, according to a note in the last edition of Sir
H. Davy’s work on Agricultural Chemistry, contains about four per cent.
of nitrogen, besides the phosphates.
was exactly doubled. The guano in this instance contained, according to analyses, 30 per cent. of phosphate of lime, with magnesia, oxalate of lime, and 25 per cent. of ammoniacal salts. From this he was led to believe that the inactivity of Liebig's manure on Carnwine, was owing to a deficiency of azotized matters in the soil, as well as the want of a sufficient quantity of phosphate, for when both were added in the guano used in Mr. Gilbert's experiment, the crop was equal to that produced by 25 loads of good farm-yard manure, and superior to that produced by 24 bushels of bone-dust. In Nos. 7 and 8, in the last-mentioned experiment, they had a striking proof of the utility of combining nitrogenized substances with the phosphates when absent in the soil, for the addition of 100 lb. of nitrate of soda in one case, and the same weight of nitrate of potash in another case, produced an increase over No. 1, when the bone-dust was used without these salts, of double the produce. Both these salts furnish nitrogen to the plant as well as an alkali, and hence their value in addition to the bone-manure, on a soil previously exhausted of these materials,—100 lb. of each furnishing about 19 lb. of nitrogen. The turnip crop can be cultivated, perhaps, with a smaller supply of nitrogenized substances than almost any other, particularly when compared with wheat, barley, beans, &c. Science now taught them that the atmosphere yields its portion to the growth of plants, as well as the soil. Hence the larger the vegetable surfaces they could present to the atmosphere in the shape of luxuriant stem and foliage, the more they should absorb from it; and this was partly effected by the organic matters in the soil, whether supplied in the shape of manure, or from accumulated vegetable and animal matter in a state of decay. Good farm-yard manure, in a recent state, not too much decayed, will afford the farmer an abundant supply, and unless these matters are supplied to the soil, the inorganic or mineral elements, such as the alkaline phosphates and silicates, will not be of much avail to the growth of the crop. Mr. Karkeek then adverted to the doctrine recently introduced by Professor Liebig, which under-estimated the influence of organic manures in the soil, and attached the more importance to the inorganic constituents of plants, by keeping a supply of which in the soil he is of opinion that the carbon and nitrogen, which are necessary for the growth of the plant, will be supplied through the atmosphere. This is a theory altogether op-
posed to the experiments which he (Mr. Karkeek) had placed before them that day, and it was also opposed to Liebig's previous teaching. They might rely upon it that the inorganic elements were of very little use in a soil as food for plants, without a corresponding supply of the organic. The reason that guano answered so well was, because it contained (like farm-yard dung) all the elements which plants require; and putting either into the earth restored those substances which the plants abstract from it, and which are necessary to their growth. For the turnip crop next season, he would recommend them to use a mixture of superphosphate of lime and guano, in preference to either of those manures singly, which he had every reason to believe would be found to be a useful and economical manure, not only for turnips, but for grain crops generally. Another advantage derived from the mixing of these manures was, that the superphosphate fixes the volatile parts of the guano, and prevents its dissipation into the atmosphere, which loss must otherwise ensue when so small a quantity as 2 cwt. or 3 cwt. is distributed over an acre of ground as a top-dressing for corn or grass, particularly in dry weather. Some of the guanos are more evaporable in the atmosphere at common temperatures than others. The South American is less volatile than that from Ichaboe and other African localities, which, under circumstances of exposure, should be either mixed with a substance that would lessen its volatility, or be quickly covered up in the soil.

_Agricultural Gazette, Jan. 23, 1847._
CHAPTER V.

ON CULTIVATION AND CROPS.

Art. LII.—PRINCIPLES OF FARMING.

By Mr. Hewitt Davis.

1. Never to be contented until all your land has been trenched and turned over by the plough a foot in depth, nor until—

2. The wet land be made dry by deep-draining, and consider no land effectually drained unless the drains be 4 feet in depth; that is to say, unless the water-level be so far below the surface, that corn shall have at least a foot of dry earth to root in, unaffected by capillary attraction of moisture from below, and the chill that water nearer to the surface causes; this can be done only by having the drains 4 feet from the surface, and within 40 feet of each other.

3. For sowing of spring corn, consider the season commences with the new year, and have no other fear than that of being too late. When the ground is dry enough, and fine enough, the sooner it is in the better; it will yield more, and the liability to blight, or to be beaten down, will be less.

4. In sowing, drill or dibble all; and have the rows not nigher than a foot between them; so as to admit of hoeing either by horse or hand, and hand-weeding at late periods.

5. Hoe and hand-weed all corn; let not a weed in flower
be seen amongst it; ever recollect that weeds occupy space and consume nutriment, displacing corn, and robbing the land.

6. Never sow two crops of one genus in succession; legumes or pulse may follow cereal grain, and cereal grain may follow legumes or pulse; but never cereal after cereal, or pulse after pulse. Recollect rye-grass is a cereal plant, and unseats the land for white-straw corn.

7. In apportioning the rate of seed per acre, do not lose sight of the bad consequences that must ensue if too much be sown. Bear in mind, that if so much be sown as to produce more plants at first than the space will afterwards allow to attain maturity, the latter growth of the whole will be impeded, and a diseased stage will commence, as soon as the plants cover the ground, and remain till harvest.

8. Manure should be applied only to green or cattle crops, and never to corn; by giving it to the former, the earth derives the advantage of the extra dressing that the extra growth returns; but when applied to corn, the earth is so much the more exhausted by the extra growth of straw, and frequently, too, the grain is thereby positively injured by being beat down and blighted in the straw, that it always is made more hazardous by dressing.

9. Were farmers to buy all their manures, they would find that the cost of maintaining their land in fair heart would be about 1l. per acre per annum. This quantity of dressing, every farm, in fair productive cultivation, would supply of itself, if a proper use and economy be made of its material to form manure, and a due care taken of it afterwards; but from misapplication and waste of the straw and fodder, and from negligence in the preservation of the dung and urine, at least half is usually lost, and the arable land of England may thus be said to be prejudiced at least 10s. per acre.

10. Were no other injury done to the crops by trees and hedges in small enclosures, than that which arises from their mischievous shade and shelter, it would be equivalent to the ordinary rent of such fields; but the farmers sustain a further loss in the additional time occupied in its tillage, by the more frequent stoppages and turns they cause, and by the encouragement to idleness in the men that their cover affords. I believe arable fields with large hedges and hedge-row tim-
ber round them, whose dimensions are under eight acres, are seldom or ever worth a farmer's cultivation. I see much poor open down land in profitable cultivation, and large districts of enclosed land of far better quality, ruinous to the occupiers; and I have not a doubt that to the difference in the size of the fields this may be principally, if not entirely, traced.

_Agricultural Gazette_, Sept. 12, 1846.

**Art LIII.—ON HIS OWN SYSTEM OF FARMING.**

**By the Rev. A. Huxtable.**

[Sturminster Agricultural Society.]

The following statement of the year's experience was made, at the late annual meeting of this society, by the Rev. A. Huxtable, who, after some preliminary remarks, said:—As so many farmers, nearly three hundred, have visited my farms during the last year, it will not be considered egotistic if I presume to lay before you the principle upon which these farms are carried on. I will begin with the arrangement I have made for my cattle by placing them on boards. These are now, after many experiments, fashioned thus: A space of 4 feet in width is allowed to each beast; the boards are grooved behind to prevent their slipping, and a fall of half an inch secures the rapid flowing away of the liquid, whilst a boy with a scraper constantly takes away the solid manure; the beasts thus kept are generally cleaner than those on straw. The benefits are: 1. That I am no longer limited in the quantity of stock I keep by the amount of straw grown—I want every lock of straw for nobler purposes; in summer to lay between the layers of green hay, vetches, clover, &c., when salted, in which state I employ it to cut into chaff with alternate layers of turnip-tops. Now, with respect to these, I assert that they are worth more for the production of milk, when given in due moderation, than the same weight of turnips. The objection to their use, in the case of dairy cows, is the offensive taste which these, far more so than the turnips themselves, communicate to the milk. Saltpetre will
not remove this; but it can be effectually removed by the use
of chloride of lime. You can get this from druggists, whole-
sale, at 4d. or 5d. per lb. Dissolve half an ounce in 1 gallon of
water, add a tea-spoonful of this to every gallon of milk
(unless the taste be strong, half a tea-spoonful will be suf-
cient), churn at least twice a week, and this application, I
will undertake to assert, will remove instantaneously all bad
taste from the milk, and therefore from the butter, care of
course being taken that the churn and all the dairy utensils
are previously well sweetened. You need not fear the use of
the chloride; in such quantities it is perfectly wholesome;
and the only evil of adding too much is, that you will give a
worse flavour than that which you seek to remove. The
second benefit produced is, that, by keeping cattle on boards,
the manure is fit, if required, for immediate use. That
which is dropped in one day, by the use of ashes, may,
if required, be drilled the next. It was in this fashion that
40 acres of stubble turnips have been grown by me this year.
Look at this root, it weighs 2 lb. its green weighed precisely
the same. If the whole field had been like this, the crop
would have been 32 tons per acre; for the turnips were
drilled only 14 inches apart, and singled out at 9 inches dis-
tance. They were not sown until the last week in August,
after one ploughing, crushing, and harrowing; And why
did not the whole field give roots like these? There are
only a few of the drills containing turnips so large; and
these are found, where, through the unevenness of the ground
a double quantity of manure was uttered by the drill. In-
structive difference! If I had but shown more faith in
mother earth, and intrusted her with 2 cwt. of guano in
addition to my home-made manure, then I could have invited
you to come and admire 30 tons of wheat-stubble turnips
per acre. Oh, if we had but capital enough, and trust
enough in the soil, with God's blessing, what a different face
our fields would wear.

I will now refer to my sheep feeding on boards. I con-
sider this method to be now perfect; in French phrase un
fait accompli. Mine have done this year admirably. I will
state the result of two weighings of a lot of six of those
sheep, which were selected as fair representatives of the flock
in the house; they were weighed at a distance of three weeks,
under precisely the same circumstances:—
which gives a gain per week of weight to each sheep on the average of somewhat more than $3\frac{3}{4}$ lb. When they were first "put up," they ate not less than 20 lb. of Swedes a day each; but latterly they have not consumed more than 15 lb. of roots, one-half being Swedes, the other half Dale's hybrids—the 160 sheep ate daily 1 bushel of linseed, which weighed 63 lb., and 1 bushel of beans, which gives 5 lb. of seed and beans per sheep each day on the average. If we assume the value of turnips to be 15s. the ton, the value of

\[
\begin{align*}
105 \text{ lb.} & \quad \text{8} \frac{1}{4} \text{d.} \\
5 \text{ lb. of beans and linseed} & \quad 7 \\
\text{Attendance per sheep} & \quad 1
\end{align*}
\]

\[
\text{Or 1s. 4} \frac{1}{4} \text{d.} \]

1 In reference to the above computation, Mr. Huxtable admits the correctness of the explanation given by the editor of the *Agricultural Gazette* in reply to a correspondent of that journal. It is this—that Mr. Huxtable named 1s. 4\frac{1}{4}d. as the price per sheep, for which he was able and willing to dispose of his weekly increase of mutton; finding this to repay him for linseed and attendance, and leaving 8\frac{1}{4}d. for the turnips consumed, a sum equal to the 15s. per ton objected to as unnecessarily high by the correspondent alluded to, as no doubt it is, if understood to mean the cost of obtaining them, instead of their (possible) value when obtained. Mr. Huxtable himself, in farther explanation, writes thus: "The object of that part of my statement was to show the high value of the turnips and green crop when consumed by sheep properly sheltered. They who heard me would not think that 15s. a ton was too great a price to be given for Swedes, if eaten by a well bred ox comfortably housed, though they are not worth half that sum to be fed off by a flock in rain, fog, sleet, snow, and puddle, 700 feet above the sea. The figures which I then gave, if correct, showed that the turnips to my sheep were worth more than 15s. a ton, and therefore that my 'dear' green crops were worth more than 10l. per acre. The estimates which I made of all my expenses were intentionally placed to their extreme limit, but this year the cost of the seed will be 1l. per acre. Your correspondent has omitted after the wheat crop the three bushels of vetches, or of rye, and I never sow less than 6 lb. or 7 lb. of turnip seed, and carrot seed is to-day given at 4s. a pound. My pea seed will alone cost 1l. an acre, and the land must bear turnips or mangold wurzel beside. 'S. X.' inquires, through the widely circulated *Agricultural Gazette*, after my pig secret. This is hardly fair to my Sturminster friends, who have not yet 'given up' the puzzle; still, as your corre-
to $3\frac{3}{4}$ lb. of meat. I need not say that this is "doing well;" but still I am obliged to remark that the vast difference between the several sheep in respect to the increase in weight, teaches us that these calculations ought to be made on a large flock, where we may hope that the various differences will correct each other, and produce a just estimate of what we may hope to effect in the average of 100 sheep. But you must not fail to remark, that a system of management which secures a value to a ton of Swedes of 15s., consumed on the farm, gives a large return. I must next tell you that I have also put my fatten fatting pigs upon boards. I almost fear to announce this, lest some wag should call me a man of wood, but you will at least acknowledge this to be better than to be "a man of straw." I rejoice to tell you that these also have done well on these "board wages"—so well, indeed, that I hesitate a good deal to tell you how well. You will not believe the machine or the weigher. I do, because it was accurately attended to. Three pigs, two hours after feeding, at 3 P.M., were weighed November 23d, and at the same hour, under the same condition, on November 30th. I will give you the weight in pounds.

<table>
<thead>
<tr>
<th>No.</th>
<th>1st weighing</th>
<th>2nd weighing</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>135</td>
<td>150</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>126</td>
<td>140</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>109</td>
<td>128</td>
<td>19</td>
</tr>
</tbody>
</table>

No one will believe this last weighing. (A farmer exclaimed, "I would not if the man swore to it!") Nineteen pounds in one week! I credit this, but I cannot expect you to do so, unless I tell you how this was effected. Gentlemen, last year at the Blandford dinner, when in full reliance on the certainty of chemical principles, I asserted that I verily believed I could grow a Swede turnip on the dinner table; on that occasion Mr. Rickman, whom I now see present, with great openness declared that I was trying to humbug the farmers. Now, I took this much to heart, and determined secretly, for fear of accidents, to put my principle to the test. But you will observe that nothing can be done in secret at my farm. A chemist in his laboratory can essay 100 experiments, and if he fail feel no blush or shame; but my farms are so overrun, and every wash-tub peeped into, that it is impossible to find a calm retreat for any hazardous trial. In spondent dates from that rural retreat, Paris, I will in strict confidence inform him that I learned the principles on which my practice is founded from 'Boussingault, Économie Rurale,' tome ii. chapitre viii. § 3.
this instance, I cut holes, as you see here (showing the block of wood), about 3 inches square, and 1\(\frac{1}{2}\) inch deep; I filled these with decaying sawdust, to keep up a supply of moisture, and the ashes of burnt Swedes; and on the top sowed some seed of the Swede turnip. For concealment I placed the plank under a hedge, which kept off the sun in fine weather and gave it lots of drip in wet; still they grew, and here are two of them (he here displayed and sent round the room a portion of the plank and one of the Swedes) about 2 lb. weight. I am certainly rather ashamed of him; but consider the hard circumstances of his birth and education. Yet surely, here, in this humble experiment, so strikingly confirmatory of the large one on Sutton Beach, which I described in this room last year, a great principle is involved; does it not tell us that no land can be so sterile, no rock so barren, no acclivity so steep, but the strong sinews of our noble labourers, when directed by science and adequate capital, will render them productive and capable of sustaining human life? I rejoice in the desert spots of our country—they may be hopeless to the plough; but the pickaxe and the spade, these can till them, and they will afford employment and sustentation to millions yet unborn. Let only the labourer be well paid, and housed, and fed, and with God's blessing I fear nothing for our country. Those barren hills, I repeat, I love them—they were intended, I believe, as sharpeners of the human intellect—*Labor omnia vincit improbus*. Whence have come all our modern improvements in agriculture? not from the rich pastures of the lazy Stour, but from stubborn, hopeless lands, where men were forced to think and contrive that they might live. Gentlemen, in these days our fields must do double duty. I will now describe to you how I have tried to get this out of them, both on my chalk and clay farms, in what used to be called the fallow year. On the chalk farm I essayed to grow peas, between the drills of mangel wurzel and of Swedes, and I did so with great success. I will only give the particulars of the beach experiment.

<table>
<thead>
<tr>
<th>Per acre.</th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoeing out drills, 2 feet apart, for the peas, and drilling them by hand</td>
<td>.</td>
<td>.</td>
<td>0 10 0</td>
</tr>
<tr>
<td>Peas, 2(\frac{1}{2}) bushels</td>
<td>.</td>
<td>.</td>
<td>0 18 0</td>
</tr>
<tr>
<td>Harvesting them, by cutting off the haulm with the hoe</td>
<td>.</td>
<td>.</td>
<td>0 5 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1 13 0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Four sacks of white peas at 32s.</td>
<td>.</td>
<td>.</td>
<td>6 8 0</td>
</tr>
<tr>
<td>Gain by this stolen crop</td>
<td>.</td>
<td>.</td>
<td>4 16 0</td>
</tr>
</tbody>
</table>
And to show that those peas did not injure the mangel-wurzel, I may add that I have stored 18 tons of roots per acre. It is important to bear in mind that the pea which I sowed is remarkably short in the haulm, not exceeding 9 inches, and also ripens early. If there was much haulm, it is plain that the pea would interfere with, or be injured by, the interstitial crop. On my clay farm, I tried another form of double culture—beans and mangel-wurzel; the plan pursued here was to bunch them, i. e., four holes within a square of 4 inches were made with a dibbling-stick, and four beans inserted; these little squares were three feet apart every way, but so that the squares in each alternate drill were exactly in the centre of the space between two squares of the contiguous drill. This arrangement secured room for the hoe, the sun, and the wind.

The cost of these operations stands thus:—

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>2½ pecks of beans for seed</td>
<td></td>
<td></td>
<td>0 3 5</td>
</tr>
<tr>
<td>Labour for dibbling the beans</td>
<td></td>
<td></td>
<td>0 5 0</td>
</tr>
<tr>
<td>Harvesting them</td>
<td></td>
<td></td>
<td>0 6 0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>£0 14 5</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Produce, four sacks, which ought to have been six sacks but for some farmer’s friends in the shape of field-mice, which ate the beans as they were coming up. You will observe that I do not charge rent, &c. against this, but against the principal crop which occupies the ground. The mangel-wurzel, in this instance, was very fine, not less than 20 tons per acre, testifying to the harmlessness of the intercalated beans. The mangel-wurzel seed and manure were also dibbled. I must also beg your attention to these two specimens of carrot, the one grown on my chalk farm, the other grown on clay. They are, as you see, very fine; they are not fair samples, but picked specimens; yet they belong to a very good crop, the chalk carrots attaining 15 tons, the clay carrots 27 tons per acre. I need not tell you that this is a valuable produce. From this case, then, we may learn, that both your chalk and your clay soils (if well drained) will, with proper culture, yield abundantly this valuable esculent.

In conclusion, I must refer to the oft-repeated question,—
What are your profits? Now, I have always been able to give the cost and profit on any given crop; but, from peculiar circumstances, I have a great difficulty in dis-
entangling all the expenses of my farm. Please to remember
that I have the kindest landlord in the world, who says,
"You may put up what buildings you like, lay down what
drains you please, grub up what fences, cut down any inter-
fering timbers." Now, I have made pretty free use of this
license, as you may see; but, as the greatest proportion of
my drains, and most of my buildings, &c., are done by my
own constant labourers, I avow a great difficulty in arranging
these separate items, classifying them respectively under
"permanent improvements," on which only per-cent age
should be charged, and the proper outgoings of a tenant.
For one portion of a labourer's day is, with me, given to
loading a cart; the other half, perhaps, in making a tank,
or putting up a cow-shed. Still, I protest against the
notion, that a yearly tenant-farmer could, with prudence,
make such an outlay as I have made without the security of
a lease, or of some legal agreement. And yet, without the
improvements which this outlay implies—without these
buildings, tanks, drains, &c., it is quite impossible that
many of the returns which I make can be effected. He
may, in many cases, grow the roots; but, without sheds and
shelter, in such a climate as this, how will he make his roots
worth even 15s. a ton? The most startling part in the
statement which I am about to make, is the high estimate
which I set upon my green crops. I said, in the commence-
ment, that I did not think our climate favourable for the growth
of wheat; and that, therefore, for that crop I think we need
a moderate amount of protection; but in the matter of roots
we may defy the world. There are many varieties of rota-
tion for the green crop year. On my wheat stubble of the
end of August, I may, as you have seen, raise a splendid
crop of stubble turnips, and then in the spring I can grow
carrots or wurzel with beans, or peas and Swedes; or I may
sow early in September winter vetches, cut them in the
middle of May, when in flower, and make them into green
hay; and then secure, at least, 16 tons of Swedes per acre;
or, if clover was sown with the wheat, and the clover is well
dunged in the winter, you can cut it twice, and then get an
excellent crop of turnips. This I did, even in the drought
of this season, on my hill farm; or, instead of stubble
turnips, you may drill on the stubble rape, and, if well
manured, it will yield immensely at the end of April, when,
of course, you can get a full crop of Swedes. I take, then,
as the basis of my calculation, that the Swede, or mangel-
wurze root, is worth 15s. per ton, at the least, to be consumed by sheep, or cows, or pigs, on the farm; and that, therefore, my root crop, including the intercalated one, is worth 15l. an acre. I assume that the wheat crop yielded 32 bushels an acre, which, at 61s. the bushel, will give 9l. 12s. an acre; taking the difference, the average annual produce of an acre of highly farmed ground I calculate, from my own returns, to be at the lowest 12l. 6s.

And now I come to the expenses; and the principal charge, which will seem exaggerated, is 37. an acre for manual labour. This is the item which gives me most satisfaction. Let us ever bear in mind that no money spent on our farms is so productive as that which goes in well-directed, well-paid labour. I believe God's blessing goes with it. But to return to the average expenses of an acre of land on a farm of 200 acres:

<table>
<thead>
<tr>
<th>Item</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rent</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tithes, 5s.; rates and taxes, 5s.</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Labour</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Horses</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tradesmen's bills</td>
<td>0</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Seed</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Manure</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Interest on 15l. per acre, at 10 per cent.</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>£9</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

But the return is £12 6 0

Estimated profit per acre £3 0 6

Gentlemen, from experience I know three crops can be raised at the expense now given; and, in thanking you for the kind attention you have given to my lengthened statement, I commend to you the 3l. per acre profit, and I wish in the coming year you all may get it.

_Agricultural Gazette, Jan. 10, 1847._
I do not think, gentlemen, that the farmers of this country apply sufficient capital to the land, that is to say, I think they take too much land in proportion to their capital. The consequence is, the best use is not made of that capital. I do not believe that any man can farm to the utmost extent of profit in these days, without purchasing artificial manures—guano, for instance, for his distant fields, thus avoiding cartage; and a larger quantity for his near fields with deep cultivation, and better agricultural implements. Mr. Hutley, a great authority in our county, who farms 2000 acres in a most profitable manner, said at our Witham meeting, that he considered guano paid itself in the straw alone besides the crop, and that he has now 100 acres of wheat dressed with 2 cwt. per acre of guano. ("He sells his straw.") No, he does not. And I can tell you further, he never feeds off a piece of clover, or a piece of fine rye-grass or tares, without giving his sheep one pound of oil-cake per day. It appears to be a great expense. But what is the result? Enormous crops both of roots and of wheat. And his system is profitable, because every two or three years he hires an additional farm. Gentlemen, the question of deep cultivation is so important that I must not leave it. I know that the majority of agriculturists consider that subsoiling is not a profitable thing, or a proper thing. Now that is one of the greatest mistakes that ever was made in agriculture. If you find a farmer ploughing his ground 5 inches or 6 inches, you will find him digging his garden to 15 inches or 20 inches depth. If you ask him why, he says, "I can grow better crops in my garden by deep cultivation." How inconsistent then! If the one operation be right, the other is wrong. Besides, if increased depth of cultivation be injurious, you must carry out the principle and say that 2 inches are better than 3 inches, and that 1 inch is better than 2 inches; and thus you must go backward, and in course of time there would be no cultivation at all. I say you must carry out the principle of deep cultivation. What is there magical in the favourite depth of 6 inches, except in the
power of a pair of horses to draw the plough and do an acre a day? Will any man say, if his horses can take 18 inches with a pair, he would not do it? I have a proof on my farm at present which will astound you as showing the effects of deep cultivation, and it may assist you in coming to a proper conclusion on the subject. I ploughed one part of a field of mustard with Smith’s subsoil-plough, 15 inches below the other, which went 9, that is, 24 inches deep altogether. The other part of the field was ploughed in the usual manner. Both were done on the same day, and both were treated in the same way as to manure. My bailiff prognosticated that I had ruined one side of the field, and that we should grow nothing—that was the part of the field subsoiled; my man remarking that “diving down into that nasty subsoil would be the ruin of the crop.” Now I had occasion to come into Suffolk. On my return, I asked my bailiff, “Well, how goes on the mustard?” He said, “Oh, I am done now!” “Done now!” said I, “what is the matter? does subsoiling answer?” “Oh,” said he, “I am wholly done!” I said, “I am glad of it, and I hope that many farmers who come to see the crop will be ‘done’ too, and alter their minds.” Many farmers have seen the result with their own eyes. In the one case the crop was 4 feet in height, and as thick as it could be; in the other case the height the crop attained was but 18 inches. The Secretary of the Debenham Farmers’ Club, Mr. Green, has seen the crop, and he therefore is a witness to the difference. Whether I shall see the same difference in the wheat crop to follow, I don’t know. I have subsoiled in other cases, and I have uniformly found it answer the desired purpose of increasing the crops. But, gentlemen, woe betide the unfortunate wight who does this without deep drainage! If he subsoil without drainage, he will make his land like the bottom of a pond, and ruin his crop. That is a distinction which should be particularly attended to, because many farmers have condemned subsoiling when they ought to have condemned themselves for not having previously drained the land.

Agricultural Gazette.
ART. LV.—IMPROVEMENTS IN CLAY-LANDS.—DRAINING.

By Mr. Dodds.

