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LIST OF ILLUSTRATIONS.

AGRICULTURAL CLASS-BOOK.

PART I.

SOILS AND MANURES.

SECTION I.

SOILS.

LESSON I.

The soil is the layer of earth in which plants live and grow. It varies in depth from a few inches to several feet, and in texture, from drifting sand to adhesive clay.

Beneath the soil lies a layer of earth, which, for the sake of distinction, is called the subsoil. Generally speaking, the same substances compose the soil and subsoil, but they exist rarely, if ever, in the same proportions in both. The soil almost always contains more animal and vegetable matter than the subsoil. They differ, also, in colour, and other properties, which will be noticed as we proceed.

If we dig a portion of soil, and place it on a piece of clean iron, over a strong fire, we shall find that it will soon darken in colour, and if the heat be continued for a short time the blackened matter will disappear altogether, leaving a quantity of ashes behind which resists the action of fire. The part that burns away is composed of oxygen, hydrogen, nitrogen, and carbon, together with a little sulphur and phosphorus, and is technically called the *organic* portion of the soil; and the incombustible portion, or that which does not burn, is called the *inorganic* matter. The relative proportions in which these two kinds of matter exist in soils are very various; some, as the poorest sands and the cinnamon soils of Ceylon, contain as little as one-half per-cent. of organic matter; others, as the peaty soils, contain as much as seventy per cent. of it.

The inorganic matter of soil was produced originally from rocks by chemical and mechanical agencies; and as these agencies are still at work, not only in rock formations but also in the soil itself, it is well that we should explain their action.

First, the oxygen, carbonic acid, and water of the air, are constantly wearing down rocks and soils. When, for example, we expose a piece of polished iron to the air, it becomes oxidized or corroded; that is, covered over with iron rust. Most rocks contain iron, which is very susceptible of atmospheric influences, and therefore easily worn away. Again, silica and potash occur in most varieties of rocks, in the state of silicate of potash; and by the action of the carbonic acid gas, which exists in the atmosphere, the silicate is decomposed, and the potash combines with the carbonic acid, forming the soluble substance carbonate of potash, which is washed out of the rock. Feldspar is an abundant constituent of granite, gneiss, &c., and is very readily decomposed on exposure to the air.

Secondly, rain water, which always contains more or less carbonic acid, exercises a powerful action in wearing down rocks. For example, limestone (which is chiefly composed of carbonate of lime) is insoluble in pure water, but soluble in water charged with carbonic acid. Of course the action of rain water is very different on different rocks. Some, such as the pure sandstones, quartz, and lava cinders, are scarcely at all acted on by it, while it acts readily on other minerals, such as feldspar, basalt, and clay slate.

Air and water contribute, by their physical or mechanical properties, towards the formation of soils. Winds, for example, frequently transfer to a distance the particles of the disintegrated rock. On the Baltic shores large tracts of arable land are annually covered with drift sand, and on the south-west coast of France the Dunes increase every year about seventy feet in breadth.

Water, besides aiding in promoting chemically the disintegration of rocks, acts mechanically in several ways. The abraded particles of rocks are transported to a distance by mountain rivulets, streams, and rivers. Immense quantities of alluvial matter are deposited daily at the mouth of the great Mississippi in this way. The Rhine has been computed to bring down, in the course of 2,000 years, material which would cover thirty-six square miles to a depth of three feet. The gigantic delta of the Ganges, which covers 20,000 square miles, has been deposited by that river. The deltas of the Nile, and the valuable tracts of alluvial land along our rivers, have been produced in the same way.

But the most interesting mechanical way in which water acts in producing soil from rocks is by its freezing. Rocks absorb water, which, on being reduced to the temperature of 40° F. and under, increases in bulk, and ruptures the rock with a force and to an extent proportionate to the amount of water absorbed. In thawing, the water is reduced to its original bulk and liquid state, and the particles of the rocks crumble down. The action of frost in mellowing and pulverizing the land is precisely similar.

The action of air and water on rocks is promoted by the constant alternations of heat and cold, producing cracks and fissures in the rocks, which admit air and water. By the constant expansion and contraction of the soil and its rock fragments, fissures are formed by which the air and water are always adding to the finely divided matter of the soil on which plants feed.