[At a late meeting of the Dorking club, Mr. Dodds read an excellent essay upon the improvements of clay-lands, in which he pointed out the advantages of draining, increasing the size of the fields, and the removal of hedge-rows, and a necessary alteration of the rotation of cropping. The following are extracts:—]

While draining is going on, another evil is to be remedied; and the operations required for its removal must go on simultaneously with the draining. It is well known that many farms, extending to quite as great a number of acres as the one I am endeavouring to improve, have their fields averaging not more than five acres each. I would demolish as many of these hedge-rows the first year as would make enclosures of about 13 acres. The surplus soil I would lay aside in some convenient spot, to be mixed with lime, as soon as the other labours of the farm permitted. This compost I would apply as a dressing for the said field in the course of being improved; taking care to have it properly prepared by frequent turning previous to application. There are two objects in demolishing these hedge-rows; to increase the size of the fields, and decrease the harbour for the farmer’s enemies. First, a saving of labour is effected, and second, a greater crop is secured. As regards draining, when the subsoil is stiff and retentive of water, the drains ought not to be placed further apart than 15 feet. In sub-soils less argillaceous, the drains may be put in with effect at twice that distance. But now that tiles may be got at such a moderate cost, when compared with what they were a few years ago, it seems advisable that, on stiff clay lands, drains should never be further apart than 15 feet. There are various opinions in regard to the direction in which drains ought to be placed. In practice, it will be found—and I believe all those who have furrow-drained extensively will bear me out in the argument—that running the trenches right in the line of descent is the most effective method. It is not my object here to go fully into the merits or demerits of any particular system of draining. I shall suppose that the whole field, consisting, as before stated, of 13 acres, has now undergone a thorough clearing, as well as a complete
draining; and that a considerable portion of the winter has elapsed before the work has been finished. Having gone so far, it is now the object of the farmer to prepare for cropping this improved land; and with due deference to those of greater experience, I would suggest that it ought to undergo a summer fallow for a crop of wheat, and be dressed with a proper supply of farm-yard manure. It may be proper to remark, that the whole breadth of the break ought to be subsoil-ploughed, which is the next step after draining. This ought to be done to the depth of 12 inches, and the following is the method which I would suggest:—A furrow is, in the usual way, and with a common plough, to be turned up to the depth of C inches; close behind this plough is to follow one of Read's subsoil-ploughs, or pulverizers, and stir up the soil beneath to a farther depth of 6 inches; thus loosening up the "old floor," which has for centuries formed the pathway of the plough team, and giving free access to the air and heat to pass down and ameliorate the soil below. In ploughing, two horses abreast are generally sufficient; and one man ought to manage them. In some cases, three may be required, but they should always be yoked abreast; as in this way they pull more equally, and are as powerful as four in a line. It is of consequence that the wheat should be got in moderately early; say as soon in October as the weather will permit. The field is supposed to be well cleaned, and if so, in spring I would sow grass-seeds; thus having it the third year in grass for cutting. I would then take a crop of oats, after which, beans and turnips, and finish with wheat or barley, thus adopting a six years' rotation, viz.:

1st year—Summer-fallow, manured.
2nd ,,—Wheat, with seeds.
3rd ,,—Grass, for cutting.
4th ,,—Oats.
5th ,,—Turnips and beans, manured.
6th ,,—Barley or wheat.

It will generally be requisite to sow barley after turnips, as they are not often lifted in time for winter wheat. If barley be objected to, wheat can be sown in spring, which often produces a good and bulky crop, although rather later than that sown in October. After the beans, however, wheat may be invariably sown in autumn. This is carrying through
the system to be followed with the first improved portion of the farm; but each year a similar quantity is to undergo the same process, and to be cropped similarly, until the whole farm has been subjected to a complete overturn. The fencing of the fields is the next operation to be considered. The most suitable fences for a farm, consisting wholly of clay, are, in my opinion, those composed of thorn or furze. The furze is superior to the thorn, inasmuch as it forms a sufficient fence in a much shorter time, and, if kept down and properly trimmed, very soon grows into a useful and ornamental fence. It is formed thus:—a narrow ditch is to be cast round the field, and the soil taken from it to be formed into a mound by the side of it. On the top of this mound, and while the earth is yet fresh and moist, the seed is to be sown and carefully covered up. A pound of seed is sufficient to sow 200 yards, and the best season for sowing it is in April. This sort of fence is often objected to, on account of want of durability; but, if kept regularly pruned once a year, in June, it will last for many years. In Wigtonshire, the furze-hedge is very much adopted, and there they are to be seen 6 feet high; and being kept as before noticed, they form an ornamental fence, as well as a shelter to the fields adjoining. Having thus endeavoured to point out the system upon which clay land is to be improved, I shall now proceed to the second head of my subject, namely, "How this system is to be most effectually secured." It is obvious that upon the relationship which exists between landlord and tenant depends, very materially, the march of improvement in agriculture, as a branch of public industry. A certain amount of capital is essential to the successful cultivation and improvement of the land. But the owner of this capital must first be satisfied that he can employ it with advantage, before he will be induced to lay it out. The uncertain tenure, then, by which a great proportion of the land throughout England is held, serves as an insuperable barrier to the investment of capital in the cultivation thereof. It thus appears that a farmer, in expending money in improving the land he uses, must have some security for a return adequate to the capital he has sunk. This security is only to be found in a written covenant, subsisting a definite and adequate period. It will be seen, then, from the foregoing remarks, that, to form a proper relationship between landlord and tenant, "the lease" must be substituted for
§33 "the valuation." In attempting to show the system of improving clay land, the tenant has been supposed to be at the whole expense, and that the improvements have been carried on under his superintendence. But as the grubbing, draining, and fencing, are all permanent improvements to the estate, they ought, therefore, to belong to the landlord; and it is at his expense, and under the directions of his steward, that these operations will be most satisfactorily carried on. The tenant may fairly be required to pay at least one per cent. more than the common rate of interest on sums expended on the improvement of his farms; and it is believed he will find it to his advantage to agree to such terms. The sum required for executing the improvements contemplated is 100l. The rate of interest to be charged on such outlay is 5l. per cent. per annum, and it now only remains to show how the tenant is enabled to pay this interest. The land formerly produced four sacks or two quarters of wheat per acre. An increase of one quarter may be reasonably expected, and this quantity (three quarters), at 52s. per quarter, is 7l. 16s. per acre, or 10l. 8s. for the whole 13 acres. The same price is put upon the wheat, although it is likely to command a higher figure. The rent of the land before, was 7s. per acre, or 4l. 11s. for 13 acres. It is now, with interest on outlay added, something more than 14s. 8d. per acre, or 9l. 11s. for 13 acres. The cost of the fallow before, was 60s. per acre, or 39l. for 13 acres; and the cost of the seed, sowing, weeding, harvesting, &c., amounted to the further sum of 32l. 10s. The expense of the fallow is now likely to be lessened, but I shall make no change upon this, and there comes out a most cheering and gratifying result. The produce of the land, then, now is 3 quarters per acre, or 39 quarters in all, which, at 52s. per quarter, is—

<table>
<thead>
<tr>
<th></th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Rent</td>
<td>9</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>2. Cost of fallow</td>
<td>39</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3. Cost of seed, sowing, &amp;c.</td>
<td>32</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>In all</td>
<td>81</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

Which, deducted from the supposed price of produce, leaves a total return to the tenant of £20 7 0

Thus it is clear that, with a small outlay on the part of the landlord, he receives a fair rate of interest for the
money expended, very considerably enhances the value of his property, and improves the condition of the occupier of his land.

Agricultural Gazette, Jan. 2, 1847.

Art. LVI.—ON MEASURE-WORK.

Prize Essay by Mr. Hugh Raynbird.

[Of the system of measure-work, it is observed by the author of this essay, that it may be adopted with advantage to the farmer, in almost every kind of agricultural labour, with the exception of that in which horses or other cattle are particularly engaged: other exceptions are jobs of short duration, and the tending of sheep and cattle.

To the labourer also the system of measure-work, or, to use its less pleasing name, task-work, presents many advantages. Some of these are noticed by Mr. Raynbird. We shall, however, at once pass on to that part of the essay in which he describes the mode in which the system may be carried out, and the different farming operations to which it is applicable.]

In most kinds of task-labour I would not advise the employment of many labourers in one company; though in hay and corn harvest, sowing turnips on the drill-system, dibbling wheat, and in some other cases, a combination of force is necessary. The objection to great numbers being together is, that there may be some men of loose habits, who will induce the others to spend a portion of their earnings in drink; when this is carried to any extent, the work is in general done badly. As an instance of the bad effects produced on the moral conduct of the labourers themselves by the promiscuous employment of great numbers of both sexes, we may mention the gang system practised in parts of Norfolk and Suffolk, and which is a great cause of vice and demoralization among the class of people who are obliged to work in them. In this practice a man called the ganger or undertaker agrees with the farmer for certain work, generally hoeing wheat and turnips, harvesting and storing away root-crops, dibbling wheat, or any light work in which women and children are employed. The undertaker having made a bargain with the farmer, gets together an assemblage of labourers of all descriptions and characters from the neighbouring towns and villages; these have often to
walk some distance to their work, and are then exposed to all the corrupting influence of bad companions; their wages are uncertain, for as soon as the weather becomes unfavourable, or the job is ended, they are thrown out of employ. To take the place of the gang I would either have a steady man, paid a shilling or two a week extra, to superintend the children, or put out work in which they are required, to men with large families, who would then have an opportunity of overlooking the behaviour of their own children.

The measurement of task-work may be most exactly taken by the chain for land and the length of drains and ditches, and the tape for taking the cubic contents of heaps of soil and manure, the dimensions of clay-pits, and the square contents of thatching. I need hardly remind the farmer of the assistance he may obtain from the agricultural table-books, which will be found very useful, and may be had at a price within the reach of every one.

The rates of payment for task-work given by me are those paid during the last ten years; the day-wages have been successively 8s., 9s., and 10s. a week; the present wages for a common day-labourer are 10s. for summer and winter; during harvest upwards of 1l. a week is earned; and in haymaking-time beer is given in addition to the common price of a day's work. A woman working from eight in the morning to six in the evening has 8d. or 10d. a day.

The usual hours of day-labour with us are in summer from six in the morning to six in the evening; in winter as long as it is light; out of this the labourer is allowed 1½ hour for breakfast and dinner. Men employed with horses work from six in the morning to half-past two in the afternoon, including a short time for breakfast: during harvest, from five in the morning to seven in the evening, or as long as the farmer pleases; out of this they rest about two hours.

The quantities of the various kinds of work which I shall state as performed in a given time, are taken from task-work actually done by labourers in our employ, and may therefore be considered an average; though, from many

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1 I find it a much better plan for horses and men, to bait the horses for an hour, excepting in the shortest days of winter; and in summer to let them lie by for two hours, or even for three, during such heat as we have lately experienced.—Ph. Pusey.

To this I agree after experience.—Portman.
causes, it is impossible for one quantity, or one price, to be taken in every case or situation.

The standard measures are always used; for, by adopting these, I am more likely to make myself understood by the greater part of my readers than if I had used any of those obsolete local measures, which I am sorry to see in use in certain parts of the country; they are the cause of many mistakes which might be remedied by adopting the standard weights and measures.

In detailing the various operations to which a system of measurement is applicable, I shall divide my subject into separate heads, to each of which a distinct mode of measurement is suited.

1st. The kind of task-work to which land or square measure is applicable, the work being paid for by the acre, rod, or square yard.

2nd. The kind of task-work to which lineal measure is applicable, the work being paid for by the chain, rod, or yard in length.

3rd. The kind of task-work to which solid or cubic measure is applicable, the work being paid for by the cubic yard or load.

4th. The kind of task-work to which corn-measure is applicable, the work being paid for by the quarter, sack, or bushel.

5th. Task-work performed by various kinds of measurement.

I.—Task-work to which land or square measure is applicable.

<table>
<thead>
<tr>
<th>Table of Land Measure.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 square feet .......... 1 square yard.</td>
</tr>
<tr>
<td>30(\frac{1}{2}) square yards 1 square rod.</td>
</tr>
<tr>
<td>40 rods 1 rood.</td>
</tr>
<tr>
<td>4 roods or 10 square chains 1 acre.</td>
</tr>
</tbody>
</table>

In using land-measure as a means of calculating the earnings of labourers by the piece, it is usual to let or put out the job at a certain rate per acre for such work as mowing, reaping, and hoeing, in which a large quantity of land is gone over; but for trenching and digging in small quantities the square rod is most convenient.

1. *Mowing permanent meadow-grass for hay* is the first operation that will come under our notice; it is one of those operations of husbandry which require to be executed with despatch, as, by it being quickly performed, the hay
harvest is shortened, and every advantage may be taken to secure the produce in fine weather. This is of great importance in the hay-country around London, where in the season of hay-making, mowers are in great request, and command high wages. In Suffolk, the rate for mowing varies with the bulk of the crop, from 2s. to 2s. 6d. per acre; beer is frequently allowed in part payment for mowing; the work is then done at 2s., and half a gallon of beer for each acre. The hours of labour in mowing grass are from five in the morning to seven in the evening, stopping two hours in the mean time; they thus labour twelve hours in a day, during which an expert mower will cut 1½ acre; the generality of men will earn in money about 3s. a day. The cost of cutting low meadow-grass is rather higher than of cutting upland. Mowing clover and rye-grass is generally more quickly performed, and consequently the rate per acre is lower. I find the average price per acre is 2s., or 20d. and half a gallon of beer; the quantity mown in a day nearly 1½ acre; the earnings of a man will thus vary from 2s. 6d. to 3s. The cutting seed-crops of clover and rye-grass does not greatly differ from the mowing for making into hay. Men engaged to mow grass by the day have 2s. and an allowance of beer; but they cannot of course be fairly expected to work so hard if paid in this manner. The making grass into hay is occasionally put out by the job at the rate of 4s. an acre for mowing and making; this gives ample employment to the wives and children of the mowers. But the farmer must not be guided in his opinion of the right time of carting by his men, for if he is, he will in all probability have it carted before it is in a fit state for stacking.

2. Mowing wheat is a practice coming into use in preference to reaping; the rate paid per acre depends of course upon the bulk of the crop, and on the abundance of labourers during harvest: for a light crop 6s., and for a heavy one 8s. are paid per acre; this includes mowing, tying, shocking, and raking. The mowing constitutes barely half the labour, though the making and binding the sheaves may be done by boys; a strong lad will make and bind sheaves as fast as one man mows. A man, in a day of ten hours, will mow upwards of an acre; and, with the assistance of another man, or of two boys, he will be able to complete the other operations required in cutting an acre of an average crop of wheat.
3. Reaping is also generally done by the acre, and in seasons when the crop is heavy or lodged by rain, it becomes a tedious labour; the price per acre for a medium crop of wheat that stands upright is about 8s.; but if the wheat is lodged, from 10s. to 12s. A good reaper will sometimes cut more than half an acre in a day, but the generality do not cut more than one-third. Reaping beans costs about 6s. an acre. Strangers are frequently employed to mow or reap wheat; I consider it a good plan to supply them with beer at the rate of a gallon for each acre: this will greatly influence the workmen, as they then will have no occasion to go to the beer-shops for drink sold at a high price. The cost to the farmer will be but little, as he can brew beer for the purpose at about 6d. a gallon.

4. Mowing barley or oats is usually included in the contract for harvest, of which I am about to give a description. A man will cut upwards of two acres of barley in a day; of oats he will not be able to get over quite so much.

5. Harvest-work is generally put out by task. Some farmers give a certain price per man to a company, who agree in return to do all the harvest work in cutting, carrying, and stacking the corn, to which an acre or two of turnip-hoeing for each man is sometimes added. Others hire a sufficient number of men, for four or five weeks, at a certain sum for that time; this method is mostly practised by small farmers, who work with the men and keep them from loitering; for otherwise there would not be much inducement for the labourers to hurry. On the larger farms two distinct modes of hiring are sometimes adopted: the men are divided into two companies—one called the crop-men, who engage to cut a certain number of acres of wheat, all the barley, oats, peas, beans, or any other crop that may be grown on the farm; to pitch and load all the corn, and to turn a portion of it when required; to this is added a certain quantity of turnip-hoeing, about one or two acres for each man. The yard-men, as the others are called, are hired by the month or five weeks; their labour is of various kinds, though principally confined to cutting wheat, unloading and stacking corn, and any other labour that may require to be done. An able-bodied man is usually paid 4l. 10s., and three bushels of malt, for five weeks' certain employment; while the crop-men, who work by the job, have from 4l. 10s. to 5l., and three bushels of malt, whether their harvest is of long or short duration.
On a farm of 240 acres of arable land, cultivated on the Norfolk rotation, six crop-men are sufficient. The following is a rough calculation of the work performed by each man, and the cost per acre:

<table>
<thead>
<tr>
<th>Description</th>
<th>Acres</th>
<th>Cost per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cutting (mowing) wheat</td>
<td>8</td>
<td>£2 16</td>
</tr>
<tr>
<td>Mowing barley</td>
<td>10</td>
<td>£1 0</td>
</tr>
<tr>
<td>Pitching and loading wheat</td>
<td>10</td>
<td>£0 10</td>
</tr>
<tr>
<td>Turning barley</td>
<td></td>
<td>£0 3</td>
</tr>
<tr>
<td>Twice hoeing turnips</td>
<td></td>
<td>£0 6</td>
</tr>
</tbody>
</table>

Total: £5 10

Where beans are grown, the cost of cutting and tying is about 6s.; the cost of making peas is from 4s. to 5s. an acre.

6. Hoeing the many crops that are benefited by the free use of the hoe, offers frequent opportunity for the employment of the labourer by measure-work. Turnip-hoeing will first come under our notice. The average price we pay for the first hoeing, or singling out drilled turnips, is 3s. per acre; that of the second hoeing, 2s. 6d.: but when the seed is broadcast, or the distance from drill to drill but small, the cost of singling out will be more. Though turnips planted on the ridge-system are at a greater distance than those drilled on the flat, yet we find, from the necessity there is of pulling the ridges down with the hoe, that the cost is quite as much. In hoeing between the drills of turnips, when the land is soft, the Dutch or thrust hoe may be used, at a cost of about 1s. 6d. per acre, where the distance between the drills is 18 inches. Turnip-hoeing is best done by men accustomed to the work, with whom a bargain is made from the completion of the work in a proper manner; the first and second (and third, if wanted) may be done on our land by the same party, at a cost of from 5s. to 6s. an acre.

Beet-hoeing is paid at about the same rate as hoeing turnips, viz., from 5s. to 6s. an acre, for twice going over: a third hoeing is often required, at a cost of 2s. 6d. an acre. More than half an acre of the first hoeing or singling of turnips and beet is generally performed by a man in a day of ten hours and a half; though, as the labour is not very severe, women and men unable to do hard work are frequently employed. The turnip-hoer may derive much assis-
tance from his children, by having a small boy or girl to follow him, and single the plants which have been left double by the hoe.

_Hoeing Carrots._—Carrots are extensively grown in the sandy soils of Norfolk and Suffolk, and, no doubt, would be grown much more if it were not for the enormous expense in the labour of hoeing and weeding; this might, in some degree, be lessened, if the drill-system of growing carrots were adopted in preference to sowing the seed broadcast. The cultivation of carrots generally gives employment to the undertaker and his gang, who is usually paid for his services by half the crop, or at the rate of 2d. a bushel: for this he finds and sows the seed, does all the weeding, hoeing, and takes up and stores away the crop. In fact, he does everything, with the exception of tillage and carting. The number of bushels is ascertained by the number of cart-loads carried away. However, when carrots are drilled, the cost of hoeing will be considerably less; I have known the price for twice hoeing (which includes singling out) drilled carrots at 10 inches, to be no more than 10s. an acre.

_Hoeing Wheat._—From 2s. to 3s. per acre are here paid for hoeing between the drills of wheat. A man accustomed to hoeing will get over three quarters of an acre in a day: and, as an instance of this, it took two men exactly four days each to hoe 6 acres on a gravelly soil, the drills being about 7 inches apart; they were paid 2s. 6d. per acre. A bargain is sometimes made for leaving the wheat-crop clean up to a specified time, usually to the end of June: in that case, the wheat receives as many hoeings as it may require, at an average charge of 6s. an acre.

_Hoeing Beans, Peas, and Tares,_ is done for about 2s. 6d. an acre: a certain difference in the rate of payment is occasioned by the width between the drills; when this is narrow, the work goes off proportionally slower. With us, barley is seldom hoed, though oats occasionally are; and if so, at the same price as wheat.

7. _Harvesting Root-crops._—The labourers, in doing this kind of work, may be paid by the acre, or, when the crop is carried off the land, by the number of cart-loads: the former method is to be preferred, as it affords a mode of measurement less liable to dispute. Men with large families are the best to engage in the taking up and storing away roots, as their wives and children will be able to do a good
portion of the labour. Harvesting roots is performed in various ways: I shall merely mention those plans most generally used. When the Swedes are laid in small clumps of about 40 bushels on the land where they grow, the roots are pulled up and thrown into long heaps, the leaves being first cut or pulled off; the heaps are then covered, first with straw, and then with earth. Seven shillings per acre will be a fair remuneration for the labour required in pulling and storing a good crop of Swedes in this manner. Should the roots be both topped and tailed, a higher price must be given. Another way of keeping Swedes or white turnips is to cover the roots with the plough; the turnips are pulled and laid in a furrow opened by the ploughman, who, with another furrow, covers the roots with soil, leaving the tops above the surface: the cost of pulling and laying in the turnips will be about 3s. an acre; but it must, of course, be done by children, with a man as overseer. Pulling, cutting off the tops, and filling turnips into carts, will cost about 8s. per acre; but this must depend upon the size of the roots, where the bulk of the crop is the same.

Harvesting Beet.—The pulling and laying the roots in heaps ready to be carted away, the leaves being twisted off by the hand at the time of pulling (which is done by men, and is rather severe labour), is paid for at an average price of 5s. an acre for a fair crop; at this rate, a man will earn 2s. a day, for it will take about 2½ days to pull an acre. As the task-men pull the roots, they are filled by boys, and carried to the places where they are stored for the winter. With us, the filling is done by day-work, at a cost of about 2s. an acre: four boys, at 1s. a day, filled 190 loads (30 bushels) off 7 acres of land in three days. The beet was pulled in the same time by six men, at the rate of 6s. an acre. Bank- ing beet is the covering the heaps, in which the roots are stored, with moulds to keep out the frost; the heap is made about 4 or 5 feet in height, sloping like the roof of a house. A man will cover about 2 rods in length in a day; the rate per rod may be from 10d. to 12d. In a hard gravelly soil, it took six men three days to earth up a heap 30 rods in length; at 1s. a rod, they would have earned exactly their day-wages at 20d. a day.

Taking up and Storing Carrots.—When carrots are sown broadcast, and the plants left thick, the cost of taking up and cutting off the tops is sometimes as high as 18s. or 20s. per acre for a fair crop; but when drilled, the cost for taking
up is much reduced: this is caused by the carrots being handier to fork up when in rows, besides which, they are generally singled out at greater intervals, and are consequently fewer in number and larger than those broadcast. We shall find that, if the work be done by day-labourers, it will take six men to fork up an acre of drilled carrots; I know this to be about an average, from having assisted in this as well as in other kinds of works that I have described. It will take six boys or girls to cut the tops off, as the carrots are taken up by the men. If we take the men at 20d. a day, and the children at 6d., we may calculate the cost of an acre will be 13s.; by piece-work, it could be very well done for 12s. an acre. If the carrots are a thin plant, the price will be proportionably lower; and if a very thick one, it may be 2s. or 3s. above the sum I have stated. It must be borne in mind that this only includes taking up and topping. I have already given (under the head of hoeing) the details of a practice pursued by many carrot-growers in the west of Suffolk.

8. Dibbling.—In the eastern counties, dibbling is much practised; and during seed-time the dropping gives employment to great numbers of children. Dibbling wheat is done in two ways—one called “whole setting;” when two rows of holes are placed on a broad furrow-slice, the rows being about five inches apart: a man will dibble, on an average, half an acre a day, and will find work for three drappers; the cost for dibbling and dropping is from 7s. 6d. to 8s. an acre. The other is called “three-quarter setting;” one row is placed on a narrow furrow-slice, the holes being rather closer together in the row: a man will dibble nearly an acre in a day; this costs about 5s. an acre. Beans and pens being dibbled at wide intervals, 4s. an acre is a fair price for them.

9. Haulmimg is the cutting or raking into heaps the stubble left by the reapers; the price varies with the bulk and toughness of the straw. A man paid by the acre will haulm, on an average, upwards of an acre in a day; the price is about 20d.

10. Paring and Burning uncultivated land is generally done by piece-work; the price is affected by the soil, the prevalence of stones and roots, and by the toughness of the sward. Paring is severe labour; the burning also requires strict attendance both day and night; in consequence of this, men will not do this work unless they are able to earn
a good deal above day-wages; the usual price is from 25s. to 30s. per acre. Cutting furze, should any grow on the land, is an extra charge; some men are able to pare a quarter of an acre in a day; but there is a great difference in the quantity done in a given time.

11. Ploughing and other labour done by the aid of horses or oxen.—In some places, this description of work is paid for by the acre, more particularly where oxen are used. In Norfolk, the ploughing is sometimes done at the rate of 14d. or 15d. per acre: the ploughman works two pairs of oxen; by keeping at it all day, he is able to get over nearly two acres. However, I think the paying for ploughing, harrowing, or any other team-work, with the farmer's own cattle, is inferior to the usual practice of hiring ploughmen by the year, or paying them by the day; for, in general, the greater number of labourers who work with the teams are young men, who, if they were employed by the piece, would have too much inducement to slight their labour, and over-work their cattle. Besides which, the labour of the teams is constantly changing from one kind of work to another; this arises from the uncertainty of the weather, as well as from other causes, and there would consequently be much difficulty in keeping a correct account of the labour. Ploughing is occasionally done by the jobbing-farmer at from 7s. to 8s. an acre; this includes a pair of horses, plough, and man.

Drill-workers are men who gain a living by letting out drills to the farmers, at a certain price per acre, or by the day's work; the charge for a corn-drill, with a man to follow, is from 12d. to 15d. an acre; for a corn-drill or seed and manure-drill, 18d. an acre is the usual charge.

12. Digging and Trenching.—Digging one spit deep (from 9 to 12 inches) usually costs 2d. or 2½d. the square rod; the quantity dug will vary with the nature of the soil, from 8 to 12 rods in a day. In 1835, when day-wages were but 16d., it took four men eight days to dig, in a workmanlike manner, 2 acres of a clayey loam—each man's work averaged 10 rods a day; they were paid 2d. a rod.

Trenching: two spits, or 18 inches deep, and loosening the bottom of the trench, costs about 6d. the rod; a man will, on an average, trench 4 rods in a day.

Digging-in seed turnips: for small roots the ground does not require digging very deep; for laying in and covering...
the roots we have usually paid 3d. a square rod. To make
myself generally understood, I shall describe the operation:
—The turnips are laid in a straight trench formed by the
spade; two diggings across them intervene between the first
and next row of plants. On a sandy soil that digs well,
I find that a man, with a boy or a woman to lay the turnips
in the trench, will get over 10 rods in a day; at 3d. a rod
they earned 2s. 6d. a day. When the turnips are large, the
work will, of course, go off slower.

14. Thatching.—In measuring thatchers' work, the prac-
tice for a round stack is to take the height in feet from the
eaves to the top, and half the girth at the eaves; these,
multiplied together, will give the dimensions in feet, which may
easily be reduced into squares or yards. For a long stack
we measure the length and the height of both sides of
the roof; but when the stack is hipped, we either allow
two yards extra in the length, or measure one in addition
to the side: the former method is adopted when the dimen-
sions are calculated in square yards; the latter when the
square of 100 feet is used. The price for thatching corn
and hay stacks is 1d. a yard, or from 10d. to 1s. the square.
I am informed by an experienced Thatcher, that, with the
help of a strong lad, he is able to thatch, in a workmanlike
manner, 100 square yards in a day, and thus earn 8s.; but
to do this he is obliged to work early and late, and leave the
finishing up of his stacks till the busy time of harvest is
over. In Hertfordshire, and other places where the thatch-
ing is done in a superior style, the charge is nearly double
that paid in Suffolk.

II.—Task-work to which lineal measure is applicable.

Table of Lineal Measure.

<table>
<thead>
<tr>
<th>12 inches</th>
<th>3 feet</th>
<th>5(\frac{1}{4}) yards</th>
<th>40 rods or 10 chains</th>
<th>8 furlongs or 1,760 yards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>make 1 foot</td>
<td>1 yard</td>
<td>1 rod</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 furlong</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 mile</td>
</tr>
</tbody>
</table>

Under this head are included those descriptions of task-work
which are usually paid for at a certain rate per chain, rod, or
yard in length; and it applies more especially to ditching,
fencing, and draining.

1. Digging Ditches and Fencing.—All operations done
with the spade depend in a great measure upon the nature
of the soil, as to the quantity removed in a given time. Some, as peat, are dug without much labour; while other soils cannot be dug at all unless they are first loosened with the pick. It has been calculated that a man will dig and move 10 cubic yards of soil in a day, the soil not requiring the pick to be used: this is perhaps under the average; for I find the labourers on the railway are paid 2l. a cubic yard for moving and digging a hard stony soil to the depth of 18 inches; of this they are able to move from 10 to 12 yards in a day.

As I am aware of the uncertainty of this kind of labour, I shall merely mention the prices and details relating to agreements for the execution of this work.—1. Paid 20l. a rod for digging an open drain in a peaty soil; the drain was 5 feet deep, and averaged 6 feet in width; a cubic yard was therefore dug for about 1l., or if we calculate it exactly, 18\frac{1}{4} yards for 20l.—2. Paid 10\frac{1}{4} l. a rod for digging a ditch 3 feet deep, 4\frac{1}{2} feet wide at top, and 1\frac{1}{2} at bottom; the ditch ran through a variety of soils, principally clay and gravel; this bargain also included, in addition to the digging, the laying in a quick for a fence, and the topping the bank with thorns as a protection to the young hedge: 5\frac{1}{2} cubic yards of earth had to be moved for every rod; and it took 70 days of labour for one man to complete the job of 114 rods, the amount for which, at 16l. a rod, is 7l. 12s., or about 2s. 2l. a day.—3. Paid 1s. 10l. a rod for a ditch and fence in a clay and gravelly soil; the ditch was 4 feet deep, and averaged a little over 4 feet in width, so that nearly 10 cubic yards of soil were removed for every rod.

2. Draining.—The cost of the labour required in draining, depends, firstly, upon the nature of the soil in which the drains are dug; and, secondly, upon the depth and materials used for filling up. Draining on a sound clay, free from stones, may be executed at a cheaper rate per rod in length than on almost any other kind of soil; as from the firmness of the clay, the work may be done with narrow spades, and but a small quantity of soil requires to be removed by manual labour. The draining of wet sands or gravels, or clays in which veins of sand abound, is more expensive than on the sound clays, because a broader spade has to be used, and consequently a larger amount of soil removed. Some soils are so hard and stony that they cannot be dug unless the pick is first used: this adds considerably to the expense. On the sound clays of Suffolk and Essex, the price for digging
drains, and laying in stubble, heath, brushwood, peat, or whatever else is used, and filling up the drains so far as cannot be done with the plough, is about 4s. or 4s. 6d. the score rods, and 6d. for each eye. These drains are about 30 inches deep. The first spit is ploughed out; the two next dug with narrow draining spades: half a score rods of this kind of draining is reckoned a fair day's work. Sometimes, however, half a score is above an average; for I know a case on a hard clay, lying just above the chalk, which was so tenacious that the men could hardly dig and fill in 6 rods in a day. The cost of digging, laying in tiles, and filling drains 4 feet deep, on a clay soil intersected with veins of sand, may cost about 6d. a rod. We have just completed digging a drain in a meadow, of an average depth of 3 feet, the first 6 inches turned up by the plough. It took thirty days' labour for one man at 20d. a day to dig 101 rods of drain, one man a day and three quarters to lay in the tiles (tops and bottoms), and about eight days to fill up the drain; making a total cost of nearly 8d. a rod. The soil was very wet, stony, and hard. On a loamy soil drained to the depth of 4 feet, with a clay subsoil, the upper 10 inches ploughed out, one man would on an average dig 3½ rods per day, throwing out about 10 cubic yards of soil—would lay in about 60 rods of soles and tiles in a day, and fill in 13 rods in a day.

3. Fencing.—All kinds of hedging, and the labour required in keeping live and dead fences in repair, and the pulling down old fences, readily admit of payment for task-work by lineal admeasurement. In the management of old fences, one of the practices in this part of the country is to cut down the old thorns even with the surface, and then to make good the loose soil which has been washed away from the roots. The price per rod varies with the age and thickness of the hedge, and with the quantity of soil required to make good the bank—from 6d. to 8d. a rod is usually paid: this includes topping the bank with the old thorns as a dead fence. Three or three and a half rods will be an average day's work; from 20d. to 22d. a day may be reckoned fair wages for hedging work, as, in addition to his wages, the hedger has all the small and decayed pieces of firewood. Breasting over hedges will cost from 3d. to 4d. a rod, but the price depends entirely upon the size of the hedge. Trimming hedges, or the cutting off the young shoots, with a light hook may be done for a ½d. or 2d. a
rod; if shears are used, the cost will be rather more. Where faggots are made, they are paid for by the score; 6d. a score is paid for the most general size, but the price of course varies a little with the size and length.

III.—Task-work to which solid or cubic measure is applicable.

### Cubic Measure

<table>
<thead>
<tr>
<th>1728 cubic inches</th>
<th>make</th>
<th>1 cubic foot</th>
</tr>
</thead>
<tbody>
<tr>
<td>27 cubic feet</td>
<td></td>
<td>1 cubic yard</td>
</tr>
<tr>
<td>2218 cubic inches</td>
<td></td>
<td>1 bushel</td>
</tr>
</tbody>
</table>

A fraction over 21 bushels = 1 cubic yard.

This applies to the moving of soil, the filling into carts of manure, clay, marl, or any other soil, the turning of compost and manure heaps; it may also be used in measuring the quantity of peat-ashes and burnt clay, should the labour of these operations be done by task-work. Though such work as digging ditches and draining is put out by linear measure, yet we ought to calculate the quantity of soil to be dug in a given length, and by that means have something to guide us in fixing the price.

1. Filling, Raising, Carting, and Spreading Clay, Marl, or Chalk—are frequently let out by the job to men who, at a certain price per yard, agree to find horses, carts, and men, and food for the horses, with the exception that the employer allows grass and straw-chaff. The number of cubic yards carted is ascertained by taking the dimensions of the pit or heap from which the soil has been removed, so that there is no means of deception or occasion for disagreement. The price per yard for carting one furlong, is for clay 7d.; a penny is added for every additional furlong; so that if the distance was two furlongs 8d., if three 9d. would be charged per yard. The work is usually done with small carts drawn by strong ponies; these appear much better suited to the removing heavy soil than the large carts and long teams which the farmer generally uses in this part of the country. I was told by an old man who has followed the business of clay and marl carter the greater part of his life, that on one occasion he had an opportunity of putting to the test the comparative merits of large and small carts. That when working in the same pit with another party of clay-fillers using large tumbrils or carts, his company of three men filling into small carts drawn by five ponies, were able to accomplish as much as four men filling into large carts drawn by seven
powerful horses; the distance and other points being equal. He also informed me that in a week of fine weather he has carted 300 cubic yards of clay, filled by three men working eight and a half hours a day; or 16½ yards of filling and picking down daily.

On our farm, at the first beginning or sinking of a pit, 140 yards of clay were filled by two men working seven and a half hours a day during fifteen days, giving an average for one man of more than 9 yards. After the pit was sunk to about 8 feet deep, the two men filling and picking down averaged 10 yards each. The spreading was done by the men and the boys who drove, working about an hour after they had finished carting for the day. The clay was carted in four small carts drawn by four ponies, with another to assist in pulling out of the pit; the distance of carting averaged 2 furlongs, and in this manner 480 yards of clay were filled, carted, and spread at a cost of 8s. a yard on about 12 acres of land. The labour of filling and spreading clay from a pit by the farmer's own labourers would be as well paid for by measuring the number of cubic yards removed; but this plan is seldom practised, the men being paid by the number of cart-loads, each containing, by rough calculation, a cubic yard; or the carts may be filled up to a mark made in the sides. The carter who works by the day keeps an account of the number of loads filled by the men in the pit; and as he is not interested, he will in all probability keep a correct one; but as the same number of heaps of clay are made of each load, it will be an easy matter for the farmer to number the heaps, and thus check any dishonest practices. About 2s. the cubic yard or load is paid for filling clay; if many stones are picked out, the men receive 1s. for each load. The time of filling is about eight hours in summer and seven in winter, the remainder of the day being employed in getting down clay for filling in the next day. A man will, on an average, fill 10 loads of clay besides stones; as an instance, it took forty-five days for one man to fill 463 loads of clay, besides 13 loads of stones; or rather over 10 loads a day. The clay at 2s. and stones at 1s. will amount to 4l. 10s., or about 2s. a day, which may be considered fair earnings. Clay laid in a large heap after being drawn from the pit is perhaps a slower operation than when first raised, for I find men only fill 10 yards each a

1 I find the quantity of clay filled in a given time is below an average; this arose from wet weather and its being a bad kind of clay to fill.
day. A bargain is sometimes made for filling and spreading at 2½d. or 3d. a load. Barrowing by manual labour must not be omitted in this account of measure work, for earth may be moved in this manner, for a short distance, cheaper than it can be moved by the aid of horses; and even for claying or chalking small fields of 5 or 6 acres, barrowing would be perhaps cheaper than carting. It has been calculated that in sandy ground three men will be required to remove 30 cubic yards in a day to a distance of 20 yards, two filling and one wheeling; but to remove the same quantity in a day to any greater distance, an additional man will be required for every 20 yards of wheeling. The following is a system of barrowing by manual labour sometimes adopted in those places where chalk lies at a considerable depth below the surface:—a shaft is dug down to the chalk; when this is deep enough, the chalk is dug, and pulled up by a rope and windlass at the top; it is then barrowed on the land. The price for barrowing on a piece of land of about 4 acres round the shaft, is 6d. a load of $2\frac{1}{2}$ bushels. This includes both raising and barrowing.

2. *Filling Farm-yard Dung.*—This is done at the rate of 2s. a score of loads of about 1½ cubic yards each; spreading will be about 1s. 6d. or 2s. for the same quantity.

3. *Turning over Manure Heaps.*—When the heap consists entirely of farm-yard manure, the labour of turning over is more quickly performed than when the heap is partly composed of heavy soil. There are also two ways of performing this operation, by one of which the work is got over faster than by the other, though the slowest way is greatly to be preferred if the farmer's object is to mix the different substances of which the manure heap is composed. One of the practices is the mere reversing the manure by trenching it over; while in the other the labourer begins at the side, and picks down the manure from top to bottom, mixing it well as he proceeds; he then throws this up with a fork, and goes on alternately picking and throwing up. The general, and perhaps the best way of paying for the labour of turning over manure heaps, is by giving a certain sum for each heap; we usually pay from 8s. to 12s.; but this of course varies with the size of the heap, and the nature of the substances of which it is composed. A fair price may be calculated by taking the dimensions in cubic yards; it will cost but a few minutes to make a measurement. Or sometimes the farmer keeps an account of the
number of loads carted on the heap, and by that means fixes a price at so much per score loads of about \( \frac{1}{2} \) cubic yards each. For turning over farm-yard manure 1s. per score, and for picking down and turning over heaps composed of earth and manure, 2s. per score loads are paid.

4. Burning Peat-ashes is an uncertain employment for the labourer; the quantity of ashes depending in a great measure upon the weather for drying the peat. The customary payment for burning peat-ashes is about 5s. per 1000 bushels, reckoning 25 bushels to a cubic yard. I think, however, payment by the cubic yard is quite as correct a way of ascertaining the true quantity. The season for burning being at an end, the ashes are laid (previously to thatching) in a rectangular heap of 15 feet average width, 3 feet in depth, and to any convenient length; the length, breadth, and depth being multiplied into each other, and then divided by 27, we shall thus have the number of cubic yards. The price paid by us, per yard, is from 2s. to 2s. 4d.; in an average season of twenty weeks (harvest included) a man and his wife burnt 200 cubic yards, which at 2s. a yard gave them 1l. a week.

IV.—Task-work to which the Corn Measure is applicable.

Table of Corn Measure.

<table>
<thead>
<tr>
<th>4 pecks</th>
<th>. . .</th>
<th>make 1 bushel.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 bushels</td>
<td>. . .</td>
<td>&quot; 1 coomb.</td>
</tr>
<tr>
<td>8 bushels</td>
<td>. .</td>
<td>&quot; 1 quarter.</td>
</tr>
</tbody>
</table>

Corn measure applies to threshing corn by the flail—a practice which will, it is hoped, be soon superseded by threshing-machines. However, as a large portion of grain is still threshed by manual labour, I cannot but give it a place in my description of piece-work. The quantity of corn threshed in a given time, either by the flail or by machines, will depend upon a variety of circumstances; the kind of soil upon which the grain grew, the season and the condition when harvested, will all affect the quantity threshed in a given time. In our neighbourhood (Suffolk) but a small proportion of the farmers have threshing-machines of their own; but there are men who get their living by letting out portable machines at a certain price per day; these are generally worked by four horses; the charge for a machine, with a man to tend, is 12s. a day, besides the expense of moving the machine and boarding the man. On an average these will thrash from
20 to 30 quarters of wheat (reaped), from 15 to 25 of mown wheat, and about the same quantity of barley as of mown wheat in a day. The annoyance of shifting the machine, with the loss of time to the horses and men, renders the practice of hiring by the day both inconvenient and expensive. However, as many large farmers are beginning to have horse-power machines, it is to be hoped that we shall soon see the good example of thrashing by steam-power which has been set by the northern farmers, followed by their brethren of the east.

1. **Thrashing wheat** by the flail is much practised by the farmers who supply the London market with straw, the generality of machines being found to break the straw. In Suffolk the price for thrashing and dressing reaped wheat costs from 2s. 6d. to 3s. a quarter—should the wheat yield well, a man will thrash out a quarter in a day. With the common land-dressing machines, 15 quarters may be twice winnowed and put into sacks by two men in a day.

2. **Thrashing barley.**—With us a much larger proportion of barley is thrashed by hand than of wheat, for it is often done as cheap by hand as it is by our present system of hiring machines. Allowing one of these to thrash 20 quarters of barley in a day of 10 hours, the following will be a rough calculation of the cost:—

<table>
<thead>
<tr>
<th>Description</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hire of machine</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Board of man</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Six horses</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Six men at 20d.</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Four boys at 8d.</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>Dressing 20 quarters at 2d.</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>44</td>
<td>0</td>
</tr>
</tbody>
</table>

The average expense of thrashing and dressing 40 quarters of barley of the same description is 40s., or 4s. cheaper than the machine, which will nevertheless have the advantage of despatch. The rate per quarter for thrashing and dressing varies from 1s. 6d. to 2s. a quarter. I have known two men to thresh and dress on an average 15 quarters a week; at 20d. a quarter they earned 25s. weekly. When barley is harvested in large barns, 2d. or 3d. a quarter is given extra for that laid in the middlestead or thrashing-floor.

**Oats** are thrashed from 1s. to 1s. 4d. a quarter; beans and peas from 1s. to 1s. 6d. The quantity thrashed varies from 1½ to 2 quarters per day.
4. **Clover and other seeds.**—The price paid for cobbing (separating the seed from the straw) and drawing the seed of red and white clover is from 3s. 6d. to 4s. 6d. the bushel of 5 stone of seed. Drawing seed by the flail is a tedious and expensive process, and is much better performed by mills constructed on purpose for the work. From 1s. to 1s. 4d. is paid per quarter for cobbing trefoil; the drawing is usually done by mills.

V. **Task-work performed by various kinds of measurement.**

1. **Trussing hay** for the London market is chiefly done by men who make a business of it, and by practice become exceedingly expert. In Hertfordshire the price for trussing and weighing ready for market is 1d. a truss; a good hand, with the assistance of a boy, will in summer make 100 trusses in a long day. In Suffolk the hay-trusser is neither so skilful nor so well remunerated; the charge for trussing is about 2d. a truss, or from 1s. 6d. to 2s. a ton.

2. **Picking stones** is paid for by the load of 20 bushels, at about 10d. a load. A woman will generally manage to pick a load in a day.

3. **Riving wood** is done by the stack, at 3s. 6d. for long lengths suited for kiln burning, and at 5s. for short lengths.

4. **Shearing sheep** is done by men who form themselves into a company, and engage to shear the sheep belonging to the surrounding flock-masters. The following are the prices for Down and Leicester sheep:—ewes, 3s. 6d. a score, of which one man will on an average shear twenty-five in a day of 12 hours' labour; hoggets or yearlings, 4s. 6d., of which a man will shear twenty; large fat sheep and rams, 5s. a score. Sometimes the employer agrees to board the shearers; he then pays 3s. a score for hoggets, and 2s. for ewes.

5. In **hiring shepherds** an agreement is sometimes entered into, by which they receive, in addition to their weekly wages of 10s. to 12s., about 6d. for each lamb brought up, and out of this money to be received pay 9d. for every sheep that dies.

6. There are other kinds of agricultural labour which admit of being paid for by measure-work, which have not been mentioned; among these are burning lime, cutting chaff, planting cabbages and potatoes; taking up potatoes: the
latter operation may be done at so much per sack—we found 3½d. to be a fair price; or they may be taken up at a certain rate per acre.

Table of the Value of Labour in Suffolk.

Wages of a common day-labourer, 10s. a week; at harvest-time, about 3s. 6d. a day.

<table>
<thead>
<tr>
<th>Task</th>
<th>s.</th>
<th>d.</th>
<th>s.</th>
<th>d.</th>
<th>per acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mowing wheat</td>
<td>6</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>per acre</td>
</tr>
<tr>
<td>barley</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>grass</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>clover and rye-grass</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaping wheat</td>
<td>8</td>
<td>0</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>beans</td>
<td>6</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pitching and loading wheat</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>barley</td>
<td>1</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hoeing, singling out turnips</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>second time</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>between drills</td>
<td>1</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>drilled carrots, three times</td>
<td>10</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>wheat</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>tares, beans, or peas</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Pulling and storing Swedes in clamps</td>
<td>7</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laying in turnips</td>
<td>3</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topping and tailing, and filling turnips</td>
<td>8</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>into carts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulling mangel-wurzel</td>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filling into carts</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking up and topping carrots broadcast</td>
<td>18</td>
<td>0</td>
<td>20</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ditto drilled</td>
<td>12</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dibbling wheat, whole setting</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ditto, three-quarter setting</td>
<td>5</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ditto, beans and peas</td>
<td>4</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Haulming</td>
<td>1</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paring and burning</td>
<td>25</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ploughing</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harrowing and rolling, each about</td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digging</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2½ a rod square</td>
<td></td>
</tr>
<tr>
<td>Trenching</td>
<td>0</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digging in small turnips for seed</td>
<td>0</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thatching stacks</td>
<td>0</td>
<td>1</td>
<td></td>
<td>a yard</td>
<td></td>
</tr>
<tr>
<td>Digging ditches (various)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Suffolk draining, 30 inches deep</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>6 a score rods</td>
<td></td>
</tr>
<tr>
<td>Tile-draining, 4 feet deep</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>8 a rod</td>
<td></td>
</tr>
<tr>
<td>Cutting down hedge, facing bank, and put-</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>ting on dead fence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filling clay</td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
<td>per yard cube</td>
</tr>
<tr>
<td>Ditto and spreading clay</td>
<td>0</td>
<td>2½</td>
<td>0</td>
<td>3</td>
<td>score loads</td>
</tr>
<tr>
<td>Filling muck</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spreading ditto</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>score loads</td>
</tr>
<tr>
<td>Turning muck-heaps</td>
<td>8</td>
<td>0</td>
<td>12</td>
<td>0 each</td>
<td></td>
</tr>
<tr>
<td>Turning over farm-yard dung</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ON MEASURE-WORK.

<table>
<thead>
<tr>
<th>Task</th>
<th>s.</th>
<th>d.</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picking down and turning over compost-heaps</td>
<td>2</td>
<td>0</td>
<td>score loads.</td>
<td></td>
</tr>
<tr>
<td>Thrashing wheat</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>&quot;   barley</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>&quot;   oats</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>&quot;   beans and peas</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Trussing hay</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Picking stones</td>
<td>0</td>
<td>10</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Riving wood</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Shearing sheep—ewes</td>
<td>3</td>
<td>6</td>
<td>a score.</td>
<td></td>
</tr>
<tr>
<td>Ditto hoggets</td>
<td>4</td>
<td>6</td>
<td>&quot;</td>
<td></td>
</tr>
<tr>
<td>Ditto fat sheep and rams</td>
<td>5</td>
<td>0</td>
<td>&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Note by Lord Portman.

There are two points in the ordinary management of task-work which require, I think, some further consideration: I mean the practice of leaving the price of a job to be fixed at its conclusion, and of drenching the men with liquor to superinduce undue exertion. I have found that measure-work, if it be well regulated, is an admirable system; but that the greatest evil results from a delay in fixing the price of the job. I am aware that it is often impossible for the master or the man to make a bargain until one day of trial has been fairly made; and I am aware that sometimes accidental circumstances are developed during the progress of the work which may render the best considered bargains unfair, and therefore not to be insisted upon; but as a general rule, the price should be fixed before the work is begun, for any measure-work, in which both parties have had sufficient experience to guide them; and on the second day after it is begun, when either party requires a trial to guide him in fixing the price. The questions for the master to determine are—What is the job worth to me?—What will it cost me at day-work?—What additional cost is it worth if it is finished in a shorter time than men at day-work will complete it in? The questions for the labourer are—How much can I earn in a day at day-work?—How much at this job, with my usual exertion?—How much can I better my income by some extra time, and some greater exertion, if I take this job?

Turnip-hoeing, reaping, mowing, thrashing, turning manure-heaps, &c., admit of some standard of value on every farm; but each job requires to be viewed before the actual price is fixed to regulate any variation from the standard that accidents in each year may create. Moving earth,
chalking, digging ditches, &c., require an opening of the
land to enable either party to estimate the price. The
too frequent practice is to say, "Go on, and I will do what
is right when we settle." The consequence is, generally
a squabble on the day of reckoning, for the men expect more
than the job is worth, because they have spent so much time
over it; and the master offers a little more than the wages of
men at day-work, because he will not trouble himself to value
the actual job. The fair price is in such cases seldom
given. The parishioners often refuse a job at a fair price,
because they say "they must have work or be kept." The
strangers take the same at a fair bargain, and do well.
I could mention case after case to illustrate this fact. The
spirit of opposition should be firmly and fairly met by
proving, when it is finished, the correctness of the value
which had been affixed to the job before it was commenced.
It is also essential to estimate the time in which the job can
be properly finished; and it should be made a part of the
bargain that the job should be completed by a given day,
unless the weather prevent it. No other excuse should
hinder it, for in the case of illness or other inability the con-
tract should cease at once. It must not be forgotten that
no summary remedy exists for the enforcing any contracts
for measure-work; and that often the labourer who works in
a party—of which the foreman alone agrees with the mas-
ter, and the rest of the men agree with the foreman—is
cheated by the foreman, and has no redress for which he
can afford to pay. The master should therefore protect the
whole of the men by some arrangement as to their individual
payment. The drenching with liquor—beer, ale, or cider—
is generally approved by the men, as it excites them for the
time, and gives them what they call "a heart to work;" but
it is very unwise to adopt it as a practice. I advise that,
when they can be led to abandon the gratification, a money
payment, rather exceeding the value of the liquor, should be
made to them, which benefits their families, and enables
the men to improve their diet. But at all events, if
they cannot be led to abandon the liquor, I should advise
the substitution of a supply of meat in lieu of a portion of the
liquor, giving thereby strength to the men, and averting the
evils of intemperance. Where the men are single or without
family, I have found it difficult to lead them to abandon the
temporary gratification; but in that case, I would narrow
the allowance as much as possible, and give them the re-
mainder that would be due to them in the shape of clothes or tools, for the purpose of proving to them the benefit of my plan. Many masters give liquor as a spur for the momentary exertion to serve their immediate purpose, regardless of the injury done to the men; some give liquor to save their pockets; none, within my knowledge, who have tried to lead the men to abandon that mode of receiving payment, have, after experience, resumed the payment in liquor, though many give, as occasion may suggest, a portion of liquor as a reward for well-timed and good-natured zeal.

PORTMAN.


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**Art. LVII.—ON MEASURE-WORK.**

The following is a recapitulation, in a tabular form, of a valuable essay on the subject of measure-work in the *Agricultural Gazette*. The different kinds of work are mentioned which are properly payable respectively by measure, or by the day, and the general cost attending the execution of each.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Earth-work in drainage, from</td>
<td>£ 0 2 to 0 0 2 3/4 per c. y.</td>
<td></td>
</tr>
<tr>
<td>2. Grubbing up old fences, from</td>
<td>0 6 ,, 0 2 6 per per.</td>
<td></td>
</tr>
<tr>
<td>3. Paring and burning old ground, from</td>
<td>1 0 0 ,, 1 10 0 per acre.</td>
<td>4 0 0 per acre.</td>
</tr>
<tr>
<td>Clay - burning, 100 yards per acre...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Quarry - work — road-stones, from</td>
<td>0 3 ,, 0 0 4 per yd.</td>
<td></td>
</tr>
<tr>
<td>Building stones, from</td>
<td>0 5 ,, 0 0 6 ,,</td>
<td></td>
</tr>
<tr>
<td>Flag-stones, from</td>
<td>0 6 ,, 0 1 0 ,,</td>
<td></td>
</tr>
<tr>
<td>Breaking stones, from</td>
<td>0 5 ,, 0 0 10 ,,</td>
<td></td>
</tr>
<tr>
<td>7. Road - making; 4 yards wide, 9 inches deep.</td>
<td>0 15 0 ,, 1 0 0 per per.</td>
<td></td>
</tr>
</tbody>
</table>
### Annual Farm Operations.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£ s. d.</strong></td>
<td><strong>£ s. d.</strong></td>
</tr>
<tr>
<td><strong>per acre.</strong></td>
<td><strong>per cubic yard.</strong></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. Subsoil ploughing — 4 horses and men</td>
<td></td>
</tr>
<tr>
<td>2. Ploughing—2 horses and man</td>
<td></td>
</tr>
<tr>
<td>3. Harrowing (each time)</td>
<td></td>
</tr>
<tr>
<td>4. Scarifying—2 horses and man</td>
<td></td>
</tr>
<tr>
<td>5. Rolling</td>
<td></td>
</tr>
</tbody>
</table>

(b) Management of Manure. (Measure before each Operation.)