Vegetation, also, contributes in no small degree to the wearing down of rocks. No sooner is the rock sufficiently abraded than inferior plants strike their roots into the fissures, and these roots, subsequently increasing in bulk, rupture the rock. The dynamic force exerted in this manner by trees is sufficient to bear down walls and houses. The common wild sorrel (Rumex acetosa), for instance, "forces its roots for a great length between the layers of the clay slate rock, and in their progress loosen and finally tear them asunder."

The farmer can derive a most impressive lesson from the foregoing considerations on the formation of soils. He sees at once the importance of exposing land to the action of air and frost. The former acts chemically on the exposed surface; and as frost sets in, the water in the pores of the soil expands, and in doing so, it separates the particles, and destroys the cohesive force which held them together. When the frozen water thaws, the particles of the soil, being no longer held together, crumble down into a fine mould, without which it is vain to expect good green crops.

Notwithstanding the various agencies in operation, the wearing down of rocks is a very slow process. Liebig remarks that a thousand years are, perhaps, necessary to form from any rock a layer of arable soil the twelfth of an inch in thickness, and to give it the physical and chemical properties which render it suitable for the growth of plants.

LESSON II.

If after the organic matter of the soil is burnt away, we pass the residuum through a fine sieve, we shall separate the large fragments or pebbles from the finely divided matter; and if we place the latter again in a vessel, pour some water on it, stir it, and allow it to settle for a few moments, we shall find—1st, that a number of fine fragments will fall to the bottom; 2nd, a quantity of very finely divided matter, the *impalpable powder* of the soil, will float in the water, and may be poured off with it into another vessel, in the bottom of which it will gradually settle; and 3rd, if we allow the water used for washing the soil to remain at rest till all sediment falls to the bottom, and pour it off gently and evaporate it, a few grains of solid residue remain behind, which is the soluble inorganic portion of the soil.

The gravelly matter first separated consists of fragments of the rocks from which the soil was produced.

The bulk of the finely divided matter deposited from the water used in washing the soil consists of silica and alumina (chemically combined in most soils), and of smaller and varying proportions of lime, magnesia, potash, soda, and other inorganic elements. In the insoluble portions of the soil the silica is united with some of the other substances, forming compounds termed silicates, which are, as already explained, capable of being decomposed and made available for our crops by the influence of the air, carbonic acid, and rain water. In the soluble portion of the soil we find some of the same substances, but in such states of combination as to dissolve readily in water.

Some years ago, Dr. Daubeny, of the University of Oxford, divided the constituents of the soil into *active, dormant*, and *passive*. As rain water, which contains carbonic acid, is the great agent which dissolves the food of plants, he regarded all that can be extracted from the soil by water charged with carbonic acid as being in the active state. He considered the dormant matter to be that which was extracted from the soil (after the active matter had been removed) by digestion in muriatic acid during four or five consecutive hours. This matter would become available within a moderate period of time. The active and dormant matters make up what he called the mineral food *available* for plants. The matters which, from their state of existence in the mass, resisted the action of muriatic acid, could not, it was thought, be capable of affording any nourishment to plants for a very long time; and were, therefore, said to be *passive*.

It follows from this explanation that a soil may refuse to yield remunerative crops, and yet contain within itself a large quantity of dormant ingredients. "At the very time that the most distant quarters of the globe are ransacked for manures, the soil itself may contain an almost inexhaustible supply of the substances on which the value of those manures depends. The soil, considered as a storehouse, may be full; all the substances needed by plants may be present in it, in sufficient quantity, but not in a state in which the roots of plants can take them up." Now, the leading object of skilful cultivation is to render the dormant and passive matters of the soil active and available for plants. And, if the reader will bear in mind the explanation we have given of the various agents which disintegrate rocks and soils, he has the key to the entire theory of cultivation. He will easily understand the paramount importance of ploughing up the stubble land intended for green crops as early as possible in autumn, and of exposing as large a surface as possible to the influence of the weather, and especially of frost, during winter. He will also comprehend the theory of the old practice of bare fallowing, by which the land was allowed to lie idle for a year, and subjected to repeated ploughing, harrowing, &c. And he will be fully impressed with the importance of affording as efficient tillage as possible to his green crops—and to his grain crops, when it can be done—in their after culture.

In analysing soils, chemists usually remove the pebbles by means of sieves, believing that it is the impalpable powder and finely divided fragments that afford nourishment to plants. It is true that the impalpable powder is the part which soonest affords nourishment to plants, and that it is the finely divided portions of the soil which chiefly keep it moist, and enable it to absorb fertilizing matters from the air, rain, and decomposing manure. But the rougher portions give porosity, and thus admit air, which produces food for plants. Dr. W. K. Sullivan has shown, in the clearest manner, that the pebbles of a soil constitute an active chemical as well as mechanical part of it; in some cases yielding to acids as much soluble matter as the finely divided matter itself.

LESSON III.

The first formed soils contained little or no organic matter; and the earlier vegetables must have obtained their organic elements chiefly from the air, as we see many of the wild plants that grow on rocks and soil destitute of organic matter, still obtaining it. After the death of these plants, their roots would decay, leaving organic matter in the soils. Organic matter is formed, in this way, in all soil, and even on the surface of decaying rocks. The roots of the heather accumulate on the mountain side; the roots of trees, grasses, and weeds, accumulate in woods; the roots of our cultivated plants, in arable land; and the roots of grass rapidly increase the quantity of vegetable matter in our pasture fields. Accordingly, one of the means adopted for enriching light lands is to lay them down to pasture, or to follow a rotation of crops which allows the land to lie in grass for a few years. The decay of worms, snails, &c., also adds organic matter of a very valuable character to the soil.

Organic matter exists in the soil in various states. First, part of it is generally in a fibrous state, and exhibits something of the structure of the organized substance from which it has been derived. In this state it exerts no direct influence on vegetation, as is well illustrated in the case of peat. The farmer should, by every means in his power, such as efficient tillage, and the application of lime, promote the decomposition of organic matter in this condition. Secondly, in well cultivated soils a large portion of the organic matter—and, within certain limits, the larger the better—exists as a fine brown powder, intimately intermixed with the inorganic matter of the soil. The name *humus* has been applied to this finely divided organic matter. The shades of quality of humus are very numerous, depending chiefly upon the stage to which its decomposition has progressed. In humus there is a number of organic compounds, the products of the partial or complete decomposition of its substance. By its partial decomposition humic acid and similar acids are produced, which, it is believed, serve useful purposes in the soil. They may combine with any ammonia that may be formed with them and help to fix it. They may also combine with lime and other mineral substances in the soil, forming compounds which may be of some direct or indirect use to vegetation. But, when, by efficient tillage, we admit the air thoroughly into the soil, and when it does not contain too much moisture (that is, when it is either naturally or artificially drained), the organic matter of the soil is converted into carbonic acid, water, and ammonia, which supply to plants the elements necessary to build up their organic part. The carbonic acid, and the salts which the ammonia forms by its combination with acids, communicate to water the power of dissolving, and thus convey into plants, some of the mineral constituents of the soil that would otherwise remain insoluble. Humus is lighter and more porous than the mineral portion of the soil. It also absorbs water more freely than clay or any other constituent of the soil, and gives up very slowly by evaporation the water so absorbed. In consequence of these properties it renders clay soils lighter and more friable: and, on the other hand, it renders sandy and other light soils more coherent and absorbent of moisture.