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£ s. d.</strong></td>
<td><strong>£ s. d.</strong></td>
</tr>
<tr>
<td><strong>per cubic yard.</strong></td>
<td><strong>per cubic yard.</strong></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. Filling into carts in yard</td>
<td>about 0 0 0</td>
</tr>
<tr>
<td>2. Hauling to heap</td>
<td>about 0 0 1</td>
</tr>
<tr>
<td>3. First turning</td>
<td></td>
</tr>
<tr>
<td>4. Second turning</td>
<td></td>
</tr>
<tr>
<td>5. Loading into carts</td>
<td></td>
</tr>
<tr>
<td>6. Carting 500 yards to field, and dividing into heaps</td>
<td></td>
</tr>
<tr>
<td>7. Spreading in the field 30 cubic yards per acre</td>
<td></td>
</tr>
</tbody>
</table>

(c) Seed Operations.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£ s. d.</strong></td>
<td><strong>£ s. d.</strong></td>
</tr>
<tr>
<td><strong>per acre.</strong></td>
<td><strong>per cubic yard.</strong></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. Broadcast sowing</td>
<td></td>
</tr>
<tr>
<td>2. Drilling corn — 3 horses and attendance</td>
<td></td>
</tr>
<tr>
<td>3. Setting potatoes</td>
<td></td>
</tr>
<tr>
<td>4. Hoeing in wheat, from</td>
<td></td>
</tr>
<tr>
<td>5. Dibbling ditto, from</td>
<td></td>
</tr>
<tr>
<td>6. Dibbling beans</td>
<td></td>
</tr>
<tr>
<td>7. Planting potatoes by spade, from</td>
<td></td>
</tr>
</tbody>
</table>

(d) Cultivation of Crops.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£ s. d.</strong></td>
<td><strong>£ s. d.</strong></td>
</tr>
<tr>
<td><strong>per cubic yard.</strong></td>
<td><strong>per cubic yard.</strong></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. Harvest-hoeing grain-crop — 9 in. drills</td>
<td></td>
</tr>
<tr>
<td>2. Hand-hoeing green crops (singing)</td>
<td></td>
</tr>
<tr>
<td>3. Second hoeing</td>
<td></td>
</tr>
<tr>
<td>4. Hand-hoeing broad-cast turnips, &amp;c. two or three times</td>
<td></td>
</tr>
<tr>
<td>Horse-hoeing drill-crops</td>
<td></td>
</tr>
<tr>
<td>Hoeing (deep) between potatoes (by hand)</td>
<td></td>
</tr>
<tr>
<td>Paring stubbles (by hand)</td>
<td></td>
</tr>
<tr>
<td>Paring and burning old sainfoin</td>
<td></td>
</tr>
<tr>
<td>Stiff burning</td>
<td></td>
</tr>
</tbody>
</table>

(e) Harvest operations.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>£ s. d.</strong></td>
<td><strong>£ s. d.</strong></td>
</tr>
<tr>
<td><strong>per cubic yard.</strong></td>
<td><strong>per cubic yard.</strong></td>
</tr>
<tr>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>1. Mowing clover, from</td>
<td></td>
</tr>
<tr>
<td>2. Mowing meadow grass, from</td>
<td></td>
</tr>
<tr>
<td>3. Mowing and haymaking</td>
<td></td>
</tr>
<tr>
<td>4. Mowing barley and oats, from</td>
<td></td>
</tr>
<tr>
<td>5. Reaping barley and tying, from</td>
<td></td>
</tr>
<tr>
<td>6. Reaping wheat and tying, from</td>
<td></td>
</tr>
</tbody>
</table>
### Piece Work.

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mowing or bagging wheat, from</td>
<td>0</td>
<td>7</td>
<td>0 to 0 10 0</td>
</tr>
<tr>
<td>Pitching the crop to the cart, and building thereon, and pitching from cart to rick</td>
<td>0</td>
<td>0</td>
<td>10 0</td>
</tr>
<tr>
<td>Stubble moving, from</td>
<td>0</td>
<td>1</td>
<td>3 , 0 2 0</td>
</tr>
<tr>
<td>Stubble raking, from</td>
<td>0</td>
<td>0</td>
<td>6 , 0 0 9</td>
</tr>
<tr>
<td>Harvesting beans, from</td>
<td>0</td>
<td>8</td>
<td>0 , 0 9 0</td>
</tr>
<tr>
<td>Mowing peas, from</td>
<td>0</td>
<td>0</td>
<td>2 6</td>
</tr>
<tr>
<td>Harvesting roots, pulling, cutting off tops, and loading in carts:</td>
<td>0</td>
<td>7</td>
<td>0 , 0 9 0</td>
</tr>
<tr>
<td>Turnips and Swedes, from</td>
<td>0</td>
<td>9</td>
<td>0 , 0 10 0</td>
</tr>
<tr>
<td>Mangel-wurzel, from</td>
<td>0</td>
<td>18</td>
<td>0 , 1 0 0</td>
</tr>
<tr>
<td>Carrots, from</td>
<td>1</td>
<td>0</td>
<td>0 , 1 4 0</td>
</tr>
<tr>
<td>Potatoes dug and pitted in field, from</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
</tbody>
</table>

### Day Work.

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turning and cleaning wheat (by hand) from</td>
<td>0</td>
<td>0</td>
<td>5 to 0 0 6</td>
</tr>
<tr>
<td>Barley (by hand)</td>
<td>0</td>
<td>2</td>
<td>0 0 3</td>
</tr>
<tr>
<td>Oats, from</td>
<td>0</td>
<td>1</td>
<td>2 , 0 2 4</td>
</tr>
<tr>
<td>Beans, from</td>
<td>0</td>
<td>2</td>
<td>2 , 0 3 4</td>
</tr>
<tr>
<td>Thrashing peas, from</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Machine-thrashing (by steam) wheat, from</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Blacksmith’s bill per pair of horses (excepting new metal)</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Saddler’s bill per pair of horses</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Expense of feeding, clearing, and attending to cattle, sheep, and pigs. For details, see articles in former numbers of the <em>Ag. Gaz.</em></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

*Agricultural Gazette, Sept. 19, 1846.*
Art. LVIII.—PLOUGHING.

<table>
<thead>
<tr>
<th>Breadth of furrow slice</th>
<th>Space travelled in ploughing an acre</th>
<th>Extent ploughed per day at rate of 18 miles, 16 miles.</th>
<th>Breadth of furrow slice</th>
<th>Space travelled in ploughing an acre</th>
<th>Extent ploughed per day at rate of 18 miles, 16 miles.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Miles, Acres</td>
<td>Inches, Acres.</td>
<td>Inches</td>
<td>Miles, Acres</td>
<td>Inches, Acres.</td>
</tr>
<tr>
<td>7</td>
<td>$14\frac{1}{6}$, $\frac{1}{4}$</td>
<td>$1\frac{3}{4}$</td>
<td>12</td>
<td>$8\frac{1}{4}$, $2\frac{1}{3}$</td>
<td>$1\frac{1}{4}$</td>
</tr>
<tr>
<td>8</td>
<td>$12\frac{1}{4}$, $\frac{1}{2}$</td>
<td>$1\frac{1}{2}$</td>
<td>13</td>
<td>$7\frac{1}{4}$, $2\frac{1}{4}$</td>
<td>$2\frac{1}{10}$</td>
</tr>
<tr>
<td>9</td>
<td>$11\frac{1}{2}$, $\frac{1}{2}$</td>
<td>$1\frac{1}{2}$</td>
<td>14</td>
<td>7</td>
<td>$2\frac{1}{4}$</td>
</tr>
<tr>
<td>10</td>
<td>$9\frac{3}{5}$, $\frac{1}{4}$</td>
<td>$1\frac{3}{4}$</td>
<td>15</td>
<td>$6\frac{1}{4}$, $2\frac{3}{4}$</td>
<td>$2\frac{1}{4}$</td>
</tr>
<tr>
<td>11</td>
<td>$9\frac{3}{10}$, 2</td>
<td>$1\frac{3}{4}$</td>
<td>16</td>
<td>$6\frac{3}{10}$, $2\frac{3}{10}$</td>
<td>$2\frac{3}{2}$</td>
</tr>
</tbody>
</table>

*Farmer's Almanac.*

Art. LIX.—TO TURN GRASS LAND INTO ARABLE.

From Prize Essay by John Bravender, F.G.S.

*Practice of Breaking up.*

The most important preliminary step to be taken previously to breaking up pasture lands is to have them well drained, if the soil be heavy and requires it, and then to pare and burn the surface for the purpose of reducing the grass, weeds, and toughly matted sward to loose charred ashes, which possess highly fertilizing qualities. The half of the ashes, which are frequently very abundant (in some cases more than 600 bushels per acre), may be carted to other lands about to be sown with turnips, and the other half left for use on the land that produced them. When the land from which the ashes have been derived is very rich and good, the whole are sometimes removed to other parts of the farm; but in this the farmer must always be governed by circumstances. Half the ashes being removed, the remainder is drilled with turnips and green crops on the land broken up, or spread over it before being ploughed. The crop of turnips, which must always succeed, is sometimes eaten off in the autumn, some-
times in the spring, and followed by wheat, barley, or oats. Those crops, according to the soil, are succeeded by vetches, beans, or other green crops, and then regular rotations commence, some of which are indicated in our estimates, but, of course, subject to variations from soil, situation, and climate. This is a general outline, merely indicative of what may be successfully practised. It has been thought an advantage—an idea not yet entirely banished—to break up land in autumn, to pare and burn, spread all the ashes, and plough and sow wheat; but this has not always been attended with success; and when paring and burning have not been resorted to, the wheat scarcely ever succeeds. The hollowness induced by sods and angular fibrous lumps, with undecomposed grass and roots, render the wheat plant more liable to be killed by frost, and more susceptible of the attacks of such insects and vermin as may have escaped destruction by burning, than when a complete disintegration of the toughly matted soils has been effected, and the fibrous lumps pulverized by the treading of sheep in consuming the previous green crops. The plan of sowing wheat without the intervention of a green crop is uncertain in its results, and will be discarded by time and experience. The farmer, by merely feeling his way in this matter, has been led to adopt that plan which he has found best, without adhering to any uniform method; and hence may have arisen variations in the modes of breaking up land, which become sanctioned under the name of local peculiarities; and the methods I am just about to describe may possibly possess something savouring of local peculiarity, and as such not applicable to all situations and climates; but I can see nothing to prevent some or other of them from being applicable to lands in all parts of England. The methods for breaking up grass land have not yet settled down into one general principle: I therefore only give the practices that have occurred under my own observation; and for the purpose of confirming those observations I have taxed the kindness of my neighbours, and will concisely describe their most recent practice, with its successes and failures.

The methods adopted by some of them assume the character of experiments, and are so applicable that one might suppose them to have been undertaken expressly to elucidate the present subject. The fact being otherwise will probably render them more valuable, as they come forth divested of everything in the nature of bias; and the persons themselves
are ignorant of the purpose for which the information was required; and, besides, I myself watched the proceedings of many with more than common interest.

Case 1.

A very good and well-known farmer broke up a large field of pasture in 1844, and, without previously paring and burning, ploughed and sowed with wheat. The land is situated on a level, and not injured by wet. The soil is a moderately light loam of 7 inches in depth on gravel, which rests on a subsoil of clay several feet from the surface. The wheat failed. There were thin patches here and there, with a very fine ear, and on the rest of the land nothing but weeds.

Case 2.

This experiment was made in 1845. The land was covered with a very thick grassy turf, which would have been very difficult to reduce without burning. This piece was intended to be planted with trees. It was pared and burned early in the spring, which produced a large quantity of ashes. They were spread regularly all over the land, and then oats were sown and ploughed in with a thin furrow. The oats were an excellent crop, at least 7 quarters to the acre. This was on poor land, worth about 12s. per acre—not more,—and not drained. The great abundance of ashes offered a good opportunity for assistance being rendered to other lands; but in this case it was impracticable, for want of other lands to take them to.

Case 3.

This farmer, in 1844, broke up a piece of land, a sandy loam of tolerable depth, with a stratum of gravel under, on a subsoil of Oxford clay. This land, in pasture, produced a very scanty herbage, and was grazed with young stock, and scarcely worth 20s. per acre. He pared, and burned, and ploughed, and sowed turnips, and bush-harrowed them in, the turf being of a looser texture than is often met with; but this operation did little more than cover the seed. He had a very fine crop, which was eaten off with sheep, and in autumn the land was sown with wheat, of which he had an excellent crop. His next crop will be Swedes, barley, seeds, and then wheat again. The method of putting in the turnips is not to be recommended as safe. Certainly not on all soils. About twenty years ago, I practised it myself on tender sward with success; but on very tough turf, full of the fibrous roots of vegetable substances, &c. &c., it failed.

Case 4.

This farmer, in 1843, broke up a piece of pasture-land, the half of which he pared and burned in autumn; and after spreading the ashes, sowed wheat, and ploughed it in with a thin furrow, and obtained a very good crop. The other half he ploughed up without paring and burning. The land was harrowed and dragged, and the wheat sown and dragged in. He had but a very bad crop, scarcely worth reaping, with abundance of
weeds. The soil of this land averages 8 or 9 inches deep, on gravel, which rests on a subsoil of Oxford clay. The succeeding crops on a four-field course answered very well.

**Case 5.**

In 1845, this farmer broke up a piece of land, and for the purpose of ascertaining what would "answer best," he pared and burned the sward of the entire piece, and spread the ashes. He then sowed half of it with turnips, and had them breast-ploughed in, covering the seed lightly with little more than the ashes, and had an excellent crop. The other half was ploughed twice or three times, and harrowed and dragged, with the view of doing it well, and reducing it to a fine state previous to sowing turnips. The turnips were sown with the land in nice order, soon after the others just mentioned, and he had nothing. The soil was a light darkish loam, inclining a little to peat, on gravel, with a subsoil of Oxford clay some feet under.

**Case 6.**

This farmer, an intelligent man, occupying a large farm, in the spring of 1845, broke up 11 acres of down-land, rather thin soil, on calcareous rubble, and determined to cultivate it in two ways for the sake of experiment. He pared and burned the whole of it, and removed about half the ashes to other parts of the farm, which were drilled with turnips. He then spread the remaining ashes, and had about 6 acres of it breast-ploughed, covering the ashes, and shortly afterwards went over it with Croskill's clod-crusher, in an opposite direction to that in which the land had been turned over with the breast-plough, and cut it into squares. It was then harrowed, and the turnips drilled, which are a good crop. After removing part of the ashes and spreading the remainder on the other 5 acres, he sowed turnips, using only half of the seed, and then breast-ploughed the ashes and the half quantity of seed in, and immediately after sowed the remaining half of the seed on the top, and bush-harrowed it in. This portion did not answer anything so well as the other, but the turnips were a better crop than some of his neighbours obtained after sainfoin pared and burnt.

**Case 7.**

In describing how this farmer intends to break up 11 acres of land of two kinds of soil in the same field, I shall only give the methods adopted by him on previous occasions, and which have always succeeded. The field he has now under hand lies at the junction of the forest marble with the great oolite, and is in consequence variable, part on rock and part on clay. The clayey part has been well drained. He intends to plant the part on the rock with turnips, and the other part with Swedes. His process will be as follows: To pare and burn the turf in the spring, as early as the weather will permit, and haul away half the ashes to be drilled with turnips on other land. To rafter-plough, and leave it for a month or so to the influence of the sun and weather; then drag it, to pulverize it as much as possible, and after having harrowed it, to plough it clean, with a slight furrow, and then drill white mustard with a portion of the ashes, on the lightest part, reserving the other portion for Swedes. The mustard will come up soon, and be ready for sheep in about a month after being sown.
The mustard is to be eaten off with sheep in folds, and the land immediately ploughed, dragged, harrowed, and then turnips are to be drilled with the remaining ashes. Of course, between the time of sowing the mustard on the lightest part, and its being eaten off with the sheep, the strongest portion will be cultivated and drilled with Swedes. Both the turnips and Swedes will be eaten off with sheep in folds; the turnips first, and the Swedes afterwards, and sown with wheat, unless circumstances render it desirable to reserve them until nearer spring, in which case the land will be sown with barley; but the former plan of sowing wheat is most usually practised. This method has been adopted by him on other lands before, and he has always had abundance of green crops and turnips, and plenty of good corn afterwards.

Case 8.

Another farmer very close to me, and whose operations I have watched with considerable interest, in the spring of 1844 broke up about 7 acres of land, situate on the forest-marble clay, with a covering of darkened soil 8 or 9 inches deep. After paring and burning, part of the ashes was removed to other parts of the farm, and drilled with turnips. This piece produced a large quantity of ashes, and the portion which was left behind formed a thickish covering for the land. It was ristbalk-ploughed, with a thin furrow, and left for a month exposed to the influence of the atmosphere. It was then dragged across and harrowed to pieces, and in June, ploughed with a clean furrow and sown with turnips, and afterwards rolled down. The turnips were an excellent crop, certainly more than 25 tons to the acre, which were nearly all eaten off on the land in September and November, a few being taken home and consumed in the stalls. The land was afterwards sown with wheat, and there is a very excellent prospect of a crop. The plant looks exceedingly healthy.

Case 9.

Although the last party alluded to succeeded to his "heart's content," the following is a more signal instance of that success which, with favourable seasons and opportunity, reward the activity and perseverance of intelligent men. This farmer has, in the years 1844 and 1845, broken up more than 40 acres of very poor pasture-land, situated on the forest-marble clay, some of very tenacious character, with a depth of 6 or 7 inches of soil on the top. These lands were first well drained at the expense of the landowner. The cost was nearly 4l. 4s. an acre, exclusive of hauling, which was performed by the tenant, who also superintended the workmen. He pared, and burned, and cropped the greater portion of it, after the manner of the last party referred to, and succeeded fully as well, if not better. A portion of this land which here more particularly claims our notice, was managed otherwise, with complete success. Instead of letting it remain idle for a month, exposed to the atmosphere, he determined on sowing it, as soon as the sods were burnt, with white mustard. This was done immediately, drilling it thick, 16 lb. to the acre, with a portion of the ashes, leaving a portion for the intended succeeding crop, half of the whole quantity, which was large, having been hauled away to other lands. The mustard succeeded wonderfully. In less than five weeks, it was ready for the sheep to eat off. The land was immediately ploughed up, dragged, and turnips drilled with ashes. The turnips were an excellent crop; they were, in their turn, eaten off with sheep in September and November; the land was then ploughed and sown with wheat, which, as may be supposed, is very promising.
I could select a multitude of instances of failure and of success, but it would be useless to multiply cases. It will be evident that the safest plan is always to let the first crop be a green crop, eaten off with sheep, by which the soil becomes pulverized and consolidated, otherwise it will scarcely bear a profitable crop of corn. When a corn crop is taken first, there is great danger of the crop failing, in consequence of hollowness produced by the tough nature of the under-turf, which atmospheric influences alone during the first year's crop fail to disintegrate. If the plants be not blown out of the ground altogether in the spring by winds, and a sufficient number escape the ravages of insects and the wire-worm, yet without consolidation by the treading of the sheep while eating off the previous green crop, a large quantity of straw is produced, which from its weight in a green state, and from the spongy texture of the soil, is very often laid, and the yield of corn very far short of the expectation of the farmer. But this state of things scarcely ever follows the eating off of the green crop, therefore we may at once decide that it would always be the best plan, first, to take green crops, which of course will vary with the nature of the soil; turnips on light lands, Swedes on a stronger soil, and rape on peaty soils. Should circumstances render it desirable to break up lands in autumn, August would be a suitable time before harvest commenced. White mustard should be drilled rather thick, which in about a month will be ready for the sheep. It should be eaten off on the land, which will be effected in good time for wheat. The treading of the sheep will break down the sods, and the land will plough up in a much mellower yet firmer state than it would have done without the green crop. Should any one venture to break up land, and to sow wheat without the intervention of a green crop, probably folding the sheep on the wheat, in the following spring, will be a means of saving the crop. This I have repeatedly seen done, and in some instances with much advantage.

It has been a custom for many years, on breaking up sward land, to commence the operation with paring and burning. This practice scarcely requires further experiment, to establish it as an essential preliminary. The burning kills insects that would otherwise devour the turnips and the succeeding wheat, it destroys the roots and seeds of weeds, and reduces to ashes the turf that would cover the land in the shape of loose sods, and render it too hollow for wheat after
TO TURN GRASS LAND INTO ARABLE. 265

the green crop. Burning produces, too, a highly fertilizing manure, composed of a mixture of ashes, burnt soil, and charred vegetable matter, impregnated with alkaline salts, which are known to be powerful promoters of vegetation. Generally speaking, land which is selected to be broken up is covered with a large quantity of coarse grass, furze, briars, blackthorns, straggling heath-plants, rest-harrow, sedge, rushes, and many other coarse and woody-stemmed plants, which could not be made to decompose with sufficient rapidity without burning. By burning, and especially stifle-burning, the roots, fibres, and stems of plants become charred, and are deprived of that tenacity which binds the sods together in matted masses.

The modes proposed for tilling each kind of land after being converted into arable, will in a great measure be indicated by the succession of crops named in our estimates. But the nature of the soil of our island is almost as variable as the rocks on which it rests, and therefore the rotations which I have named can only be applicable to a limited extent. They cannot be strictly applicable to all soils, nor to the same soil in different circumstances. There are exceptions to all rotations arising from situation, climate, soil, population; and, therefore, I dare not presume to offer them as applicable under all conditions. They are only indices of that system which may be successfully applied on soils having characteristics in common with those which we have mentioned. Even on the soils possessing those general characteristics, the crops may be very much varied from those which we have named. Thus it may occasionally be best to sow oats instead of barley, and beans, and other green crops, on a portion of the land which I have assigned for seeds, and many other changes may arise from circumstances, which will cause the farmer, indeed compel him, to deviate from those systems; but if he adhere to the one grand point of following the white crops with green crops, whatever system he may adopt will have nearly the same result as those proposed.

On thin light calcareous or gravelly soils, sainfoin will answer better than seeds, and therefore should be substituted. The strong fibrous roots of sainfoin operate on the thin loose soils of calcareous rocks, like the arundinacea on the sands on the sea-coast, in imparting cohesion to the soil. Sainfoin also produces, by the time it is worn out, a tough sward, full of vegetable matters, which by paring and burn-
ing furnish a large quantity of ashes, exceedingly useful to the succeeding turnip crop. It will, therefore, be desirable to sow sainfoin on all such lands, with the view of modifying the physical character of the soil, as well as to obtain manure for turnips, and a large quantity of feed from poor thin soils, sometimes exhibiting scarcely anything on the surface but the comminuted portions of rock, on which, however, sainfoin flourishes and remains in vigour for years. Downs are principally confined to the chalk, and there sainfoin will often take the place of seeds after barley, lasting for five or six years. It arrives at perfection the second year, and begins to decline about the fifth, after which the breast-plough is diligently used, and turnips succeed. In our estimates we have considered the green crop to be comprised in the term turnip crop, which is made up of tares or vetches on all the better kinds of light loams after wheat, which are the same season succeeded by turnips. On stiffer kinds of soils the green or fallow crops, which are to be partly consumed on the land, are composed of Swedes, turnips, cabbages, mangel-wurzel, vetches, and white mustard; and on good loams of a sandy character, in addition to those mentioned, carrots, peas, rye, and buckwheat; and, on peaty soils, rape. It will answer the farmer’s purpose to vary these green crops as much as possible, and not repeat the same kind on land that during the previous fallow had been planted with it.

In breaking up old sward land there are almost always more ashes than are required for the turnip crop. The surplus is taken away to other parts of the farm and drilled with turnips and bones, leaving the farm-yard dung in greater abundance for the Swedes. Newly broken up land may thus be rendered a source of improvement on the remainder of the farm. The ashes thus appropriated will cause a better crop of turnips to be grown on the other land for that season, which, when eaten off, will retain the sheep longer on the land, and create more manure, and ensure a better and more regular consolidation. This consolidation, as well as the increased turnip crop, is of great consequence on light loams, the effects being apparent through the entire course. More corn is the result, and of course more farm-yard manure. And when such land comes in turn for turnips again, it receives a better and heavier dose of this, the best and most useful manure.

With the modern good management, and plenty of green crops, to break up a piece of sward land is of considerable
benefit to the whole of the farm. It enables the tenant to commence the improvement of his land in the most simple and economical manner.

It will not be desirable to attempt to make thin soils deeper by ploughing up the hungry rubble or poisonous clay from beneath all at once. If done at all, it should be done gradually, and each successive attempt be made before winter, to give the land a chance of becoming tempered by the frost and reduced by atmospheric influences. In spite of what is said in favour of deep ploughing in the north, it will not answer on all soils, and even on those that would in the end be improved by being deepened, it would not be advisable to do it all in one season.

On the choice of Land to be broken up.

Our prescribed limits will not admit of this portion of the subject being treated at length; I shall, therefore, only insert a few summary observations. Probably they may not be the less useful for assuming this condensed appearance.

**Lands that may be broken up.**

Chalk downs of good depth of soil.

Chalk downs of the depth of 5 or 6 inches on farms where there is a great portion of down land, but care must be taken not to harass the land with too many corn crops.

Lands of light, dry, sandy, gravelly, rubbly nature, on a rocky or porous subsoil, with a southern aspect and gentle inclination.

Large tracts of rough pasture, now of no great value, which are used for rearing young stock, especially that with a clay subsoil, or gravel on a subsoil of clay, which is kept cold and moist through want of draining.

All cold pastures, with a subsoil which changes to a marly substance on being dried, and which becomes shivery and splits upon being wetted again, and which falls to pieces on being exposed to the atmosphere.

Strong shallow loams on limestone rubble.

Dry loams intermixed with clay.

Deep moist running sands that are favourably situated for turnip culture.

Lands of moderately light sandy nature, but of considerable depth, on porous rock, or on gravel of a considerable depth, on a tenacious subsoil.

Peaty soils with subsoils of calcareous clay. The clay may be serviceable in consolidating and imparting cohesive power to the peat. Gravel will sometimes have the same effect. Peaty soils should, if possible, be converted into water-meadows.

Very stiff soil, with little surface-soil, for the purposes of field-gardens, to be cultivated by the spade, or in cottage farms of a few acres.

Heavy, cold, clay lands, which are rendered porous and friable by
draining, but near to and adjoining large towns. This description of land should be reserved to supply milk, butter, &c. &c. to the inhabitants, which would pay the farmer, and, of course, the land-owner, as well as perhaps better than it would if it were broken up. Such lands are favourably situated for improvements from manure, compost, &c.

Heavy lands that are stiff and tenacious throughout their substance because of the moisture they retain, but which change their texture by draining.

Cold sandy loams, forming pastures of a medium character, frequently occupied for dairy purposes, which cannot always be denominated cold clays, but rather cold sandy loams on a tenacious subsoil, from the abundance of moisture they contain, and which are comparatively barren from want of draining and better cultivation.

Pastures intrinsically of a secondary character, and a portion of those which have been reduced to that state by long-continued careless dairy management. Breaking up will recruit the former, and enable the latter to recover their lost fertility.

Lands of this description might be made a great deal more of than they are at present. They might be so far improved as to supply the deficiency of dairy produce which would arise from breaking up one-fourth of the whole quantity of such land. All the farmers thus situated would afterwards find it unnecessary to purchase wheat. The quantity to be broken up must always be governed by circumstances. There are situations where it would not be desirable to break up more than 10 per cent., just barely enough to produce straw, &c. for litter; and on others half to three-fourths the farm; but this cannot be recommended to be done at once. Probably the situations are not very numerous where it would answer to do so; and any prudent person, of course, would feel his way by beginning on a small scale at first. On dairy farms without arable, 20 to 30 per cent. may be appropriated for arable culture, but this should not be all undertaken at once. If done by degrees, the effect may be watched; and, if unpropitious, the coming storm may be averted by desisting in time. Except in peculiar circumstances, I am not prepared to advise a greater extent to be broken up.

Lands that should not be broken up, or concerning which the farmer should deliberate, and be fully satisfied of the nature of the undertaking before he begins.

Very stiff clay soil, with little or no surface-soil, and not drained, should be trenched and planted.

Elevated poor sandy or rocky clayey soils should be planted in preference.

Lands that are poor from the thinness of the soil.

Very light shallow loam on rock, limestone, &c.
TO TURN GRASS LAND INTO ARABLE.

Very thin chalk soil which exhibits the naked rock, or coarse debris of the chalk, on or very near the surface.

Deep moist running sands that cannot be conveniently drained, should be trenched and planted.

Poor clay soils, on a cold-bottomed retentive subsoil, and northern aspect.

Very poor ferruginous sands which are covered with heath, unless in peculiar circumstances.

Rich feeding pastures.

Water-meadows, and those that can by any likely means be converted into water-meadows.

Fine rich alluvial pastures and meadows.

Dairy farms near towns: lands which are occupied for the purpose of supplying the inhabitants with milk.

Rich pasture lands.

Lands which are liable to floods. If converted into arable, the best portion of the soil would be in danger of being swilled away.

Lands adjoining and near to the homestead. This rule is frequently violated on the chalk.

Salt marshes; and doubts may arise about other marshes: locality, and facility for draining them, will best determine their eligibility.

Very stiff clay that would require to be summer followed for wheat. Small portions for spade culture may be excepted. Such lands may be much improved in pasture by draining, and occasional swillings with liquid manure; and frequent dressings with soil, rubbish, road-scrapings, &c., made into compost, and spread over them when practicable.

Elevation of Lands above the level of the Sea to be considered.

Lands much elevated, apparently possessing the qualities which would in other situations determine their eligibility, would not answer, because of the crops not ripening in a kind and natural manner. I should hesitate to convert any land into arable raised more than 1000 feet above the sea, unless the aspect was favourable, and the locality not farther north than the 53rd degree of north latitude. When situated at or beneath this level, aspect will assist us a little in our choice. Thus, if we have two fields at an elevation of 1000 feet, one with a southern aspect, sloping away at a gentle angle, and the other with a northern aspect, also sloping away with a moderate angle, and we wish to convert one of them into arable, our choice would naturally fall on the field with a southern aspect, because, at this critical point, aspect alone might be sufficient to turn the balance. Corn grown above the height of 1000 feet is uncertain of producing good grain: hence, to break up lands much elevated, unless something local sanctioned the proceeding, would be to
exchange a certainty for an uncertainty, a step which generally indicates a deficiency of judgment, and which is of too speculative a character for the cautious agriculturist to indulge in.


How Pasture should be broken up.

All clay pasture lands should be pared and burnt; there are many advantages attending this operation in all cases, but there are some peculiar to clay lands—such, for instance, as the improvement it effects in the texture of such soils. At the same time it should be remembered, that land when wet will appear to have an adhesive texture, which when drained will prove a friable open soil; and therefore no decision on this subject is advisable until after drainage. The object of the landowner in naming the terms (on this head) on which he will permit the farmer to break up grass land, should be to arrange so that he may have half of his land in green crop and half in grain during the first and all succeeding years; and in the case of clay land it is necessary to burn all, because while there is no immediate necessity for it in the case of that half of it which is to be sown with oats, beans, or wheat, as the case may be, yet on such soils the sward will not have been sufficiently reduced by the ploughing and rest for a year, which that half of it will thus receive, to answer for the green crop, which in the succeeding year follows those crops. In the case of light land, however, there is no such difficulty, and therefore on such soils it will be advisable to plough up the half intended for grain crops (it will thus be sufficiently rotten and reduced by next spring for green crop culture), and to pare and burn the half intended for turnips, Swedes, &c. That was the mode adopted on the farm I now occupy; about half of it was ploughed and half pared and burnt. A great crop of oats, and a great crop of turnips, was thus obtained, and a large stock of sheep and cattle were thus kept during the first winter; a large stock of manure was thus produced, and a sure foundation thus laid for the permanent fertility of the land.
The farmer has to superintend and bear the expense of all these operations. We have put the amount of expense he will incur beyond the ordinary cultivation of the land at 30s. per acre on half of the pastures converted. If he enters on the land at Michaelmas, which will be the most convenient term for him, he will be able to plough those grass lands which are to be ploughed, in the autumn (we suppose all the landlord's operations, except the buildings, to have been completed). The grass should be cut close, and the land ploughed about 4 inches deep; and it will be the better of being rolled before winter, so as to press the furrow-slices home, in order that no grass may grow between them. In March, 4 bushels of oats per acre may be sown broadcast—they will fall into the furrows and spring up as if they had been drilled—they should then be harrowed up and down and across the former ploughing; rolled, and left till harvest. The farmer will also, during winter, be able to get all the hedgerows that are to be removed grubbed up.

With regard to those fields which are to be pared and burnt, they must lie till the spring; but in ordinary seasons there will be no difficulty in getting them ready, part for Swedes and part for common turnips. They may be pared either by hand or by plough; in the latter case it is right to cut the land by circular shares, arranged on an axle and weighted, so that they shall pierce the sward in lines about a foot apart. The paring-plough in crossing them, and turning over a furrow-slice about 10 inches wide, will turn over, not a continuous riband of turf, but a series of patches about a foot long, 10 inches wide, and 1 inch deep. These are more manageable in the burning. This ploughing, I imagine, will cost about 9s. or 10s. per acre. I have had no experience of it. All this farm was pared by hand, by the breast-plough, at a cost of about 12s. per acre. The burning, which should be done in as large heaps as possible, and as slowly as possible—the one to ensure against the fires being put out by every passing shower, and the other to ensure black ashes—will cost about 10s. or 12s. an acre more; and the ashes where the turf has been cut about an inch deep, will cost 3s. or 4s. per acre to spread—the burners being allowed the rubbish off and out of the adjacent grubbed up hedgerows to assist them.

The next operation is to plough this land as shallow as possible (say 3 inches deep), in narrow furrow-slices, and thus bury the ashes. The ploughed land should then be
Rolled hard, and then harrowed twice or thrice lengthways; and, lastly, twice or thrice across the ploughing—and the soil should by that time be pretty well torn to pieces. Let the land be then again rolled, and ploughed 6 inches deep across the former ploughing. This will bring up the 3 inches of fast land below the ashes, and bury those 3 which had been on the surface; the ashes, as before, being between them, or 3 inches deep in the ground. If the same succession of rollings and harrowings be again repeated, the land will be ready for that drilling up at intervals of about 26 inches, which prepares it for the seed. The additional cost in preparing turf land for the seed, may fairly be put at 30s. per acre over the cost of preparing arable land. In ordinary seasons, a large extent of grass land may thus be broken up in one season, half of it being got ready for a crop of Swedish, and the other half for a crop of common turnips.—M. S.

_Agricultural Gazette, Oct. 3rd, 1846._

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**Art. LXI.—ON DRESSING GRASS LAND.**

**By Mr. J. Smith.**

The following remarks may, perhaps, be useful both to those who are inclined to try the effects of artificial manures, especially guano, and to those who have done so. I have under my charge a hundred acres of grass land, in very poor condition; and as my employer is likely to be in possession of it for several years, of course the sooner it can be improved the longer time he will have to reap the benefit. Farm-yard manure cannot be got here without costing twice its value for carriage; and therefore I thought something less expensive and easier to be got at, would better suit my purpose. Some of my friends recommended a dressing of marl, there being plenty on the estate; others soot; others salt, &c.: but I was rather doubtful of the efficacy of some of these. I thought it advisable to try a small quantity of each as an experiment for the first year, and I selected a piece of ground as nearly as possible equal in quality, which I divided into quarters of acres. To have the pieces as near each other as possible, I lined them off at half a chain in
width, which increased them in length, giving each the chance of greater variety of soil, should there be any. The following table shows the different manures, the quantity applied, the time when applied, the cost, including preparation and the labour of applying them, the weight of produce compared with that where no dressing was put on, at the time of putting into the stack, calculating the value at 4l. per ton. The produce was cut on the 7th of July:

Without Dressing.

<table>
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<tr>
<th>Manure</th>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guano, 9 cwt.</td>
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<td></td>
</tr>
<tr>
<td>Produce</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Deduct</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Value of extra</td>
<td>1</td>
<td>16</td>
<td>2</td>
<td>4</td>
<td></td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Deduct cost of</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Leaves gain of</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total profit</td>
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<td>13</td>
<td>11</td>
<td>2</td>
<td></td>
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Guano, 5 cwt. per acre, applied March 24th.

<table>
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<tr>
<th>Manure</th>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£</th>
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<tbody>
<tr>
<td>Guano, 5 cwt.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produce</td>
<td>1</td>
<td>16</td>
<td>2</td>
<td>20</td>
<td></td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Deduct</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Value of extra</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Deduct cost of</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Leaves gain of</td>
<td>0</td>
<td>13</td>
<td>1</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total profit</td>
<td>£0</td>
<td>8</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Guano, 3 cwt. per acre, applied March 24th.

<table>
<thead>
<tr>
<th>Manure</th>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guano, 3 cwt.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produce</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>20</td>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Deduct</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>20</td>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Value of extra</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>20</td>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Deduct cost of</td>
<td>0</td>
<td>12</td>
<td>0</td>
<td>20</td>
<td></td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Leaves gain of</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total loss</td>
<td>£0</td>
<td>13</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Soot, 20 bushels per acre, applied March 29th.

<table>
<thead>
<tr>
<th>Manure</th>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soot, 20 bushel.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produce</td>
<td>0</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td></td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Deduct</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Value of extra</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Deduct cost of</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>11</td>
</tr>
<tr>
<td>Leaves gain of</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total loss</td>
<td>£0</td>
<td>2</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Coal-ashes, 224 bushels per acre, applied April 10th.

<table>
<thead>
<tr>
<th>Manure</th>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal-ashes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produce</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>20</td>
<td></td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Deduct</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Value of extra</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Deduct cost of</td>
<td>0</td>
<td>12</td>
<td>2</td>
<td>12</td>
<td></td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Leaves gain of</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total loss</td>
<td>£1</td>
<td>6</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Lime, 12 quarters per acre, applied April 10th.

<table>
<thead>
<tr>
<th>Manure</th>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lime, 12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Produce</td>
<td>0</td>
<td>11</td>
<td>3</td>
<td>20</td>
<td></td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>A decrease of</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>20</td>
<td></td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Total loss</td>
<td>£2</td>
<td>17</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

T
Marl, 24 tons per acre, applied April 10th.

<table>
<thead>
<tr>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produce</td>
<td>0</td>
<td>9</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>A decrease of</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

Total loss. £3 2 11¼

Salt, 2 bushels, per acre, applied March 23rd.

<table>
<thead>
<tr>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
<th>£ s. d.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produce</td>
<td>0</td>
<td>7</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>A decrease of</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>24</td>
</tr>
</tbody>
</table>

Total loss. £1 5 1

The following table will show the advantage the 9 cwt. of guano has over the 5 cwt. and the 3 cwt. per acre:

<table>
<thead>
<tr>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The extra produce of 9 cwt...</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Ditto</td>
<td>5 cwt...</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Balance of 9 cwt. over 5 cwt...</td>
<td>0</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Value... £2 2 1½</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The extra produce of 5 cwt...</td>
<td>0</td>
<td>13</td>
<td>1</td>
</tr>
<tr>
<td>Ditto</td>
<td>3 cwt...</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Balance of 5 cwt. over 3 cwt...</td>
<td>0</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>Value... £2 7 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ton.</th>
<th>cwt.</th>
<th>qr.</th>
<th>lb.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Here 9 has the balance over 5 of</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Value... £4 9 4¼</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It is thus proved, by the above, that only two out of the eight dressings will meet their expense, that of the 9 and the 5 cwt. of guano to the acre; and this also shows that a little will not do. People are very liable to err by trying small quantities: they say, we will try 1 cwt. to the acre, and, if we profit by that, we will try more next year; but when they compare the produce with the expense, they find they are great losers, and the manure is condemned. Manure is to the soil what medicine is to the human frame. For instance, we may have an inward complaint, and take one pill to cure it; to-morrow, being no better, we take another; next day the same, and so on, perhaps, for twelve months; but if one dose does no good, and we take three, we get relief almost immediately, and the cure is certain; this is on account of the more powerful stimulus: had we taken it in time, one pill might have proved effectual; but we neglected it till it got too deep a hold, and beyond the power of one, and therefore it required three. It is exactly the same with this poor land; it has got beyond the power of
3 cwt. of guano, and consequently we must give it 9 cwt. of guano before the desired effect is produced. Again, we have medicines which are quick to operate, and vice versa; it is the same with manures: therefore, I cannot condemn those that have not yielded me profit this year. I shall see what next year does; perhaps they may yield double crops, and for years to come, when the more stimulant sorts are exhausted. I have at times applied lime with the greatest success, especially on stiff cold land. (This, on which the experiment was made, I may mention, is of a gravelly flinty nature, with a chalk bottom.) Part of the failure in the lime I attribute to its being put on late; but still it was on before the grass had made any growth. I may also state, that where the guano was applied, the hay was of very superior quality, and fit for cutting three weeks before the others, which would have insured a good second crop by this time, as it is now in advance of the others. Next year I mean to try the manure water; but as the quantity will be limited, I must have other manures as well. Perhaps some of your correspondents will be kind enough, through the medium of your paper, to state what with them has proved the most beneficial, also the quantity applied, and the mode of applying it, &c.

United Gardeners' and Land-Stewards' Journal.

Art. LXII.—ON THE CULTIVATION OF THE RED CLOVER, AND THE CAUSES OF ITS FAILURE.

By Robert McTurk, Esq., Hastings Hall, Dumfriesshire.

[In considering this subject, Mr. McTurk reviews the different opinions that have been maintained as to the cause of the gradual deterioration which ensues, when the same variety of crops has been cultivated on the same field for a number of years consecutively, or even at short intervals. For although this condition has been more apparent—or more closely observed of late years in its relation to the red clover than to any other crop—it is one of more general bearing, involving, in fact, a fundamental principle of vegetable physiology, whose influence is co-extensive with the whole vegetable kingdom. We shall only name the theories noticed by the author of this Essay, in order that we may pass to its more strictly practical portion.]
1. The necessity of an alteration of crops is presumed to be owing to a peculiar excretion or discharge from the roots of plants, rendering the soil unfit, for a time, for the healthy growth of the same kind of plant.

2. After repeated cultivation of the same variety of plants, the soil becomes exhausted of the ingredients which constitute the specific nourishment of such plants.

3. The failure (of the red clover in particular) has been attributed "to a want of a certain degree of cohesiveness in the particles of the soil." Hence the soil's power of retaining heat is diminished; and all plants, particularly clover, which are impatient of sudden changes of temperature, are thus easily destroyed by the frost.

Of these opinions, Mr. McTurk adopts that which bears the stamp of this inductive age, viz., that plants degenerate in soils which do not supply them with a sufficiency of the elements of which they are composed—of what, in animals, would be called their food. He proceeds to consider this, as well as other circumstances, important to the successful cultivation of the red clover.

It now remains for us to show that there are various causes which have all more or less influence in occasioning the failure of the clover plant, and to endeavour to point out the means by which the evil may be remedied.

When we ascertain the composition of any plant, we will find that the proportions of its organic and inorganic constituents are, in many respects, different from every other plant, however nearly allied it may be to them all, and that even the different parts of the same plant contain those same constituents in different proportions. In so far as the inorganic constituents are concerned, there is no source from which they can be derived in sufficient abundance but the soil; and as these substances are found to exist in the soil in very unequal quantities, there is no doubt but that, while one kind of plant is withdrawing one substance in greater amount, another is appropriating another substance in a larger degree; and so it is with every crop. It is therefore evident that, unless these substances are restored in quantities equal to what have been abstracted, the soil must, in course of time, be exhausted. It is also evident that, while some of these substances readily accumulate in sufficient abundance from the decomposition of matter which is continually taking place, others are very slowly restored, and some scarcely at all, unless when contained in the manure which is from time to time applied. It may be observed that, in the course of the ordinary operations of husbandry, some of the more soluble of these substances may be carried down by the rain into the soil, while in a pulverized state, in greater abundance than they are produced by natural causes, to a depth
to which the roots do not extend. Under these circumstances, it is not to be wondered at that the soil should be sooner unfitted for the growth of some crops than for others; and especially for those crops which require a larger amount of those substances which, in the first instance, exist in the soil in more limited quantities, or which are more soluble, and carried away by rain to a depth beyond the reach of their roots. ¹ This is, perhaps, more the case with red clover than any other plant, which will be more apparent when we avail ourselves of the aid that chemistry affords. It tells us, in the first place, that 1,000 lb. of red clover, in the dried state, according to the analysis of Sprengel, contain the following proportions of inorganic matter:

<table>
<thead>
<tr>
<th>Substance</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potash</td>
<td>19.95</td>
</tr>
<tr>
<td>Soda</td>
<td>5.29</td>
</tr>
<tr>
<td>Lime</td>
<td>27.80</td>
</tr>
<tr>
<td>Magnesia</td>
<td>3.33</td>
</tr>
<tr>
<td>Alumina</td>
<td>0.14</td>
</tr>
<tr>
<td>Silica</td>
<td>3.61</td>
</tr>
<tr>
<td>Sulphuric acid</td>
<td>4.47</td>
</tr>
<tr>
<td>Phosphoric acid</td>
<td>6.57</td>
</tr>
<tr>
<td>Chlorine</td>
<td>3.62</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>74.78</td>
</tr>
</tbody>
</table>

From this analysis, we learn the very large proportion of potash which red clover abstracts from the soil, when contrasted with the other crops with which it is generally associated in the course of a regular rotation.

Wheat contains in 1,000 lb. of the grain 2.25 lb. of straw, 1,000 lb. of barley 2.27 lb., 1,000 lb. of oats 15.0 lb., 1,000 lb. of rye-grass hay 3.31 lb.

If we allow that the straw is double the weight of the grain, then in 1,000 lb.

- Of wheat, there is only 0.89 lb. of potash.
- Of barley 2.13 lb.
- Of oats 6.30 lb.

Thus we see that 1,000 lb. of red clover requires nearly as much potash as is contained in twenty times the same amount of wheat, eight times the amount of barley, and

¹ See Professor Johnston’s Lectures on Agricultural Chemistry, p. 235.
three times the amount of oats, and twice of rye-grass, the very crops which are made to form part of the rotation along with it. ¹

Besides, potash is one of those substances which has a strong affinity for water, and is, on that account, very soluble in every state of combination in which it is found in the soil; hence its great liability, when the land is under cultivation, to be carried off by rain. This observation, however, applies more to the rain which falls in inland situations, or to those localities which are screened from the sea by some high mountain range; for there is good evidence to show that portions of the various saline substances contained in sea-water, and which contribute so much to the fertility of the soil, are often carried to considerable distances from the shore.² We may further observe, that it is owing to the still greater amount which the different green crops require of inorganic as well as of organic food, that a large application of manures is found to be necessary for their growth, in which case those substances cannot be said to be abstracted from the soil.

Although these remarks are made more particularly in reference to potash, as the substance which, with the exception of lime, enters more largely into the composition of clover than any other, and one which is more apt to be washed from the portions of the soil which is subjected to frequent cultivation, still they are applicable to other inorganic constituents, though many of them are less soluble, and exist often in much larger proportions than potash. This view of the case helps to explain why the red clover crop is less abundant on land which has been frequently cultivated, and why its failure is more perceptible on inland situations, than in those more exposed to the sea. But there are often causes of failure on soils which cannot be said to be deficient in any of the substances essential to the growth of this crop.

In the spring of 1841 we commenced a series of experi-

¹ Gypsum has been strongly recommended by Sir Humphry Davy, and other writers on agriculture, as a valuable manure for red clover; but we have found that coal, peat, and wood ashes—particularly the ashes of ash-wood—are much more efficacious. This is chiefly to be attributed to the potash which they contain.
² Liebig's Agricultural Chemistry, pp. 110, 138. And we believe that Dr. Madden, when at Penicuick, had satisfactorily proved, by a series of observations there recently made, that the rain which falls between the sea and the Pentland hills contains more saline substances than the rain which falls beyond that range.
ments, with the view of obtaining some information on this subject, and conceived that we were more likely to arrive at the truth by beginning at the germination of the seed, and marking with care the progress which it made in the different stages of its growth. A piece of ground was selected adjoining the house, the soil consisting of a light fresh loam, and as much alike in character as one soil could be. Two rows of boards, 8 inches broad, were placed edgeways, parallel with each other, at 6 feet apart in the ground. The earth was then put in, and equalized between the boards till an inclined plane was formed by it, with a rise of 1 inch in the foot. The earth was thus level with the upper edge of the south board, and 6 inches below the upper edge of the north one. This inclined plane, though only 6 feet wide, was 70 feet in length. Sixty-eight gentle impressions were made upon the mould with the handle of a rake, after the plane was made as smooth and uniform as it could be. In those impressions, the same number of the different kinds of seeds most commonly used in agriculture were sown,¹ and more earth was then put in till it was level with the upper edge of the boards. The seed sown in this way, had little or no cover of earth at one end of the rows; but the cover gradually increased, till it reached a depth of 6 inches at the other end. The boards enabled us to make this cover with great accuracy, so that at every part of the rows in which the seed germinated, there was an inch of additional covering of soil for every foot in length; so that by applying the foot-rule to the surface, we could ascertain at any time the depth of the seeds, and by assuming the half of the space in which the seeds germinated, that gave the proper depth of covering. The seeds were equally exempted from the risk of germination, being prevented by too much cover, and at the same time from being lost, in case of dry weather, from having too little. We thus arrived at what may, with confidence, be regarded as the proper depth at which clover seed should be placed; and of six samples sown in this way, namely, English, French, American, Flemish, Juliers, Sucklings, the average, and therefore the proper depth may be stated at 1 inch.

There is no doubt that seeds will germinate at a greater depth in a light gravelly or sandy soil than in a clayey

¹ For these, we are indebted to the kindness of Mr. Thomas Kennedy, nursery and seedsman, Dumfries.
one; but we consider the soil in which the experiments were made as equally removed from both these extremes, and, in this respect, as of a very fair average for an experiment of the kind.

Having ascertained the depth, we proceeded, in the first week of June in the same year, to find out the proportion of seeds that might be expected to germinate in a given number of medium quality, such as are commonly sold in the shops. Out of 500 seeds sown in rows, at a distance of 6 inches in the row, 426 germinated; showing a deficiency of nearly 15 per cent. Out of one of Mr. Lawson's best samples of 500 seeds sown, 475 germinated; showing a deficiency of only 5 per cent. This was not the only loss sustained at this stage of their growth, for before they had attained to what might be considered the rough leaf, there was scarcely a plant for every two seeds sown; showing a deficiency of at least 50 per cent. The insect which chiefly committed these depredations was the same that so often destroys the turnip crop; although we cannot say that the slug had no share in them. In these experiments it was not our object to destroy insects, but rather to learn the extent of the ravages which these enemies of agricultural plants are capable of committing. Whether they have been as destructive in former years we have no means of knowing; but it is not unlikely that they, like every other species, may increase with the means of subsistence, and for whose support the extended cultivation of the turnip crop makes ample provision.

From what has been said on this part of the subject, it must be obvious that, even under the most favourable circumstances, much of the seed committed to the soil never attains maturity. When we think of the great disadvantages to which its seeds are exposed in field cultivation, the numberless chinks and crevices in a soil but moderately rough, in which they may be cast, it is not to be wondered at that from this cause alone the expectation of the cultivator should sometimes be disappointed. No clover seed should ever be sown until the soil intended to receive it is made as fine and light as straight-toothed harrows can make it, to fill up the crevices, and only one strake should afterwards be given with them. There is another practice in many districts of Scotland, of eating down young grass with sheep and other stock occasionally, from which much injury is sustained. It is but too common to see the grasses nipped as close to the surface as teeth can reach; and we have often
OF THE RED CLOVER.

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observed clover, by this treatment, nipped over at the neck, which must, in every case where this happens, prove fatal to it; but although it may not have sustained injury to this extent, still it is stripped of its leaves, and these, from the way in which they come out from the stem, and spread around it, are well adapted to afford the required protection to the stem and root. It is true that the leaves themselves are often laid prostrate by the severity of the frost; but this only causes them to fall around the neck, and cling more closely to it. We would not be understood as condemning all pasturing of young grass, for this often proves a great convenience for sheep; and we have invariably found it an unfailing antidote to inflammation of the bowels, or braxy—the disease to which young sheep are most subject; but we most decidedly condemn it when carried so far as to deprive the clover of all protection. Upon the same principle, we also regard the practice of mowing the grain crop with which the clover is sown, as very hurtful to the young grasses.

Having arrived at the knowledge of these facts, with regard to the depth of clover and the depredations of insects, we began in the following spring another set of experiments, at the same time allowing all the clover plants of the previous year to remain in the ground, with the view of watching their future progress. We then set off a piece of ground, 10 feet square, and divided it into equal parts of a foot each; 400 clover seeds were then selected from Mr. Lawson's best sample, one-half of which were of the lighter yellow, and the other half the dark purple-coloured variety; and the yellow was sown in the one-half of the ground, and the purple in the other, to ascertain if there was any difference in their germination or durability in the ground; but in both respects there was scarcely any difference, the yellow, by a few plants, having the advantage in germination. Four of the selected seeds were planted in the centre of each foot of the ground previously laid off, with the intention of insuring one plant in each division; and as soon as the plants were considered out of danger from insects, only one was left in each space. Mostly all were in flower in September; but in this respect there was considerable difference; and all were cut down by the end of the month, that their treatment might be similar to what they would have received if grown with a crop. With the exception of six plants, they all survived the winter, and we believe they were those which were most advanced at the time of cutting, and after which
they exhibited but little symptoms of throwing out fresh leaves. In this experiment no manure of any kind was applied, as the object was to obtain a knowledge of the durability of the red clover in the ground, when grown under the most favourable circumstances in regard to space and new soil. The ninety-four plants which survived the winter grew most luxuriantly in the summer of 1843, some of which brought to perfection fourteen stem-flowers, and none fewer than six, at the beginning of August, at which time one-half were cut down, and the other half allowed to grow to the end of September, much about the time that the second crop attains its maturity, when we found that the plants which had thrown out the greatest number of flower-stems, when cut in August, were deficient in the number of their stems to the plants which were less vigorous at that time. After the September cutting they began to throw out leaves of a more sickly character than they had yet exhibited, but no flower-stems. Not more than nine plants survived the winter; and the only indication of their having done so was but a few sickly leaves, which made their appearance in April 1844, after which they died.