While organic matter performs most useful chemical and mechanical purposes in the soil, we are not to suppose, as some authors teach, that the value of the soil is to be measured by the quantity of this kind of matter it contains. We sometimes find soils containing four or five per cent. of it more productive than others containing eight or ten. Five per cent. may be assumed as the average quantity in productive lands. Some crops are benefited more by the presence of a large quantity of organic matter in the soil than others. "Oats and rye," says Johnston, "will grow on a soil containing only one or one and a-half per cent. of it: barley, where two or three per cent. are present; but good wheat soils contain in general from four to eight per cent., and, if very stiff and clayey, from ten to twelve per cent. of organic matter." Dr. Voelcker found three to three and a-half per cent. of it in the best English wheat soils which he analysed. Dr. Anderson found upwards of ten per cent. of it in a first-class wheat soil from East Lothian which he examined, and only four and a-half in another from Morayshire. Dr. Hodges found nearly four per cent. of organic matter in a specimen of soil from the School Farm, Cork, which, by good management, yields superior samples of wheat, beans, oats, and barley. A field on the Albert Model Farm, on which wheat was apt to lodge, was, a few years ago, found to contain about fourteen per cent. of organic matter, which is too much for the cereals. Turnips, mangel wurzel, and cabbages delight in a soil, like that of the Albert Model Farm, rich in humus, and containing, at the same time, sufficient inorganic matter. But the grain crops are liable to lodge, and to be affected by disease on such land. In order to suit a soil of this kind, for the growth of a full and healthy crop of oats or barley, the organic matter should be diminished, either by growing green crops by means of artificial manures, or by applying quick-lime, which decomposes this kind of matter, and converts it into food for plants.

LESSON IV.

As clay, sand, lime, and vegetable matter form the great bulk of soils, and as the character and value of any soil depend mainly on the proportions in which these four substances enter into its composition, we may, for practical purposes, divide soils into four great classes: —1st, argillaceous or clayey; 2nd, siliceous or sandy; 3rd, calcareous; 4th, peaty.

Though these four classes of soils are distinguished by well marked characters, yet very vague notions have arisen from the loose way in which the terms clayey, sandy, calcareous and peaty have been used. It will be necessary, therefore, to define these terms.

The chief characteristic of the very variable mixtures to which the term clay is applied, is a certain degree of plasticity, due to the alumina they contain. The impalpable matter that is held in suspension when we wash a soil is clay; and any soil which contains one-sixth its weight, or upwards, of this finely divided matter may be termed clayey. Clay soils vary much in texture, composition, and value. The pure or porcelain clay leaves no residue of sand when washed, and is so stiff as to be unmanageable for agricultural purposes. The brick clay, which is not quite so stiff, and which leaves a residue of from 5 to 20 per cent. of sand, is tilled with extreme difficulty. And it is only when the sand exceeds 40 per cent. that clay soils admit of being worked with ordinary appliances. But clay soils generally contain such an abundant supply of plant food, though often in the dormant state, that the husbandman is always amply compensated for any extra labour he may skilfully bestow on their cultivation.

The term sand is applied to the matter that falls to the bottom of the vessel in which we wash the soil. The sand may be composed of particles of silex, lime, or some other substance. When composed of silica it is called siliceous sand; if composed of lime, it is called calcareous sand. According to Sir Humphrey Davy, the term sandy should not be applied to any soil that does not contain seven-eighths of its weight of sand. Gravel consists of larger particles than sand. A gravelly soil may, therefore, be described as a sandy soil mixed with a greater or less quantity of pebbles or stones. Where there is a large quantity of pebbles the soil is, usually, worth very little. Where the sand is of a calcareous or clayey character, and the stones undergo decay rapidly, we have the richer gravelly soils, which, notwithstanding their open texture, yield fair crops of barley and oats, provided there is sufficient organic matter.

A calcareous soil is one that contains something more than the average quantity of carbonate of lime. The presence of this substance in the soil is detected by muriatic or sulphuric acid. If we pour either of these acids on a soil containing five per cent. or upwards of carbonate of lime, bubbles of carbonic acid will immediately escape. The quantity of carbonate of lime in the soil is determined from the loss of carbonic acid.

The term calcareous is not usually applied to soils containing less than 20 per cent. of carbonate of lime. When it is between 5 and 20 per cent. the soil is said to be marly.