It appears from this experiment, and also from the duration of the plants of the first experiment in which we tried to find out the proper depth of cover, that all the different varieties of red clover generally cultivated in this country, whether the seed is from Holland, America, or any other quarter, are biennial, instead of perennial, as they are often represented to be. It is true that we often find plants of red clover, in fields which have been sown out with it, years afterwards; but these have arisen from seeds which were placed under circumstances unfavourable to germination. As, for example, besides a sufficient depth of earth, stones are often pressed down with the roller upon the top of seeds, the air excluded, and germination for a time prevented. Next spring the stones are taken away on account of the hay-cutting; or they are turned over by sheep in winter, when this obstacle to germination is removed; but instead of in the first spring, this change in circumstances might take place at any future period, and the seed will spring up then, if it has not lost its vitality. Besides, there is a variety of red clover which is perennial, and indigenous to many soils of this country, more especially the drier parts of meadow land which have not been ploughed; but the seed of this variety is not commonly sold in the shops.
Much about this time our attention was particularly directed to the improvements of Francis Maxwell, Esq., of Gribton, a gentleman in this neighbourhood, who, several years before, had commenced spade-trenching and thorough-draining on a very extensive scale. He had completed seven or eight fields of large extent, but of the worst quality on his estate, with thorough-draining and spade-trenching fifteen inches deep. We had almost constant opportunities of seeing the same fields for more than twenty years before these improvements were commenced. None of them were worth more than twelve shillings per acre, exclusive of the local advantage which they possessed; and others were of the very worst description of land in the country. They had at first been broken out of thin moor, with a cold and retentive tilly subsoil. The crops which they had yielded were very scanty, such as might be expected from such land. The clover never deserved the name of a crop. The fields had been limed in the first stage of their cultivation, and also slightly after being trenched. The rotation of crops taken after the improvements was first oats, then potatoes or turnips, then barley or oats, all of fair quality, and at the same time sown out with rye-grass, and red and white clover. The healthiness of the red clover, on some of the fields, was very evident after the grain crop was cut, and also in the rye-grass hay; but the after-crop of the clover in October seemed one solid mass, and in several parts was completely lodged. These improvements on a large scale coincided with some experiments we had been making on a small one. That land which has been frequently cultivated, and which has become clover-sick, may be benefited by deepening the soil, and bringing a portion of those substances to the surface, of which it is either exhausted by the repeated cultivation of the clover, or which have been carried down by rain, is a fact every day receiving the additional testimony of those who have had recourse to subsoiling; and, although the advantages of such operations are very evident on other crops, on none is it more so than red clover.

It may now be proper to show how the alkalies are restored to the soil, when rest or pasturage is substituted for cultivation. All soils consist of disintegrated rock; and whether these changes may have been, in the first instance, produced by some mighty cause, which produced more immediate results than we see in operation at the present time, agents are still constantly at work in the atmospheric
changes of heat and cold, wet and dry, which are not less capable of accomplishing the disintegration of the hardest materials of which the globe is composed, and, in course of time, their decomposition also. By marking the operation of these agents, we learn the process by which the alkaline bases are made to form part of the soil, and the various saline combinations into which they are enabled to enter. Rocks of every formation contain some one or other of the alkalies, and often more than one, according to Liebig. Feldspar contains not less than 17 per cent. of potash; albite 11 per cent. of soda; zeolite, 13 per cent. of both alkalies taken together; granite, greywacke, porphyry, basalt, clay-slate, clinkstone, sandstone, lime, lava-loam, contain each their certain proportions; and the decomposition of any one of these rocks must always restore to the soil one or more of the alkalies. In the course of cultivation, there is always a constant breaking down of the materials of the soil, to which the tear and wear of the iron implements employed bear ample testimony; and although portions of the stones (fragments of the different rocks) of which they consist are in this way pulverized, still they supply no new food for the succeeding crops until they have been decomposed, and rendered soluble—changes which will then be more speedily effected, and the alkalies restored in greater abundance, than required for the purposes of pasturage. Carbon, azote, and the elements of water, which, in different proportions, unite to form so many of our most valuable animal and vegetable substances, and which are equally essential, are derived from other sources which can be more readily supplied to the soil; but, until of late years, when science began to lend her aid to agriculture, the application of the alkalies (with the exception of lime), as necessary constituents of every fruitful soil, formed no part of the practice of agriculture; and it is only when these substances are exhausted that a soil is reduced to the sterile condition alluded to by Liebig, when he says, that "no quantity of manure could fertilize it for the production of certain crops;" and not, as he attributes it, to the injurious nature of the substances excreted from the roots.  

1 Although Liebig gives countenance to the doctrine of radical excretion, which we have previously quoted, there is scarcely a chapter in his Chemistry of Agriculture, in which he does not, in one shape or another, recognise the truth which we have here stated. "It must be admitted," he says, "as a principle of agriculture, that those substances which have
In these observations we have pointed out the causes to which the failure of the red clover crop is chiefly to be attributed, and shall now, in conclusion, shortly advert to what has been advanced on that subject, as well as on the remedies suggested.

1st, We see, then, that much seed is lost from falling into chinks and crevices; and that, even in certain conditions of the soil, with the common harrow, so much cover may be given to the seed as to prevent its germination. This is more particularly the case when the soil is rough or damp, or of a heavy and impervious character. Clover seed can scarcely be sown in such descriptions of soil without more than one-half of it receiving from two to three inches of cover; and, when rolled, it is entirely lost. It would be much better, under such circumstances, to sow the clover seed after the harrowing has been finished, and simply to roll afterwards, and in this way rather to risk the chances of its being destroyed by an over-dry summer: the chances are at least three to one in its favour, the circumstances favourable to the growth of red clover being a dry or well-pulverized soil, and not more than one inch of cover.

2nd, It is also evident that a very large proportion of the plants, in the first stage of their growth, are liable to be destroyed by insects and slugs. At the present time, we are aware of no remedy of general application for the evil but to sow less sparingly. In many districts the neglect of this precaution is too common an error. The quantity allowed in some is from 4 to 6 lb., in others from 6 to 10 lb., and in some of the finer lands still more. Suppose, then, that in the first of these 5 lb. are given to the imperial acre of seed of average quality; 1 this is only one seed to every ten square inches; and if we deduct one-half for the loss sustained in germination and by insects, we have only one seed for every twenty square inches. We also found that 5 per cent. was lost by frost, which will also make the distance still greater; and if we take the acre of Scotch measure, by which the soil is still calculated in many parts of this country, we have been removed from a soil must be restored to it; but whether by means of excrement, ashes, or bones, is in a great measure a matter of indifference.

Professor Johnston, in his Lectures on Agricultural Chemistry, has established the same important truth upon a foundation from which it can never be removed.

1 Supposing that there are 130 seeds in five grains, or 15,362 to the ounce.
shall have a space of nearly twenty-eight square inches around each plant.

3rd, Before clover can be successfully cultivated on wet, or even damp land, it must be drained; first, because clover delights in a dry soil; and secondly, when the frost expands the moist soil in contact with the neck of the plant, it is left bare after the thaw arrives, and is therefore more liable to be destroyed by the next frost.

4th, If clover is too closely cut down, it is left without the leaves, its natural protection; and, if the frost is afterwards severe, it is sure to be destroyed.

5th, Mowing is objectionable to a certain extent, for the same reason. When the crop is cut with the sickle, a larger amount of stubble and foliage are left upon the ground for protection.

6th, These precautions are necessary to have a sufficient number of plants in the ground in spring; but it is clear that the future crop must also depend on the amount of the proper nourishment contained in the soil, and the facility with which it can be appropriated by the plants in every stage of their growth; for, if stinted before the tillering commences, fewer stems will be thrown out, sometimes only two or three, and often, when food is more plentiful, as many as a dozen, and all of them more luxuriant. From this cause, the crop may either be one-fourth the weight, or four times that amount, as was well illustrated in the case of Mr. Maxwell’s (of Gribton) crop, which had not received more than 3 lb. of seed to the acre; but, from the improvement which he had effected, nourishment of every kind was abundant; and the extraordinary manner in which the plants tillered in consequence, furnishes us with a satisfactory explanation as to the uncommon weight of crop from so small a quantity of seed.

7th, It must also be evident that the practice of eating down the second crop with sheep must have a much greater tendency to maintain the soil in a favourable condition for the growth of clover, than when the practice of carrying it off the land to be consumed was more generally prevalent.

8th, We recommend with very much confidence thorough-draining and trench-ploughing, as the most efficacious remedies which can be resorted to for restoring to its original fertility land which has become clover-sick.

Trans. of the High. and Agric. Soc. of Scotland, July 1846.
Art. LXIII.—ON THE SCARLET TREFOIL.

*(Trifolium Incarnatum.)*

By Mr. Foaker, Kirby, Colchester.

Immediately after harvest, sow or drill a peck and a half of the seed per acre on a wheat stubble, without ploughing, and harrow it in; this is all the cultivation necessary.

It has been said that it will not bear out winters; this may be true when it is brought direct from the south of France, or from Italy. I brought mine from Switzerland, and have had it eighteen years on my land, and I have no doubt it would stand the winter in every county south of the Grampian Hills; the more sheltered the situation, of course the earlier in spring it will lift its crimson head. On burning soils, where in dry summers the clovers are grilled into tinder, and when the husbandman can take the produce of an acre home in his apron, and the work is finished; on such lands, half a peck of the trifolium seed (which I will prove presently will cost but one shilling, if the farmer grows the seed himself), sown on the young clover directly after harvest, and harrowed in, would double or treble the crop. I always do it in every field where I am doubtful of the young clover.

I am not advocating growing the scarlet trefoil as a crop in place of the clover; this mistake has been made, and it is a great one; it leaves the land, more particularly light land, in too frothy a state for the wheat crop; it should be sown as a crop after the wheat, not before it. Sheep and lambs prefer it to clover when young, but in blossom are not so partial to it; yet, when made into stover, they will eat the whole greedily. Dry land suits it best; in low places on heavy land, where the water stagnates, it is likely to lose plant. If the farmer grows the trifolium seed himself, one acre of tares costs him four times the amount of an acre of trifolium; and I will point out how he may prove himself that one acre of trifolium is worth two of tares.

The land on which tares are grown is the fallow, and whether the tares are there or not, the rent, the tithes, and parochial expenses must be paid; the land also must be ploughed up in the autumn, therefore the only fair charge
that can be brought against the tares is the seed; some agriculturists sow three bushels per acre. I will, however, only reckon two, at 6s. 6d. per bushel,—13s. Now, let us see what the trifolium will cost. Here is also no extra expense beyond the seed. The average growth of the seed with me has been 15 bushels per acre; if cut when the straw is green, which it may be without injuring the seed, thrashed the next or following day, and the straw immediately stacked, it will pay all the workmanship. When it is also considered that the crop is generally clear from the land the first week in July, leaving the best months of summer for fallowing, 6l. per acre is a full remuneration to the agriculturist for the crop; this brings the seed to 8s. per bushel, or 2s. per peck; thus the farmer may have an acre of the trifolium by the end of April, for 3s. less than one-fourth part of the cost of his washly tares. Tares at all times are better physic than food, and in wet seasons they are for horses that which seamen and soldiers designate bad small beer—swipes. As the potato occupies the lowest step of degradation as food for civilized man, so do tares for the brute; they are Frenchmen's water-soup diluted.

As soon as the scarlet trefoil begins to blossom, put two or three horses to it in one yard, and the same number on tares in another; keep them thus a month, no further proof will be necessary of the superiority of the trifolium. I will grant it is not so certain a crop as the tares, but what does this amount to? I grow 40 acres of wheat a year, and have the same quantity of fallow. If I sow the whole 40 acres with trifolium, and 20 acres fail (very unlikely, by-the-by), on this 20 acres I lose 3s. per acre; the 20 acres that remain will pay me tenfold for the whole. I care nothing about the 20 acres lost, the land is ready for fallow or turnips, as it was ultimately intended.

I have had about three waggon-loads of trifolium stover per acre, therefore, exclusive of cutting and getting up, it cost me 1s. per waggon-load; if I lose half the crop, as above stated, it costs 2s., and I am convinced that the land was not 2d. the worse for it. This is no wild theory; it is the experience of eighteen years. If it can be proved that the land is the worse for this green crop, then some charge ought to be made against it beyond the price of the seed; but I contend it is not. I have grown it side by side with the long fallow, the same with the tares, and I could see no difference in the following crops, except that my clovers
were invariably better after the trifolium than after the tares.

Do not let the farmer dream he is buying the scarlet trefoil seed this year at 8s. per bushel; if he does, he may well be surprised at finding it 2l., and cheap, too. One peck and a half will give an acre of green food next May worth nearly double the money; a second peck and a half, on good land, will give three waggon-loads of stover; the remaining peck will produce from 10 to 12 bushels of seed.

The first step towards a good crop is good seed. I have seen bushels of seed sold for trifolium that was not worth its weight in sand; and when the price gets high, it floods in from France; seeds of all kinds, good and bad, perchance mixed with dodder and other parasites.

I have begun cutting the trifolium for the horses on the 14th of May, and for stover the 19th. This gives time for turnips, if the land is calculated for them.

_Agricultural Gazette, June 1846._

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**Art. LXIV.—ON WHITE MUSTARD.**

**By Mr. Thomas Cooke Burroughes. (Prize Essay.)**

[The cultivation of the White Mustard 
(_Sinapis alba_ of Linnaeus), the plant commonly grown in our gardens for early salading, has of late years been attracting the notice of agriculturists as a useful fallow crop, either for sheep-feed or for ploughing in as a green manure. The consideration of its properties and uses forms the subject of a Prize Essay in the _Journal of the R. A. S. E._, from which the following abridged account is taken.]

There is scarcely any soil, however poor (provided the climate be adapted to it), upon which it will not grow; but, of course, its luxuriance will be in proportion, other things being equal, to the fertility of the soil. A good friable turnip soil, capable of producing good crops of wheat, with a dry sub-soil, is well adapted to its growth; upon peat soils it flourishes with extreme luxuriance.

To disperse it as completely as possible over the land, the most approved method of sowing it is by a seed-drill having no coulters, or by a barrow-seed engine; a well-practised and careful seedsman may sow it evenly enough by hand to answer all purposes.
The land should be reduced to as fine a tilth as for turnips; the seed should be sown upon a harrowed surface, and then covered by light seed-harrows, going twice over the ground, the second time across or obliquely.

Quantity of seed to be sown, from three-quarters of a peck (if the land is in a very fine state) to a peck per acre.

The ground should not be in a very dry or cloddy state; nor should the seed be *puddled in* when the land is in a very wet condition, as dry weather quickly following would be apt to cause a crust upon the top of the soil, which would much hinder the progress of the seed in coming up.

If sown in May or June, or up to the middle of July, the crop will, in an average of seasons, have attained to its full growth—that is, be ready to burst into bloom—in six or seven weeks. As the autumn advances, its growth is slower. In a favourable season it may be sown even as late as the end of September, and produce a considerable bulk of crop to be ploughed in before the winter frosts destroy it.

From reference to Mr. Burroughes's journal kept during the summer of 1845, it appears that he ploughed up 6 acres of fallow on a light turnip soil which had been sown with rye-grass (in the wheat crop the previous year), and fed off and folded by sheep, which was rolled down and harrowed, and sown with a peck per acre of white mustard—4 acres on the 10th, and the remaining 2 acres on the 16th May. On the 21st June began to feed it off (being about 2½ feet high) with 228 sheep and 70 lambs, which kept them, being folded upon it at night, with only a bare layer to exercise upon in the day, twelve days; the sheep improved much in condition.

July 8th and 11th, the whole was sown with white turnips, after one ploughing and deep scarifying. The turnips came up rather shy, and grew slowly at first, and were not quite a full plant, but very good size in bulk. Four acres of white mustard were also sown *after tares*—2 acres on the 5th, and 2 acres on the 11th August 1845; after one ploughing and sundry harrowings, upon a fertile mixed soil, and which was begun to be fed off with sheep on the 10th October, it being then a very fine crop, nearly as high as the hurdles, this ground was afterwards sown with wheat.

Of the efficacy of white mustard ploughed in as a green manure, Mr. Burroughes had no experience at the time when he sent in his Essay. "I can only say," he observes, "that
my present growing crop of wheat after mustard ploughed in, which was sown after tares, presents a healthy and luxuriant appearance; and where wheat was sown after mustard, folded off by sheep in October last (as before mentioned), the fulness of plant and healthy appearance far exceed, at present, wheat put in rather earlier upon a clover layer and sheep-folded.”

It is a healthy food for sheep, but, like all other succulent vegetables, should be given at first sparingly, and for the first few days in conjunction with some other food. It is in greatest perfection for eating just before it comes into blossom; but as its progress towards flowering is rapid, it is advisable to begin stocking it several days, or a week, before it is in this state, or it becomes too old and sticky. It should also be sown in succession about twice a week. Although bulky in appearance, there is not above half the wear in it that there is in a good crop of cole; but it may be sown to come into use at a time when flock-masters are at a loss to provide for their sheep; if sown upon a clean fallow in the latter part of April, or beginning of May, a fair crop of white turnips may succeed it; but when a bulky crop of turnips is of indispensable importance, Mr. Burroughes cannot, from the experience of himself and others, recommend its cultivation as an intermediate green crop.

White mustard following tares, either to be fed off by sheep or ploughed in as a green manure may answer very well. It is said to be an antidote to wireworm. It is a very useful crop to grow upon heavy land fallow (unfit for turnips), sown about midsummer, after the land has received its due culture, and eaten off by sheep in August or September previous to laying up the land for winter.

As a green manure, it should be ploughed in before exhausting the land by fallowing; and all the top ends of the plant should be well turned under the furrow, which can only be accomplished by means of a chain, one end being fastened to the “hake” of the plough, and the other to the top of the coulter; a wooden clog being in the centre of the chain to keep it down, and dragged along the bottom of the furrow, by the motion of the plough, just before the succeeding furrow falls upon it.

**Note on White Mustard appended to the above.**

By Ph. Pusey, Esq.

Mustard is certainly not in general a dangerous food for sheep; but as one instance of serious injury has occurred from its use in my own neighbourhood, it is right that the circumstances of that injury should be known, in order to prevent the recurrence of a similar loss. They are stated as follows, in a letter from Mr. Williams of Buckland:

"I am sorry to say I have had a loss with my sheep from eating mustard; but I consider it purely accidental. My son had sown about 3 acres; in six weeks it was fit for the sheep; we did not begin it, however, until the end of about nine weeks. For the first four days the sheep ate it well; and wishing to consume it as quick as we could, to plough the land for wheat, my shepherd, seeing the sheep do well, ventured to give them double the quantity; the consequence was, the whole flock of 205 ewes were all of them in a most alarming state when found in the morning—five of them being dead, and most of the others much swollen; only the five, however, died, and I consider it was entirely from giving them so much. After a few days, we ventured the same sheep upon the rest, and finally they finished it without any failure.

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**Art. LXV.—RUSSIAN BEAN.**

By Mr. Hewitt Davis.

This bean, which I believe originally came from Russia, greatly resembles the Heligoland, and is becoming generally known as the Russian or winter bean. Its capabilities to stand our winters in the south, when sown in September and early in October, I have fully tested, having grown it every year the last sixteen or seventeen years, and never saw it hurt except on springy land, or when it has been later sown. I think it a most valuable introduction for loamy soils; the advantages from growing it are, that it does well on soils unsuited for spring beans, affords an excellent alterative crop and
HARVESTING CARROTS.

By the Editor of the "Agricultural Gazette."

The harvesting of root-crops is best done by piece-work. The harvesting of a good crop of carrots has hitherto cost us from 17s. to 25s. per acre—that of Swedes and mangelwurzel, from 6s. to 10s. For this sum, the contractor pulls the roots, cuts off the leaves, fills the roots into carts, and gathers and loads the leaves also.

In the operation of harvesting carrots, the spade is required; it is pressed into the ground, and used as a lever by the right hand, while, by the left, the root is pulled up. Each man lifts two rows as he proceeds, and four men forming a company, eight rows are thus pulled and laid regularly
on the ground in two lines. Two women can top the roots, \( i.e. \) cut the leaves off them, as fast as this number of men can pull them; and, leaving the roots in a central row, they throw the leaves into two lateral ones, as they proceed. The carts, the number of which, varying according to the distance from the heaps, must be such as will convey the roots off the land as fast as they are ready, following close upon the cutters; a man and a boy will be able, under ordinary circumstances, to fill both roots and leaves into them as fast as those already mentioned can prepare them; and another man and boy will be able to pile the roots up in the heaps, and thatch and finish them off as they proceed. We mention all these details, because it is all-important to the speed and economy of the operation that the forces employed in the different parts of it should be rightly proportioned to each other.

The leaves, if they be already withered, may either be left on the ground and ploughed under, or, as on land already rich enough for grain crops, they may be carried away to the fold-yard and trod down by the cattle. When they are still green, they may be used as fodder. As long as leaves are green, they remain useful in the growth of the plant. The only reason why we should harvest our carrot-crop before the roots have stopped growing, is their extreme sensitiveness to frost. This is so great, that it is of the greatest importance to secure, before night, all the roots pulled during each day; if they get frozen, though it be merely on the surface, it will be almost impossible to preserve them through the winter.

We have but one more remark to make, and that is on the fact that rottenness, when it is owing to any external cause, always commences at any cut or bruised portion of the surface. It thus becomes of importance that the surface of the roots should be cut or abraded as little as possible. The root-fibres should not be cut off at all, and the leaves should be cut off so far from the crown of the root, as that they may fall separated from one another. So far as our experience has hitherto gone, if these points be carefully attended to, and if such a plan of harvesting be adopted as fulfils the three requisites of success before alluded to, there is but little risk of the farmer losing much of his crop, by heating or putrefaction, before the spring.

*Agricultural Gazette*, Oct. 17, 1846.
Art. LXVII.—TO PRESERVE THE SWEDISH TURNIP.

By Mr. Charles Allix.

Having read and tried every method, I believe, that has been suggested as to the management of the Swedish turnip when taken up previous to the winter, I have never been quite satisfied, as, whether they were placed with a good deal of trouble and labour in long piles, and covered with straw, or straw and earth, or in round heaps and covered with earth, or between wattled hurdles, or topped and tailed and deposited in a furrow made by a double mould-board plough, and covered by the common plough, there have always been too many rotten to satisfy me. If deposited in a barn or building; it might answer very possibly, as in the case of mangel-wurzel, which I have for several years managed in this manner. I do not remember ever having had a single rotten one. But for Swedes, it would be almost impossible to store any great quantity, so much room would be required— as, for instance, for only ten acres. However, this year I tried a plan that does appear to answer, very simple and very cheap; but only having tried it one year, and that year a remarkable one for its mildness, I will not speak positively, and shall be happy to hear any remarks upon the plan, or any improvements suggested by brother farmers. The plan is this:—In December, or when you please, with the horse-hoe, only one of the side knives being on, and that knife reversed, you will be able to cut all the tap-roots, and scarcely disturb a turnip in the rows. This alone is of use in the spring, even if you do not wish to do more, as it will very much prevent the turnips running to seed, and of course the tap-roots from drawing the ground. I tried two rows at a time, both knives on; but my man found it almost impossible to hold the instrument sufficiently steady, and the turnips were consequently disturbed in the rows. The tap-roots having been cut, I then pass the double plough up the centre between every six rows, and let the turnips (which pull up, the tap-root being cut, as easily as possible) to one of my labourers at 2s. 6d. an acre, at which, he finding two children, probably his own, he will make good wages, the average wages in this country being 2s. a day for a man. A child on each side of him hands the
turnips to him, and he places them in the furrow made by the plough. One ploughing then with the common plough completes the business, by turning the earth to the turnips and covering them to the necks; if not quite so neat as you wish, a man with a hoe will quickly and easily make it perfect. By this means, I believe the plants will resist almost any frost, will be ready when wanted, cannot draw the ground, and scarcely a turnip will be rotten.


Art. LXVIII.—Cultivation of Wheat.

By the Editor of the "Agricultural Gazette."

Wheat-sowing has doubtless commenced more than a month ago in the bleaker parts of the country; whilst in others the autumn seed-time will not be over for a couple of months to come. There are several points connected with the practice, on which the widest difference of opinion exists. Among these is the propriety of growing it after corn crops, which, as the ordinary rule in farming, we cannot but deny; the propriety of making this the crop in the rotation to which farm-manure is chiefly applied, which we very much doubt; and the propriety of using much or little seed per acre, which necessarily depends upon the circumstances under which the crop is grown. In reference to the first of these, as experience has already sufficiently indicated, the necessity, as a general rule, of growing corn crops, or crops for sale, alternately with green crops, or crops for consumption on the land, there is but little need to appeal to the theory of the matter. It is sufficient to say, that, under any circumstances, the sale of produce, and especially where it is in the concentrated form of grain, is necessarily an injury to the land, which, until we better know how to replace its loss, should not be permitted oftener than once in two years. The interval permits the operation of fallowing, with the growth of a fallow crop, and thus enables us to clean the land and to restore its fertility.

As regards the second point above mentioned, it is only necessary to say, that where this alternate system of husbandry prevails, the bulky, crude, and coarse manures so
CULTIVATION OF WHEAT.

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rich in carbonaceous matter, which the farm-yard supplies, are certainly better made use of for the growth of a large bulky crop, such as turnips or mangel-wurzel, than for the growth of wheat, where the chief object is not straw, but grain. This, we are sure, will be agreed to by all except those whose soils, by the repeated robbery to which we have above alluded, are always at the lowest pitch of poverty.

In reference to the question of seed, it is impossible to give any rule upon a subject which is so manifestly dependent on circumstances. All will agree that a certain loss of seed occurs every year from destruction by birds, water, and frost, wire-worm, &c.; and it will also be agreed that these causes must be much more influential in some localities than in others; add to this the fact that some soils will cause a seed to throw out twenty heads, while others fail of producing five; and we can easily see how it is that some farmers, speaking from experience, recommend 3 bushels per acre, whilst others, on equally unanswerable grounds, have asserted 3 pecks to be more than enough. Our general practice is to sow about 1½ bushels per acre, drilled in rows 9 inches apart; but we have grown the crop from less than 2 pecks per acre with very fair results. It is obviously of importance that each should in this matter determine for himself what, under his circumstances, it is best to do; for, while the evils of thick sowing involve a serious waste of valuable food, those of thin (using the term as being on the other side of what is right) equally tend to our loss by inducing a late harvest, a tendency to mildew, not to speak of a want of plant.

As regards the preparation of the land for this crop, the wheat plant likes a firm seed-bed; it prefers a stiff soil, and is thus best sown on a stale furrow when the land is wettish, and it should be sown by drill or dibble, not broadcast. As regards the choice of varieties, this doubtless must be left to circumstances, and our advertising columns publish many sorts of unquestionable abundance, as well as quality of produce; but wheats differ in their straw, as well as in their grain, and this should have some influence on our choice. Short-strawed wheats should be chosen for rich soils.