The quality of peaty soils varies as widely as the quality of any of the other great classes into which we have divided soils. There are moory peats and the true peats. When the peat does not exceed one-fourth of the soil, and when the remainder consists of clay and sand in good proportions, the soil may yield fair crops, particularly when it rests on a substratum of clay. When one-half the soil is composed of peat it will not yield good corn crops, unless manured with clay, or otherwise improved; and as the quantity of peat increases above this, the value of the land decreases. Strictly speaking, the term peat should be applied to inert vegetable matter, such as exists in bogs and moors. But when a soil contains an undue quantity of vegetable matter of any kind, it is said to be peaty. According to Davy, "a soil, to be considered peaty, ought to contain at least one-half of this matter;" but the term is now applied to soils which contain 20 per cent. or upwards of organic matter.

As the term *loam* is used very frequently in speaking of soils, and as it is not uniformly used in the same sense, it may be well to attach to it a definite notion. Davy defined loam as the finely divided matter of the soil. At present, the term is applied to this matter only when it contains a sensible quantity of organic matter. A soil is said to be loamy when it contains from 5 to 10 per cent. of organic matter in a fine state of subdivision, or in an advanced state of decay; and when a soil contains from 10 to 20 per cent. of this kind of matter it is called *vegetable mould*.

Soils improve as they approach the loamy state; and in well cultivated districts, the great breadth of the land is in this state.

When we determine the amount of water, organic matter, carbonate of lime, clay, and sand in a soil, we are said to make a mechanical analysis or examination of it.

SECTION II.

CLAY SOILS.

LESSON V.

The most characteristic properties of clay soils arise from the large quantity of alumina they contain. Of all clays the kind called porcelain clay contains the largest proportion of this substance. One hundred parts of the porcelain clay, or Kaolin, found in Wicklow, Down, and Tipperary, contain—of silica 47, of alumina 40, and of water 13 parts.

The term *pure clay* has been adopted by authors as a kind of standard of comparison. It is the pipe-clay of these countries, and contains from 36 to 40 per cent. of alumina, 3 or 4 per cent. of oxide of iron, and a trace of lime, and is not so strong as the pure porcelain clay; it consists of the latter, with a mixture of siliceous and ochry particles in so intimate a state of mechanical union that they cannot be separated by washing.

The quantity of alumina in clay soils is subject to great variation. A soil from Nebstein, in Moravia, which was known to have yielded 160 successive crops of corn without manure, contained 8·51 per cent. of it. A virgin soil from the banks of the Ohio River, North America, celebrated for its fertility, contained 5·66; and a third, from Alt-Arenberg, in Belgium, which bore scourging crops of beans, wheat, oats, barley, &c., for nine consecutive years, contained 4·81 per cent. of alumina.

Five per cent. may, therefore, be considered a moderate average of the quantity of alumina in heavy clay soils. In ordinary arable land the average quantity may be taken at one and a-half per cent.

It is perhaps necessary to remark that these quantities represent merely the alumina in the finely divided matter of the soil.

Alumina is not supposed to enter into the composition of plants. A moderate quantity of it is, however, quite useful in the soil, imparting to the clay a certain degree of adhesiveness and the power of absorbing and retaining moisture and the constituents of manure. The alumina exists in the soil principally in combination with silica, as silicate of alumina. It exists in the same state in feldspar, mica, clay-slate, and other rocks, and in the fragments of those rocks met with in soils, by whose disintegration many clays have been produced.

Those rocks contain a large quantity of the alkalies, potash, and soda; and clay soils produced from them contain these valuable substances in far greater abundance than any other class of soils. The superior natural fertility of this kind of land is largely owing to the abundant store of potash and soda they contain.

While, however, it is true that many clay soils contain, within themselves, potash and soda, and all the mineral constituents of plants in great abundance, it does not follow that these substances always exist in those soils in a condition available for plants. On the contrary, they exist often in a most dormant state; and the success of the farmer then consists in rendering them available at the smallest possible cost. All clay soils do not contain the same abundant store of potash and soda as those which are derived from feldspar and similar rocks. This is very well evidenced in the soil of the Ulster School Farm, which, though a most adhesive clay, shows a smaller per-centage of alkaline matter than many light soils. That clay lands are, generally, a vast magazine of plant-food there is the most unequivocal proof. In the first place, we have seen that the rocks from which they are generally derived, are rich in potash and soda. Secondly, clay land is shown by chemical analyses to be exceedingly rich in all the most valuable constituents of plants. So much is this the case, that the opinion has been more than once expressed that they are practically inexhaustible, and that if we till them well there is scarcely any limit to the number of crops which may be obtained from them without manure. Thirdly, if clay lands did not abound in plant food, they could not have borne the scourging system of bean and wheat cropping to which they have been very often subjected.