Agricultural Gazette, Oct. 10, 1846.
Art. LXIX.—PREMATURE DECAY IN WHEAT.

[In reply to an inquiry in the *Agricultural Gazette*, as to the cause of wheat dying away prematurely, Mr. Hewitt Davis offers the following facts, having come within his own observation, as proving to him that lands will not bear a very frequent repetition of wheat—he observes:—]

**Prior to my occupying the Spring Park farm, it was farmed by the wealthy and intelligent owner, and, from want of drainage and trenching, was then unsuited to the growth of clover or beans, and he confined his cropping to roots, oats, rye-grass and trefoil, or tares and wheat, frequently taking wheat after the roots. He purchased manure largely, and besides, used on the arable land the dung from a large racing and hunting stud, and from 30 to 40 brood mares, so that the winter growth of his wheat was always luxuriant: but I noticed that soon after the wheat was in ear it became scrawled or root-fallen, and was laid by wind or light showers; the ears filled imperfectly, and the appearances were as described by you. For some time this was ascribed to causes—such as the want of lime, the consequence of spring-hoeing, the heavy rolling, and the like; but since I have changed the course of cropping, that is, have introduced beans or peas, and red clover into the rotation, I have not suffered; my wheat stands perfect. I do not hesitate to ascribe the evil to want of strength in the straws from too frequent repetition in the crop; and had I had any doubt before this summer, which I had not, I should have none now; for a field of wheat of mine this year, on part of which wheat had been taken two years ago, showed the consequence of repeating this crop too often. Where the wheat was two years ago the crop went off, whilst the remainder stood till harvest. In my inspection of land, I frequently find districts where the wheat is more liable to be laid, and I fancy I even trace this evil to the injudicious cropping then adopted; for it too often occurs that this crop is erroneously considered the only paying one, and that its frequent return is desirable; and hence it is taken till the return diminishes, and more is lost by this dependence upon wheat than is imagined.

*Agricultural Gazette*, Aug. 29, 1846.
I shall now proceed to describe the plant, the soils best adapted to its growth, and the management of the crop. Flax belongs to the genus *Linum*, of which there are several species; the most important and the only one that is cultivated is *Linum usitatissimum*—common flax. Root annual, fibrous; stalks upright, 2 or 3 feet high or more, round, smooth, leafy, branching only at the top; leaves lanceolate, sessile, at the lower part of the stem growing thickly together, without any order, on the upper part of the stem more distant and alternate; flowers large, of a delicate purplish-blue colour; petals fine, wedge shaped, deciduous, streaked with veins of a deeper colour, the tips notched as if eaten by insects, the claws white. According to the analysis of Leo Mayer, the seed contains 11·265 of fixed oil, 0·146 of wax, 2·488 of soft resin, 0·550 of resinous colouring matter, 0·926 of a yellow matter analogous to tannin, 1·48 of amidine, 6·154 of gum, 15·12 of vegetable mucilage, 2·921 of gluten, 2·712 of albumen, 10·881 of sweet extractive, 44·383 of husks containing mucilage. Although the soils best adapted to the growth of flax are deep and friable loams, and such as contain a large proportion of vegetable matter in their compositions, yet it is grown in inferior soils in Belgium and Holland, rendered rich by manure, and upon mere bogs in Ireland. In truth, the plant will flourish upon most soils not absolutely barren. The diseases of flax are few, consisting chiefly of the mildew and the rust. The young plants are sometimes attacked by the fly, but these casualties rarely occur in this country. With respect to the management of flax, I shall be able to state more clearly by taking each part under a separate head.

**Rotation.**—The place for flax in the rotation is after lea or corn crop, and as soon as possible after the land has been broken up from grass; it will therefore succeed, with propriety, oats or wheat after lea, and this may be regarded as the proper place for flax in the rotation. It should not by any means come after turnips or potatoes, as the fibre would be invariably coarse, and the stalks uneven, from the manure not being properly incorporated with the soil. It must not
be cultivated on land which has been recently limed, certainly not sooner than the third or fourth year.

Preparation.—In preparing the land for flax, the objects to be attained are the reduction of the soil to a fine tilth, and the thorough eradication of weeds. The preparation of the land for this crop is even of more importance than the quality of the soil itself. The land should receive a deep ploughing in the autumn, as soon as the previous crop is removed off the land, as this ploughing facilitates the after pulverization of the soil in the spring. In this state it remains during the winter; and as early in the spring as the state of the soil will admit of the action of the implements of tillage, its further preparation is to be resumed with a good harrowing, to reduce partially the furrow slices which have stood the winter. After this another ploughing is to be given in a direction crossing the preceding one; after which the harrowing is to be repeated, and continued as long as it is found to have a beneficial influence in pulverizing the soil. Such weeds as have been brought to the surface by the action of the harrows are then collected over the surface, and removed from the field, as well as all large stones, which in most soils are also disengaged by the action of the harrows. In favourable cases, and in rich and easily-pulverized soils, this preparation may be sufficient; but in most cases another ploughing and harrowing will be requisite. The action of the clod-crusher will be a necessary auxiliary to that of the harrows, especially on adhesive soils, the lumps of which, in dry weather, will resist the action of the harrows alone.

Sowing.—The best seed time is during the latter part of March and beginning of April, the precise period being regulated by the weather and consequent state of the land. Flax-seed that is proper for sowing should be fresh, smooth, plump, and so heavy as to sink in water; it should taste sweet, and on being broken it should appear of a bright yellowish-green colour, and oily. The quantity of seed sown is from 6 to 9 pecks, or 3 bushels per acre, or even more when particularly fine flax is required. It is better, perhaps, where fibre is the primary object, to sow too thick than too thin; as, with thick sowing, the stem grows tall and straight, with only one or two seed capsules at the top, and the fibre is found greatly superior in fineness and length to that produced from thin-sown flax, which grows coarse, and branches out, producing much seed, but an inferior
quality of flax. After sowing, cover it with a seed harrow, going twice over it, and once across, or anglewise. This makes it more equally spread, and prevents the deep creases generally made by the teeth of the harrows.

Weeding—Commences when the weeds can be readily distinguished amongst the plants, or about the third week. In this country it is usually performed in the same manner as the weeding of corn.

Pulling.—The best criterion is, when about two-thirds of stalks are observed to turn yellow, and to lose their leaves; and also when, by cutting the seed-pod across horizontally, the seeds have changed from the white milky substance which they first show, to a pale brown colour, and are pretty firm. In pulling, take the plant close below the bolls; this allows the shortest of the plants to escape: with the next handful, the puller draws the short plant, and so keeps the short and long each by itself, to be steeped separately. This should be particularly attended to, as it enhances the value to the spinner, and consequently to the grower, who will be amply repaid for his trouble. As soon as pulled, the flax is stooked without binding. The handfuls are set up, resting against each other, and the top ends joining like the letter A, forming stooks about 8 feet long, a strap keeping the ends firm. In this way it will resist wind and rain, and dry quickly. In six or eight days it may be bound into sheaves with wheat-straw bands, and stacked; the seed may be taken off at leisure; the mode of taking the seed is by repeated strokes of a beater, the foot being at the same time kept on the root end of the flax, to prevent it from being turned about, which would impede the after process in its manufacture.

Steeping.—It is the practice of some to steep as soon as the flax has been dried in the field. A great disadvantage in treating flax in the autumn is the difficulty in many cases of preserving the seed after rippling. The system now advocated is, that flax should be steeped the following May; a system which possesses the advantage of affording the farmer the best season of the year for steeping and grassing; and at a time of comparative leisure, when his attention is not called off the harvesting of other important crops. The object of causing the flax to undergo this process is to facilitate the separation of the fibre from the stem, during which the mucilaginous matters, causing the fibres to adhere to it, partially undergo the putrefactive fermentation. The water for
this purpose should be soft, pure from all mineral substances, clean, and clear. The sheaves of flax are put into a frame made of common poles, something like a large earthenware crate, with the root end uppermost. The whole is immersed in the water; a covering of straw, to shade off the light, is found to be advantageous. When covered over in this manner, stones are placed upon the frame, till the whole is sunk a little under the surface of the water. The bottom should not touch the ground, so as to allow the water to flow over and under it. A gentle stream should, if possible, always pass over the pond; it carries off impurities, and does not at all impede due fermentation; it is essential to produce flax of good colour; flood and all impure waters should be carefully kept off. The test for knowing when the flax is sufficiently watered is this:—Try some stalks of an average fineness, break the woody part in two places, about three inches apart, at the middle of the length; catch the wood at the lower end, and if it will pull out (downwards) for those three inches freely, without breaking or tearing the fibre, it is ready to take out. This trial should be made every day, after fermentation subsides, for sometimes the change is rapid. It is safer to steep it too short a period, than ever so little too long. In the first case, merely a little more time is required in the future processes; in the second, the strength and texture of the fibres may be injured. When the flax is sufficiently watered, it is taken out of the pond, and placed on the banks to drain for a few hours.

Spreading.—Short and close pasture land is the proper place on which to spread the flax, and in this operation it is important to distribute it evenly over the surface, and to make the rows perfectly straight, to prevent confusion in turning. The intention of this process is to wash and bleach the flax by exposure to the sun and rain. After remaining two, three, or four days, according to circumstances, it is turned over by long poles or wattles, run under the rows, beginning with the first row, and proceeding, so that the second falls upon the ground occupied by the first. The length of time during which flax should remain on the grass is variable, depending on the weather and state of the flax. If possible, it ought not to lie longer than five days.

Breaking.—The flax is bruised by an instrument called a break; which consists of two frames fixed together at one end by a hinge, and works the one into the other; or by passing it through a breaking machine, which consists of
four pair of fluted rollers, placed upon a frame of wood. Through the flutes of the rollers, which revolve into each other, the flax is passed in small handfuls. In this manner the flax is bruised, and put into a state to have the ligneous refuse separated from the fibrous part by scutching.

Scutching.—This operation may be performed either by machinery or by manual labour. When performed by manual labour, a handful of the flax is held by one hand in the opening of the scutching board, and beaten by an implement called a swingle, held in the other hand, by the repeated strokes of which the woody particles of the stem are separated from the fibre. Or the operation of scutching may be performed by a machine called a scutching mill. It resembles a small caravan; in the interior are three recesses, formed for the men to stand in while at work, and for their protection from the action of the swingles, which being placed in an iron axle, and set in motion, would, if necessary, strike the flax resting on the scutching boards at the rate of about twelve hundred times in a minute. The scutching mill and breaking machine were the invention of Mr. Warnes.

The Plough, Dec. 1846.

Art. LXXI.—ON THE CULTIVATION OF FLAX.

By the Editor of the "Farmer's Almanac."

The cultivation of the finer varieties of flax in England has been lately proposed, as not only causing very considerable extra demand for labour, but as being productive of considerable profit to the grower. It is, perhaps, through the error of regarding flax as being so very exhausting a crop that its cultivation has been retarded in England. It is supposed not to exhaust the soil more than a crop of wheat; and even this exhaustion is avoided if it is pulled green for the purpose of spinning into yarn, without allowing the seeds to ripen. "It is grown," remarks Mr. G. Nicholls, "on light poor land, in Belgium and in Holland; and I have seen it growing on mere
bog in Ireland." 1—"The soil," adds Mr. Sproule, "to which the cultivators of flax in Flanders and the northern parts of France give the preference, is strong loamy land. Strong clays do not answer well, nor soils of a gravelly or dry sandy nature. The climate of Ireland, from its humidity, is well calculated for the growth of flax. Flax, it seems, follows a crop of oats or wheat after a lea, and should not be sown oftener than once in seven years. A fine and deep tilth is very desirable." 2 The seed is sown during April, broadcast, about 2½ bushels per acre, and the best comes from Holland or America. The seeds are excellent as an article of food for cattle, and should be consumed on the farm. 3 Mr. J. Barker, of Ramsay, says, "I am now feeding fourteen horses and colts with straw and hay compound. My plan is, to add to 8 bushels of cut hay and 8 bushels of wheat, 28 lb. of crushed linseed boiled in 18 pails of water. This I give at night. In addition, each horse has one pint of pea-meal per day, and 1 cwt. of straw per week." 4 The expense per acre of flax-growing in Ireland is, it appears, 5

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<th>Item</th>
<th>£</th>
<th>s.</th>
<th>d.</th>
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<tr>
<td>Rent and taxes</td>
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<td>5</td>
<td>0</td>
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<tr>
<td>2½ bushels of seed</td>
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<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Ploughing and sowing</td>
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<td>10</td>
<td>0</td>
</tr>
<tr>
<td>Weeding, twelve hands at 8d.</td>
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<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Pulling, twelve hands at 1s.</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Watering, seven hands at 1s.</td>
<td>0</td>
<td>7</td>
<td>0</td>
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<tr>
<td>Scutching, 70 stone at 10d.</td>
<td>2</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>Lifting, &amp;c. &amp;c., ten hands at 1s.</td>
<td>0</td>
<td>10</td>
<td>0</td>
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<tr>
<td>Carting to mill and market at 6s. 2d. per ton</td>
<td>0</td>
<td>19</td>
<td>8</td>
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The ordinary produce on the continent is said to be from 20l. to 30l. per acre; and much larger crops than these have, on rare occasions, been obtained.

According to Dr. Kane, 6 100 parts of the dried stem of the flax plant is composed of—

<table>
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<tr>
<th>Element</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Carbon</td>
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<tr>
<td>Hydrogen</td>
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<tr>
<td>Oxygen</td>
<td>48.39</td>
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<tr>
<td>Nitrogen</td>
<td>5.76</td>
</tr>
<tr>
<td>Ashes</td>
<td>5.00</td>
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</tbody>
</table>

2 On Flax, p. 9.
3 Agricultural Gazette, vol. i. p. 754.
4 Ibid. p. 789.
5 Ibid. p. 121.
6 Sproule on Flax, p. 38.
In 100 parts of these ashes he found—

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<thead>
<tr>
<th></th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
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<tbody>
<tr>
<td>Water</td>
<td>18</td>
<td>13</td>
<td>.15</td>
</tr>
<tr>
<td>Fat</td>
<td>12.4</td>
<td>10.5</td>
<td>.8</td>
</tr>
<tr>
<td>Organic matter exclusive of fat</td>
<td>63</td>
<td>69.5</td>
<td>.71</td>
</tr>
<tr>
<td>Ash</td>
<td>6.6</td>
<td>7.4</td>
<td>.6</td>
</tr>
</tbody>
</table>

Analysis of three varieties of linseed-cake, by Gyde:—

Art. LXXII.—GROWING FLAX ON NEWLY BROKEN UP GRASS LAND.

From an Essay on the Advantages or Disadvantages of Breaking up Grass Land.

By Mr. Thomas Rowlandson, Liverpool.

The course here recommended for breaking up old leas is different from that usually pursued, oats or wheat being generally taken: the most common course is to take a crop of oats. I am averse to both; oats, on account of the crop being of so little value, whilst it is extremely exhausting; wheat, because it is particularly obnoxious to the wire-worm on lea land, and in other respects is objectionable. It may appear strange to recommend rape and potatoes for the purpose, but I can assure the reader that it is the usual course pursued in the best potato-growing districts in Lancashire and Cheshire, and is the almost universal practice in Ireland, excellent crops being obtained in this way; rape also grows well on lea. But I do not deem down-land adapted to rape; I should on such recommend potatoes to be taken. There is

1 *Agricultural Gazette*, vol. ii. p. 549.
one crop better than all others adapted for lea, provided it is in fertile condition, viz., flax, which on down-land that would bring 4 quarters of wheat when broken up from the lea, would yield a crop of flax worth 30L., the charges on which, including rent and taxes, at 30s. per acre, would amount to about 13L. 10s., of which sum 11L. 10s. would be expended in labour. The growth of flax ought to be encouraged above all other descriptions of agricultural produce. As it cannot be profitably grown unless the ground is in good condition, both as regards cleanliness and heart, many landlords have prohibited its growth, under the impression that it is a highly impoverishing crop; yet it is not so impoverishing a crop as wheat, even if allowed to stand for seed; and if pulled in the white is the least impoverishing crop that is sold off the farm. The water in which flax is retted should always be thrown on meadow or pasture land. There is a singular circumstance that peculiarly fits flax for cultivation on weak soils, such as downs and sandy soils, viz., that a crop of 38 stones is often more valuable than one of 70 stones; indeed, poor soils, with care and attention, will yield quite as good a return from the sale of flax fibre as richer lands, but poor soils will not bear its being so frequently grown. I shall, on the subject of flax, again quote Mr. Walkden, with which quotation I shall nearly conclude the subject:—

"I beg to give you another instance of down-land of a stronger and better description, being brought into the northern system of cultivation by Mr. Brough, of Shaw Farm, near Marlborough. He has boned his land to a very considerable extent; and his turnips thus managed have invariably been a great crop. It is his opinion, that were the system of two corn crops in succession, and of mowing the seeds for hay instead of pasturing with sheep, done away with, the land would become more certain for turnips, particularly Swedes, than in the north. He has also grown linseed with success, for which he considers the lightest of the downs particularly adapted. He thus obtains a substitute for oil-cake—the carriage on which from London renders it very dear. Linseed is sown instead of barley or oats in spring. He has brought into cultivation the whole of his down pastures, and is enabled, by artificial grasses, to keep more sheep in summer, and much better than in its original state. But his greatest advantage is in the winter; a good turnip system, instead of hay, enabling him to provide food
for many more sheep at a far less cost, as well as keeping
them in a much higher state of condition. In short, the
farm will bear comparison with the rich lands of the neigh-
bourhood considered of twice the value."

When a flax crop is to be taken, the following course may
be recommended:—Flax on the lea; if pulled in the white,
a crop of turnips taken the same year, fed off, followed by
potatoes (if left for seed, wheat next); wheat after potatoes;
clover, hay, pasture, potatoes, tares, and rape, and pasture
seeds. In this course, as well as all those precedingly
related, potatoes can be replaced by Swedes if desirable.


ART. LXXIII.—ON FLAX, ITS VALUE AS A STOCK-FEEDING
AND REMUNERATIVE CROP.

BY MR. THOMAS DIXON, AGRICULTURAL ENGINEER.

[At the December meeting of the Darlington Farmers' Club, Mr.
Dixon spoke on the subject of 'the quantity and kind of stock that can be
kept upon a clay-soil farm, half arable and half grass, compared with when
it is nearly all arable.' He impressed upon the meeting that the greater
the number of cattle fed and kept upon a farm, the greater the profit that
farm is likely to yield; he enforced the necessity of proper drainage and
efficient cultivation; he reminded them that, on a former occasion, they
had come to a resolution that it was more economical to keep all heavy
cattle in the house upon green cut food during summer, than to turn them
out upon the pastures, and that by doing so a greater number of cattle
could be kept with advantage. From all these premises, he considered it
quite evident that a farm nearly all in tillage could carry a much greater
number of cattle to advantage than a farm half arable and half grass would
do. He then proceeded to the consideration of the value of linseed as
food for stock.]

Old prejudices are fast wearing away, and therefore you
will not be surprised when I tell you, that if I live a few
years longer, I expect to see linseed used as a general ingre-
dient for feeding cattle on almost every farm; and not only
this, but I also expect to see every farmer grow his own lin-
seed for that purpose. It is true that flax has from time
immemorial been condemned as a scourging and injurious
crop to produce on a farm, and therefore it has been in many
farm leases and agreements prohibited from being grown;
but for all this, I very much doubt if it is a more exhausting crop than several others that are grown; and the principal reason of its being thought a scourging crop has, I believe, arisen from an improper course of cropping having been pursued, and thereby the fertility of the land in some cases injured; whereas the great art in following out a proper course or rotation of cropping, is to adopt such a scheme, that no particular crop may follow another which has already extracted from the soil a great portion of the principal ingredients required for the succeeding crop, without first adding to that land such a description of manure as will remedy the defect. I may here also be allowed to name that at another of our past discussions I was deputed to introduce a subject, which was "The comparative advantages and profitable cultivation of old grass land as compared with arable land of similar quality." I then showed that it required, at the very least, two acres of good grass land to keep a fattening beast for a year; and I now wish to show, as clearly as I am convinced myself, that less than an acre and a half of medium tillage-land, by adopting a proper system, will do the same thing, and also will feed the cattle much faster than the old method. There are already some gentlemen, not far distant from our immediate locality, who are using considerable quantities of linseed, as steamed food, along with meal, cut straw, and turnips, for winter feeding, and I believe also with very good effect; and I think the probability is that, to some extent at least, it will be also applied by the same parties to summer feeding, along with green cut food. There is one gentleman in particular whom I may name, John Hutton, Esq., of Sowber Hill, who has adopted this system, and who very kindly invited our chairman, along with Mr. Johnston and myself, to go to his place, and see the whole process of preparing the food, and the way in which the stock seemed to thrive upon it. We availed ourselves of his kindness, and by that means obtained a treat of no common order, when he gave us in detail all the different items of expense that he was at in the preparation of the food; and during the few hours that we spent at Sowber Hill, we were three different times amongst the cattle, and each time found them lying down resting; in fact, their quiet appearance and healthy thriving condition were such, that we felt perfectly satisfied that they were feeding in a very superior manner; whilst Mr. Hutton quite convinced us that by using the steamed food along with turnips,
he could feed at least twice the number of beasts with the same quantity of turnips that he formerly did, and that in a much less time than was required when the steamed food was not used along with the turnips. He was also convinced that it was with equal, if not greater, profit to himself.

Now, in order to give you a clear view of my own ideas on this matter, it will be requisite to go a little into detail, to show what may be done by growing such produce upon a farm as is requisite for cattle-feeding, viz., corn, linseed, and turnips; also rape, tares, clover, and rye-grass. Now, an acre and a quarter of land will grow 208 stones of corn; another acre and a quarter will produce 90 stones of linseed; and upon three-quarters of an acre you may grow 14 tons of turnips. Now these quantities, the corn being ground into meal, the linseed steamed, and both mixed as required with a sufficient quantity of cut straw, will, with the addition of the 14 tons of turnips, be ample for feeding four beasts during the whole of the twenty-six weeks of the winter half-year. This would be at the rate of two feeds of the compound, and two feeds of turnips, in each day. Then, for the summer half-year, I am pretty certain that it would be a considerable advantage to give one feed of compound per day, along with mown clover, tares, or rape; and by this means five-eighths of an acre of corn, five-eighths of an acre of linseed, with one and a half acres of rape, tares, and clover, would be sufficient to feed four beasts through the twenty-six weeks of the summer half-year; thus the quantity of land required to feed four full-grown beasts for a year, is six acres. But I must now tell you, that the whole of the produce of the six acres would not be required; for you will recollect that in this calculation I named above an acre and three-quarters of linseed. Now, if the fibre on this acre and three-quarters and twenty perches of flax be rough-dressed for the market, it will yield a profit of about 12L 10s., independent of the linseed used for the cattle-feeding; and therefore, this being the case, if we reckon five acres we shall be much nearer the truth. Now, gentlemen, if it be found by experience that flax is a more remunerative and profitable crop than most others, I do not see why it should not be grown under proper management, when it is also seen that the seed is so valuable in the feeding of cattle; besides which, it is now well known that the manure produced by linseed-feeding is much more valuable than that produced by ordinary stall feed; but
the most profitable part of the crop is the fibre of the flax. I have taken some pains in endeavouring to ascertain the expenses of rearing and preparing a crop of flax; and I find that the profits thereon are generally much greater than upon ordinary crops of corn; and, from the information I have got, I am led to believe that 40 stones per acre is certainly not above an average crop, but which, without reckoning anything for the seed produced, would yield a profit of about 7l. per acre. The expenses of cultivating an acre of flax, and preparing it for sale, will be about as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>£</th>
<th>s</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>To rent of one acre of land</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>To rates and taxes</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>To ploughing, harrowing, &amp;c</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>To seed, 2½ bushels</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>To weeding</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>To pulling</td>
<td>0</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>To saving and dressing seed</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>To watering and grassing</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>To carting home</td>
<td>0</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>To scutching 40 stones</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total expenses per acre</strong></td>
<td>£10</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

By 40 stones of flax, at 7s. £14 0 0
By 18 bushels of seed, at 7s. 6 6 0

**Total produce per acre** £20 6 0
**Deduct expenses, as above** 10 4 0

**Profit per acre** £10 2 0

I must beg of you, gentlemen, to pardon me for thus digressing from the question at issue; but I have done so to show that it is desirable that each farm should produce its own linseed for feeding; and that it is profitable to do so; and also to show that it would not be fair to take the whole six acres, which I have before named, into account for the feeding of four beasts for twelve months, but that five acres are sufficient, as follows:

First, for the summer twenty-six weeks:

<table>
<thead>
<tr>
<th>Description</th>
<th>A.</th>
<th>R.</th>
<th>P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land to grow corn for meal</td>
<td>0</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>” linseed for steaming</td>
<td>0</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>” clover, tares, and rape</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total quantity for summer</strong></td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>
Then for the winter twenty-six weeks,

<table>
<thead>
<tr>
<th>Item</th>
<th>A.</th>
<th>R.</th>
<th>P.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land to grow corn for meal</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Linseed for steaming</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Turnips</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total for winter</strong></td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total for summer</strong></td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total for the year</strong></td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Deduct for the flax</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Quantity of land required 3 0 0

Therefore, gentlemen, this shows that five acres of arable land, of medium quality, under proper cultivation, are sufficient to feed four full-sized beasts for twelve months: whereas, on a farm half arable and half grass, eight acres at least would be required to do this; therefore, this, I think, shows pretty clearly that a considerable quantity more stock may be kept on a farm in which the land is chiefly under the plough. Now, I would not have you to understand that I would confine the system to feeding beasts only, certainly not; for, if it answer well for fat stock, I do not see why it should not answer well for milch cows and other heavy cattle. A farmer's milch cow, upon ordinary land, generally consumes from an acre and a half to two acres for her summer's keep, and about as much more for winter; but I have no doubt, if the same cow were fed in the house upon cut-food with a feed per day of the compound, that one-half the quantity of land would be ample for the same purpose. Then, if this be so, there can be no doubt but similar results would accrue in all cases of heavy stock being fed in the stall instead of in the pasture. From inquiries which I have made, I find that in winter, feeding with the steam compound, the following quantity is sufficient for a grown beast per day:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linseed</td>
<td>2 lb.</td>
</tr>
<tr>
<td>Ground corn</td>
<td>5</td>
</tr>
<tr>
<td>Cut straw</td>
<td>10</td>
</tr>
<tr>
<td>Turnips</td>
<td>30</td>
</tr>
</tbody>
</table>

This quantity is given in two feeds of the compound, and two feeds of turnips; and a little straw is also given at night. Milch cows and other cattle might have one feed per day of this compound, along with their ordinary food. The great advantage derived from the use of the compound which I have now partially described, seems to arise in different ways.
1st, From the food being cut, ground, and given in a warm state, both mastication and digestion is considerably assisted, and thereby the animals obtain more rest, and consequently fatten in less time. 2nd, By using the compound a greater number of cattle can be fed, which is a very important matter, more particularly where turnips are not plentiful. 3rd, The manure produced by this method of feeding is found to be more valuable than by turnip feeding only.