In its natural or unimproved condition, clay land has three defects, to which it is well to advert here, and towards overcoming which the skilful cultivator should direct his attention. First, strong clay land absorbs water largely and parts with it tardily. The consequence is that it is always cold, and late in maturing crops. Pure clay is so impervious that water lodges on its surface, and cannot easily find its way into drains when they are made to carry it away. In this state it cuts like soft cheese, and feels greasy and slippery under the foot. Secondly, air being excluded, no beneficial chemical change can take place in the constituents of the soil. Thirdly, being the most adhesive of all land, its cultivation requires the greatest amount of horse and manual labour. And while a little moisture makes it soft, a little drought makes it hard. On drying it cracks and presents a number of fissures, and collects into lumps which cannot be broken by the ordinary implements of husbandry.

Drainage is the first and most essential step to be taken in the improvement of clay land.

The other means which suggest themselves for the improvement of stiff clay land, are—(1) mixing with sand; (2) paring and burning or charring; (3) liming.

The application of sand to heavy clay land would appear one of the most common sense ways of overcoming its extreme tenacity. The instances are, as we shall afterwards see, innumerable in which the contrary practice of adding clay to light land has been attended with the best results. We believe, however, there are comparatively few well authenticated examples of the improvement of clay land by applications of sand. The late Mr. Pusey has made the same remark in one of his valuable essays. We have, however, seen sand applied with marked success on clay land in the South of Ireland. And, according to the "Scottish Farmer," an application of from 200 to 300 loads of sand to heavy clay land has been found of permanent advantage in North Britain. "The cost of the dressing will vary from £2 to £5 per acre; but the outlay will be repaid even with only eight or ten years of a lease to run." When sand can be applied at the above cost of from $2\frac{1}{2}d.$ to $4d.$ per load or ton, the outlay may be expected to prove highly remunerative. In many places it will cost far more; in some cases the sand may be so remote, or so ill-adapted for the purpose, that its application should not be attempted.

LESSON VI.

The agency of heat may be resorted to for improving the character of very heavy clay land. The operation commonly called "paring and burning" is a very old practice, and one on which the most contradictory opinions are entertained. Some contend that it is an injudicious, if not a ruinous, practice on any land: others maintain that on clays and peats it is very beneficial. We are of the latter opinion, and shall now proceed to give a concise sketch of the theory and practice of the process.

The operation is usually performed at that period of the rotation when the land is foulest. A paring plough, or spade, slices off and turns over about two inches of the surface, whether in grass or stubble, in which state it remains till dry enough for burning. The slices are then made into small heaps and burnt, and the ashes afterwards spread evenly and ploughed in. In the heavy clay land districts of Essex, "there are usually about 40 heaps to the acre, each containing three cubic yards of ashes. The labourer commences by forming a sort of artificial furnace with some of the larger slices, leaving it open to the windward side: on the top of this he places some dry stubble, and wood or thorns, and partially covers with some of the driest pieces; the fire is then applied, and as it progresses more slices are put on; and care is taken not to allow the fire to burn out through the external surface without applying a fresh supply of them." We have seen this system of burning carried out at a cost of £1 10s. per statute acre, the quantity of ashes obtained being about 80 cubic yards, which gives 4½d. per cubic yard.* Instead of collecting the skinned surface as described above, the ground is sometimes ploughed and harrowed, and if necessary cross-ploughed before the harrow. The clods are then collected and burned. This operation is called "clod" burning; and if the clods are burned in small heaps throughout the field, it need not, in this country, cost much more than 25s. per acre. When collected into large heaps of 200 or 300 cubic yards, it will cost more.†