Henry Chaytor, Esq., of Clerveaux Castle, said, that if the system of stall or box feeding cattle were carried out to a greater extent than at present, he had no doubt but that it would be beneficial, more particularly if the linseed required for the purpose was cultivated and grown upon the farm where it was consumed; and he had very little doubt but that the system partially detailed by Mr. Dixon, the secretary, might be carried out successfully, as well as beneficially; and if the fibre of the flax could be profitably saved and prepared for the manufacturer, which he did not see any reason to doubt, he thought it would be the means of producing a good deal of labour in vacant seasons for the wives and families of the labouring man, which, he considered, would be a very good thing. Now, a good deal had been said with regard to flax being an exhausting crop, and no doubt it might be so; yet he had reason to believe that wheat and some other crops were also exhausters of the land, perhaps as much as flax; therefore, in that respect, he fancied there were no difficulties but what could be removed by judicious cultivation and a proper course of cropping. But in discussing this subject there were so many things which ought to be taken into account, that it was, he thought, utterly impossible for the present meeting to come to any correct conclusion; for, although Mr. Dixon had entered pretty largely on the subject, yet there were many points which bore upon the subject that would require explanation: as, for instance, he had not shown how it would answer to stall-feed in summer with grass cut from old sward, in comparison with tares, clover, or rape. He also thought that Mr. Dixon's estimate of the expenses of cultivating an acre of land and winning the flax was too high, as was also the value that he put upon ordinary land; yet there was no doubt but the profit would be equal, if not superior, to the profits upon ordinary crops of corn, if at all judiciously managed.

ON THE TUSSAC GRASS.

Art. LXXIV.—ON THE TUSSAC GRASS.

By the Governor of the Falkland Islands.

[Of this new variety of green food, an interesting account appears in the *Journal of the R. A. S. E.*, in the form of a letter from the Governor of the Falkland Islands to Lord Palmerston. It is described as a plant which loves the sea-spray, the finest plants growing almost in the water. It grows on peat-bogs, on exposed islands in the Falklands, 800 and 1000 feet above the sea, open to the westerly gales, which are laden with moisture. But it also grows and flourishes in sheltered inland situations. When once it has taken root in any soil, drift-sand blowing over it, amongst it, and almost burying it, does not seem to injure it. As to its propagation, Captain Moody writes,—]

In the garden I was so successful with the plants from seed, that I proceeded to transplant suckers from the wild ones on the rocky shore to the rich mould in the garden, and I found them to thrive vigorously. I took suckers from these again, also from the plants raised by seed, and planted out more rows. Every plant answered admirably. I cut them down, and they grew more bushy and spread, throwing out fresh suckers. I should soon have filled a paddock with the plants; but as it was necessary to change the site of the chief town, I had to abandon my garden, and begin new and arduous labours, which have occupied the time of all hands too much to spare any for experimental agriculture. In laying out a piece of ground for tussac grass, the following circumstances must be borne in mind:—the plant grows in bunches, occupying from 2 to 3, and sometimes even 5 feet in diameter, and the blades of grass, when full grown, are 7 or 8 feet long. The roots seem forced up from the ground, and I have been in patches of fine full-grown tussac in which a man on horseback is almost concealed. I should therefore sow the seed in rows 2 feet apart, some in a garden, and some on exposed points of peaty soil, close to the sea, and within reach of the spray, carefully weeding between the plants as they grow up. When they are 9 inches or a foot high, the suckers might be separated and planted out 3 feet apart in rows. As the plants grow large, every alternate row should again be planted out, in order to leave room for a man, cow, or horse, to pass between the rows without treading down the plants. To raise from seed appears a
more uncertain and much slower method than that of planting out suckers from the finest plants.

[A plant so hardy and of such luxuriant growth, should it retain these qualities in this country, cannot fail to prove a most important addition to our agricultural resources. It is green all the year round; frost does not appear to injure it, nor does snow cover it; it is a soft, succulent, and highly nutritious grass, extremely relished by all animals—cattle, horses, sheep, and pigs. Cattle and horses fatten upon it in a surprising manner: they eat the whole blade, down to the root, which they relish most: they will eat old dry tussac thatch from off the roofs of houses. In the autumn of 1845, the Governor caused a government herd, consisting of 800 head of cattle, and about 60 or 70 horses, to be placed, for the winter months, on an island having an area of, as nearly as possible, 800 acres—about 400 were covered with tussac grass—the remainder thinly covered with coarse wing-grass and rush, a very wretched piece of pasture-land, affording scarcely any nutriment. The animals remained on this island nearly six months, with no other nutriment than what it afforded. The tussac was eaten down to the roots—by the following autumn it would have entirely recovered. The quantity of the grass "injured, by being trodden down and eaten too close, is incredible; and the horses, from preferring the root, do more mischief than the cattle."

The plant is of slow growth, and would probably be three years in coming to perfection, during which period, however, it might be cut annually with advantage. When once full grown, it springs up rapidly after being cut down, the blades reaching their full height of 7 feet by the end of summer, though cut down in the spring. I kept up a favourite horse in a loose box one winter, and had him fed entirely on tussac, cut for him and given green. He ate it greedily, and was always in excellent condition; but as a general rule, I should consider it soft food for a horse doing any work.

When it is remembered that this invaluable provision of nature thrives luxuriantly where scarcely any other vegetation will exist; that it is most nutritious, and much relished by cattle, it is impossible to resist feeling the most earnest desire to see it extensively tried in those portions of the United Kingdom which in climate and soil bear some resemblance to the Falkland Islands. I might easily expatiate on the extreme beauty of its vegetation, covering rocky
storm-beaten promontories and small islands with a dark rich verdure, always reminding me of tropical luxuriance; but its importance in a practical point of view is what I am desirous of making fully known to your lordship and to all interested in agricultural pursuits. I should wish to send a large quantity of tussac seed to England every season, but the settlers here are as yet far too few in number and far too busy to spare time to collect it. It appears to me it would be money well laid out if one of our leading agricultural societies were to send here an intelligent person to remain the six summer months collecting seed. He would be absent from England about a year, and the whole expense would not exceed £300. He should bring either a wooden or iron house, 10 feet square, with a small stove; three tons of coal, provisions, such as biscuit, pork, coffee, and sugar; gunpowder, shot; warm clothing, bed and blankets; a folding table, two stools, and a military canteen. More things would be an encumbrance. Dettleff, whom I have mentioned above to your lordship, usually goes from the settlement on foot, and takes only a good dog and a stick. He is absent about two months, sleeps under a rock, lives on wild geese and rabbits, and occasionally a calf, and invariably returns in the best possible health. A person from England might, however, fix his little residence on a small tussac island close to the settlement, and at present reserved by Government, and in one summer collect such a quantity of seed, with Dettleff’s aid, as would more than cover his expenses, to say nothing of the advantage of having a good authority at home, that could be referred to at any moment. I have given a close attention to this grass for four years; and though at first it may appear a dreamy kind of enthusiasm, I do not hesitate to say, that, should it be found on trial to succeed in the United Kingdom as well as it does in the exposed portions of the Falkland Islands, it will raise the annual income of many landed proprietors from “hundreds” to “thousands.” A tussac-fed ox is in the finest order here at the end of the winter, though never housed or cared for in any way. In the Falmouth Packet and Cornish Herald newspaper, of the 23rd August 1845, I have been shown a paragraph stating that J. Matheson, of Lewis and Achany, M.P., sent some tussac grass seed, procured from the Falkland Islands, to Stornoway, and that Roderick Nicolson, tacksman of Coll, has been perfectly successful in raising grass from the seed. I should be glad to hear of
some of the seed being sown in the salt-water marshes near Southampton, Dungeness, Isle of Sheppey, the fens near the Wash in Lincolnshire, the banks of the Thames, and south shore of Essex round to Harwich—in short, anywhere near the sea, preferring, as a general rule, marsh and peat-bogs to sand-hills or downs, although I would always try both. I should also be glad to hear of some having been tried on inland bogs, as the bog of Allen and "Chatmoss." I have omitted to mention that I would sow the seed very early in the spring, and not too deep.


[From the Irish Farmer's Journal, May 20, 1846.]

The tussac grass seed in its early stage requires gentle treatment, otherwise the young plants will fail after they have vegetated; and during the first year they appear delicate and uncertain: at least such is the result of my observations. I do not mean, however, to infer that the plant will not prove sufficiently hardy for our climate; on the contrary, I think it abundantly so: but more than one-half of the plants raised here became sickly and dwindled away, without any apparent cause that I could perceive, after they were planted out last May. Considering that this occurred from their being deprived of saline matter, I had a very weak solution of common salt in water tried on two plants, leaving the others as they were. This solution was kept fully six inches from their roots, and did not appear to have any effect. The plants only commenced to grow freely towards the end of August, when they continued to make considerable progress until the middle of November. Being anxious to increase the stock as speedily as possible, and ignorant of the effect our winter would have upon them, I had the strongest plants taken up, divided, and replanted in a glazed frame, where only one out of the eight survived the winter. Three others were lifted with balls of earth, and potted without being disturbed. They continued to grow during the winter, and so did one good plant which was left without any protection in the open border, and which is now the best we have. It is growing vigorously, and will afford good side-shoots for propagating. These grow readily, if carefully slipped off, and planted in small pots at this period of the year. I have, therefore, no longer any doubt of the tussac grass being freely introduced within a short period. From
ON THE BEST TIME FOR HAY HARVEST.

one good plant perhaps forty may be propagated in one season, if taken early in the year, as the offsets soon become strong, and afford young plants in their turns; neither have I any reason to doubt its suitableness for inland situations. Mr. George, gardener at Clonbrenny, county Meath—who, for intelligence and knowledge of his profession, is surpassed by very few in his line—informs me that the single plant he raised is now growing most vigorously, and producing plenty of young shoots. He further states that he is cultivating it in well-manured, rich, loamy soil, mixed with sand. The strongest plant we have is growing in peat and sand, where it was weak until I had it well supplied with liquid manure, which it appears to relish, from the great progress it has made within the last four weeks. The leaves are now fully a foot long, and nearly half an inch broad. The indigenous grass to which the tussac grass bears the greatest resemblance is the cock's-foot (*Dactylis glomerata*), both in the foliage and manner of growing in tufts. I allude to the young plants as they now appear, which of course will alter very considerably as they advance towards perfection.

D. Moore.

*Royal Dublin Society's Botanic Garden, Glasnevin.*

**ART. LXXV.**—A FEW HINTS ON THE BEST TIME FOR HAY HARVEST.

By O. Whistlecraft, Author of the "Climate of England."

Many farmers complain that they are never lucky with their hay; and if they begin to mow between the 22nd and 30th of June, they seldom, indeed, can be fortunate in harvesting it. The best time, i. e. the safest, is between the 11th and 21st, which, five years out of six, will be fine, and never was a rainy period. Why? Because it is the lulling time before the quarterly storm period; and hence it is that those who cut after the 21st expose themselves to storm. In the finest summers, a storm will come about June 23rd; a turn of wind occurs, and a temporary change, on account of its being one of the four critical positions of the sun and earth; so that when, in March and September, the sun becomes apparently half way between extremes, or when, in June and
December, its extremes happen above and below the equator respectively, it affects the air, and causes a convulsion at those changes; and in every year we see it more or less at those periods, or a few days after. We never had it so glaringly illustrated as of late; to-wit, as follows:—In 1844, after a long drought, the first rain came on June 24th. In 1845, after the severe winter, rain and wind first came March 22nd. After a hot fortnight, a thunder-storm June 24th, followed by more wet. A thunder-storm again September 21st, at the quarter; and another December 22nd, and the only snow of last winter. Again, in 1846, on the 23rd of March, heavy thunder-storms; and after a continued scorching-time, on June 22nd, at night, a series of storms set in for some days. What can be clearer than the fact that it is unsafe, and moreover unwise, to mow grass and clover on June 21st, when it can safely be got up prior to that day, five years in six at least? The clover is generally fit by June 12th, and if the grass be not by the 17th, wait till July comes in. The following table shows the number of fine and wet days between June 21st and September 21st, from 1831 to 1844, both inclusive. In this, the term wet days merely shows all days whereon any rain fell:

<table>
<thead>
<tr>
<th>Years</th>
<th>From June 21 to July 21</th>
<th>From July 21 to Aug. 21</th>
<th>From Aug. 21 to Sept. 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>1831</td>
<td>20 10</td>
<td>23 8</td>
<td>21 10</td>
</tr>
<tr>
<td>1832</td>
<td>23 7</td>
<td>25 6</td>
<td>18 13</td>
</tr>
<tr>
<td>1833</td>
<td>20 10</td>
<td>22 9</td>
<td>20 11</td>
</tr>
<tr>
<td>1834</td>
<td>25 5</td>
<td>26 5</td>
<td>20 11</td>
</tr>
<tr>
<td>1835</td>
<td>22 8</td>
<td>31 0</td>
<td>19 12</td>
</tr>
<tr>
<td>1836</td>
<td>22 8</td>
<td>22 9</td>
<td>15 16</td>
</tr>
<tr>
<td>1837</td>
<td>21 6</td>
<td>25 5</td>
<td>15 16</td>
</tr>
<tr>
<td>1838</td>
<td>18 12</td>
<td>17 14</td>
<td>25 6</td>
</tr>
<tr>
<td>1839</td>
<td>20 10</td>
<td>17 14</td>
<td>17 14</td>
</tr>
<tr>
<td>1840</td>
<td>14 16</td>
<td>24 7</td>
<td>24 7</td>
</tr>
<tr>
<td>1841</td>
<td>13 17</td>
<td>20 11</td>
<td>21 10</td>
</tr>
<tr>
<td>1842</td>
<td>21 9</td>
<td>26 5</td>
<td>20 11</td>
</tr>
<tr>
<td>1843</td>
<td>22 8</td>
<td>20 11</td>
<td>25 6</td>
</tr>
<tr>
<td>1844</td>
<td>20 10</td>
<td>19 12</td>
<td>26 5</td>
</tr>
</tbody>
</table>

Farmer's Almanac.
Art. LXXVI.—NATURAL INDICATIONS OF BARRENNESS AND FERTILITY.

As the day is now (August) rapidly approaching when the young farmer commonly enters upon his farm, it will be useful to remind him of the scientific indications afforded by soils of their degree of productiveness; since, after all the cautions which skill and practice can suggest, mistakes, especially by the stranger, are not always very readily escaped. It was thus that the celebrated Arthur Young was, much to his cost, deceived in hiring (although assisted by his Suffolk bailiff) a farm in Hertfordshire. "I know not," he said, in his usual emphatic manner, "what epithet to give this soil. Sterility falls short of the idea: a hungry vitriolic gravel. I occupied for nine years the jaws of a wolf." In a recent prize essay, Mr. J. Bravenden, and also Mr. J. Arkell, have skilfully examined this important question.¹ Amidst many other natural indications, the colour of a strange soil should be carefully recorded; barren soils are generally of a lightish brown, foxy, fawn, pale red, and whitish-yellow colour—a deep yellow is a certain sign of barrenness. Mr. Bravenden thinks all soils should be called barren that do not produce on an average 20 bushels of wheat, or 30 bushels of beans, oats, or barley, per acre. The spontaneous growth, in considerable proportions, of the following plants, is an indication of a barren soil:

The agrimony.............dry sandy soils.
Rough dandelion.............dry barren pastures.
Woody betony ..............in woods.
Canterbury bells.............high chalk pastures.
Heath-bell flower.............on heaths.
Plea rush....................in wet places.
Star knapweed ..............barren meadows.
Corn marigold ..............on sandy soils.
Common cudweed .............barren meadows.
Smooth catsear .............sandy and gravels.
Silver weed..................lands subject to floods.
Sheep sorrel .................sandy meadows.
Wild thyme..................barren elevations.

Of the natural grasses which tenant barren soils are—

Common bent..............? dry heaths, limit of elevation above
White-rooted bent.........§ the sea 2000 feet.

Creeping bent .......... clay soils.
Marsh bent ............... damp and shady places.
Tufted hair ............... limit of elevation 1500 feet.
Slender foxtail .......... black peat.
Common quaking .......... poor soils.
Soft brome ............... poor exhausted pastures.
Sheep's fescue .......... dry sandy soils.
Wood fescue ............... in damp woods.
Woolly soft ............... moist peaty pastures.
Wild sainfoin .......... barren chalk pastures.

Timber trees flourish best on soils which are for—

Sycamore .......... sandy lightish.
Maple ................. deep sandy.
Alder ................. wet.
Birch ................. light, moist, and sandy.
Hazel nut ............... deep, sandy, moderately fertile.
Beech ............... calcareous.
Ash ................. deep, flourishes on the inferior oolite.
Walnut ................. dry loamy, rich.
Larch ................. thin, dry, and rocky.
Poplar ................. wet, boggy.
Pine ................. light, dry, and rocky.
Elm ................. deep rich loam.

Of the plants whose chief occupancy of the ground indicate a fertile soil, are—

Stinking May-weed, dandelion, fat hen, pale persicaria, cow-parsley, sow-thistle, virgin's bower, chick-weed, goose-grass, nettle.

The same presence of the following grasses also indicate a fertile soil:

The meadow fox-tail, meadow fescue, sweet-scented vernal, rye-grass, meadow oat-grass, rough-stalked meadow, florin, perennial red clover, crested dog's tail, white clover, cocksfoot, creeping vetch.

Of aspects, a northern aspect is rather an indication of barrenness, so is N.E. or N.W.; pasture lands with these aspects are the most subject to moss. S., S.E., or S.W., or W., are very favourable aspects. A fertile inclination should not exceed 150 degrees; soils of a greater inclination are thin, and near the rock or subsoil.

Elevation.—1500 feet may be considered as the limitation of natural fertility. Wheat seldom ripens at above 1000 feet. "High farming, however," adds Mr. Bravenden, "embracing the best modes of cultivation, is found to ameliorate the severity of the climate, and to place us, as it were, in well cultivated districts, several degrees nearer the
equator, and reduces the highest of our cultivated hills several hundred feet."

The *geological* character of a district is also a great criterion by which to judge of the fertility or barrenness of its soils and their prevailing quality. With this view, the following table will be of service.¹

<table>
<thead>
<tr>
<th>TERTIARY SYSTEM. Deposits.</th>
<th>Prevailing quality of the Soil.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alluvial</td>
<td>Clayey. Sandy or rocky. Loamy.</td>
</tr>
<tr>
<td>2. Diluvial</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>3. London clay</td>
<td>barren.  fertile.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Upper chalk</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>2. Lower chalk</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>4. Green sand.</td>
<td>barren.  fertile.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wealden clay</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>2. Hastings sand</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>3. Ashburnham beds</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>4. Purbeck beds</td>
<td>barren.  fertile.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Upper oolite</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>2. Kimmeridge clay</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>3. Coral rag</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>5. Cornbrash</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>6. Great oolite</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>7. Fuller's earth</td>
<td>barren.  fertile.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Upper lias shale</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>2. Lias marls</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>3. Lower lias shale</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>4. Lias rocks</td>
<td>barren.  fertile.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Upper new red sandstone</td>
<td>barren.  fertile.</td>
</tr>
<tr>
<td>2. Lower ditto</td>
<td>barren.  fertile.</td>
</tr>
</tbody>
</table>

| Magnesian limestone          | barren.  fertile.               |

### Table continued.

<table>
<thead>
<tr>
<th><strong>Carboniferous formation.</strong> Deposits.</th>
<th>Clayey.</th>
<th>Sandy or rocky.</th>
<th>Loamy.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Coal measures .................</td>
<td>barren.</td>
<td>barren.</td>
<td></td>
</tr>
<tr>
<td>2. Millstone grit ...............</td>
<td>......</td>
<td>barren.</td>
<td>fertile.</td>
</tr>
<tr>
<td>Old red sandstone ...............</td>
<td>......</td>
<td>barren.</td>
<td></td>
</tr>
</tbody>
</table>

**PRIMARY.**

| Silurian rocks ............... | ......  | barren. |        |
| Cumbrian rocks ............... | ......  | barren. |        |

**Metamorphic rocks.** Deposits.

| Mica schist ............... | ......  | barren. |        |
| Gneiss ................... | ......  | barren. |        |

**Plutonic rocks.**

| Basalt .................. | ......  | barren. | fertile. |
| Serpentine ............. | ......  | barren. | fertile. |
| Sienite ................. | ......  | barren. |        |
| Granite ................. | ......  |        |        |

*Farmer's Almanac, Aug. 1846.*
CHAPTER VI.

MISCELLANEOUS.

Art. LXXVII.—ON KEEPING FARM ACCOUNTS.

By the Editor of the "Agricultural Gazette."

The matter of greatest difficulty to any one who would keep his farm accounts with any minuteness, is the distribution of the sum paid for labour amongst the several heads on which it is chargeable. Imagine a farmer, at the end of each week, paying two dozen labourers, men, women, and children, who have, during that period, been working, each of them for days and parts of days, at different sorts of work; if he enters the time of each man separately in his day-book, he may have every week, for labour alone, forty entries to make there, forty in the journal to which he transfers them, and eighty in the ledger to which they are posted on the Dr. and Cr. sides respectively of the accounts which they concern. To do this every week would be endless work, and some contrivance is therefore necessary by which the labour may be shortened.

(The Editor then proceeds to give the following description of the labour-book employed by him, and by which the above supposed 160 entries are reduced to twelve or twenty.)

The following is a copy of the page in such a labour-book for the week ending Dec. 5, 1846.
### ON KEEPING FARM ACCOUNTS.

<table>
<thead>
<tr>
<th>Name</th>
<th>Labour</th>
<th>Wood</th>
<th>M.</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Pigs</th>
<th>Figs</th>
<th>Shear.</th>
<th>Xingel-wurzel</th>
<th>Total.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td></td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
<td>£ s. d.</td>
</tr>
<tr>
<td>1. Wicket</td>
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<td>0 0 0</td>
<td>0 0 0</td>
<td>0 0 0</td>
<td>0 0 0</td>
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<tr>
<td>2. Carros</td>
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<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0</td>
<td>0 0 0</td>
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<tr>
<td>3. Cattle</td>
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<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
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<tr>
<td>4. Sheep</td>
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<td>0 0 0 0</td>
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<tr>
<td>5. Xingel-wurzel</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0</td>
</tr>
<tr>
<td>6. Pig</td>
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<td>0 0 0 0</td>
<td></td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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</tbody>
</table>

### FARM LABOUR ACCOUNT, FOR WEEK ENDING DECEMBER 5, 1886.

<table>
<thead>
<tr>
<th>Day</th>
<th>Labour</th>
<th>Wood</th>
<th></th>
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<tbody>
<tr>
<td>Sunday</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
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<td>0 0 0 0</td>
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<tr>
<td>Monday</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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</tr>
<tr>
<td>Tuesday</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>0 0 0 0</td>
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<tr>
<td>Thursday</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
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</tr>
<tr>
<td>Friday</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
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<td>0 0 0 0</td>
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<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td>0 0 0 0</td>
<td></td>
</tr>
</tbody>
</table>
In explanation of this table, we must first beg our readers to imagine the columns 1 to 4, and 5 to 8, to be present; they are omitted merely because, as no work during that week was properly chargeable on the accounts of barley, oats, turnips, &c., which they severally represent, they would merely and uselessly occupy room.

To put into words all that this table signifies would fill many columns; we shall merely say a word or two of explanation, and in proof of its usefulness point to the fact, that in place of the forty-nine entries in the day-book, which would otherwise be required, six only are necessary. Instead of a separate entry for each of the particulars stated here, one only is required for each of the columns; for the total in each indicates the whole amount of labour during the week for the benefit of the account which that column represents. The mode in which the work of each day is put down will be understood by reference to the figures at the head of the columns: whatever crop or account a man has been working for, the number of the column belonging to that account is placed opposite his name at the end of the day; and so at the end of the week the book-keeper is able to divide the whole money due to him among the several columns in which it is chargeable. The fact is, that during the week referred to the chief works on the farm were ploughing for wheat, carrying out dung for wheat, thrasing wheat, carting carrots and mangel-wurzel home, and looking after the stock; and any one looking at the number of the columns will easily see how this tallies with what the table tells him.

The labour of book-keeping is very much diminished by this expedient, and it may be still further lessened if the labourers be paid only once a fortnight, as ours are. The totals of the first week may then be carried forward to head the columns of the second, and the several sums paid are thus transferred to day-book and journal only once a fortnight. All piece-work payments, and any petty sums, as market expenses, &c., may very properly be recorded here, too, and this will still further diminish the number of the entries to be made in the ledger.

There is one class of expenses which should be kept separate from all the others—viz., those which are incurred in the permanent improvement of the land, and in bringing it into that state of cultivation which it is intended to maintain. Many tenants, secured by a lease, are engaged in this, which
is properly landlords' work; and for them, in the first and second years of their occupation, to charge against the returns of those years the whole cost which has been then incurred would be obviously wrong. Wherever the same capital is invested, and the same skill and judgment exercised, the accounts should certainly show a similar annual income; and so, no doubt, if properly kept, they will, plus or minus, the extra-ordinary effect of weather and prices. But to do as is often done—to charge upon each year all that during it has been invested in the permanent improvement of the land, would have the contrary effect of exhibiting a loss upon every fresh investment of capital, and consequent additional exercise of skill. All such expenses should be placed in a "dormant capital" account, and on the whole sum which appears there at the end of each year (along with all the rest of the farm capital) the usual percentage should be charged in the annual balance-sheet; such a portion only of the principal should also annually be charged before the "balance" is struck, as shall exhaust the "account" by the end of the lease. If 100l. be spent in draining during the 10th year before this period, then year after year, on the debtor side of the dormant capital account, the sum standing will be 90l., 80l., 70l., &c.; 10l. per annum being annually abstracted and charged on the gross produce of the farm before the clear profit of the year can be ascertained, and, in addition to this, 5 per cent. has also every year to be charged on the 90l., 80l., 70l., respectively, which at those periods represent the amount of the farmer's capital still remaining invested in that particular form.

Now, as regards the yearly inquiry into the profit or loss attendant upon the twelvemonth's proceedings, it is really a very simple affair. Suppose a farmer to have commenced his year's accounts aright, he then entered (whether actually or not), by purchase, into his position; and the several portions into which his capital at that time invested might then have been divided were placed on the debtor side of the several accounts which concerned them. The sheep account received its record of the value of sheep on hand, and of that portion of food to be consumed by them then remaining; the wheat account received its record of grain in rick and barn, of seed sown, of ploughings, harrowings, &c., by which the crop had till then been benefited; and so on. Since then, payments on account, whether for labour, or stock, or food; and receipts on account for produce of all kinds have
been regularly entered; and all that has now to be done is to estimate the present position of the farmer just as if he were about to give up business altogether, and to place, as per valuation, his present invested capital on the creditor side of the several accounts to which it belongs. It then merely remains to arrange the balances of these accounts—debtor or creditor as the case may be—in columns on a sheet; to charge 5l. per cent. upon the working capital of the concern, together with that share of the dormant capital which this year must return; and the balance, when struck, will represent the income of the year.

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