The advantages of burning heavy land in the modes now described, have been supported by the clearest and strongest testimony. In Essex, says Mr. Pusey, it renders the land more easy to pulverize for several years, and improves the first grain crop 20 to 25 per cent.; and the quality of the barley is improved to the value of 2s. per quarter. But, perhaps, the most striking case on record is that of a piece of poor clay in Worcestershire. In its unimproved state it was worth 7s. 6d. per acre. In May, 1840, it was skin-ploughed to the depth of about an inch and a half, and all that the plough raised was burned with faggots at a cost, including spreading, of 42s. per acre. It was then ploughed and scuffled, and rendered perfectly clean. In October it was planted with vetches, upon which sheep were folded the following summer. This was followed by wheat, which yielded 45 bushels per acre,

* In a prize essay on Paring and Burning, in the 8th vol. of the English Agricultural Society's Journal, Mr. Rawlinson estimates the cost of the practice, as described in the text, at from 4d. to 8d. per cubic yard.

† Mr. Mechi, who adopts this practice, gives the cost at 7d. per cubic yard, which includes firewood.—*Jour. Roy. Ag. Soc. Eng.*, vol. vii., p. 299.

and which sold for more than the fee simple of the land in its former state.

Sometimes, again, a system called "border" burning is adopted. This consists in burning, in large heaps, the clay of headlands, waste corners, &c., and spreading the ashes over the land. A farmer who practised this system for seventeen years in two English counties, Cambridge and Bedford, thus describes the system:—"The work of burning borders, headlands, &c., is begun in May, and continued throughout the summer, in heaps containing from 50 to 100 yards each, at an expense of from 6*d*. to 7*d*. per cubic yard. The quantity of the ashes applied to strong clay land varied from 40 to 50 yards per acre. And by this application the average produce of wheat was increased 10 bushels per acre, and other crops in proportion."

The effects of paring and burning on the ground may be reduced to two heads—It destroys, or at least diminishes, the organic matter, and produces chemical changes in the inorganic constituents of the soil.

Organic matter performs three most useful functions in the soil. By its decomposition, carbonic acid, water, and ammonia are produced, and serve as direct food for plants. 2°. These compounds aid in dissolving the mineral constituents of the soil. 3°. Organic matter imparts to the soil the property of absorbing moisture largely. The mere enumeration of these functions is enough to show the farmer that paring and burning would be injurious on all light land except the peaty, as it would render them still lighter and more porous; and, by dissipating the small quantity of organic matter they contain, it would render them less absorbent of moisture than before. It is different with heavy clay lands. Their texture is improved by burning; and, besides, as clays retain a great deal of rain water, they are not as dependent on the absorption of atmospheric moisture as light lands.

The beneficial effects produced on the inorganic constituents of the soil by burning, have been recently investigated by Dr. Voelcker, who has shown that the application of heat up to a given degree increased the quantity of soluble matter in the soil; but when the temperature was very high, the clay was overburnt, and its constituents rendered less soluble than in the natural state.

Now, as there can be no doubt that the soil is most fertile when its inorganic constituents are in the most soluble or available condition, it is evident that a moderate degree of heat may prove very beneficial, but that excessive heat is to be avoided in paring and burning.

Dr. Voelcker also found that by burning, a considerable quantity of alkaline matter, and more especially of potash, was rendered soluble and available for crops. And as potash is one of the most valuable and essential constituents of soils, it may be assumed that its liberation is one of the chief chemical causes of the beneficial effects of burning heavy clay. The more insoluble potash the soil contains, the more likely it is to be benefited by torrefaction. A heavy clay, in which fragments of feldspar and other minerals rich in potash exist, or in which the chemist can discover a large quantity of insoluble potash, is sure to have some of this potash made available for plants by the judicious application of heat. On the other hand, when, as in the case of the Ulster School Farm, the soil does not contain so large a quantity of insoluble potash, the effects of paring and burning are less striking.

Farmers are often known to resort to paring and burning on light land as the easiest and cheapest way of raising a crop; and as they are either ignorant of its effects, or prompted by cupidity, they never think of returning, in the shape of manure, any of the constituents which the heat rendered available, and which the crops removed from the ground. The consequences of such a system are manifest. If repeated too often, it would weaken and impoverish the strongest and richest land. It would soon render light land barren. When these lands are cropped with corn, after paring and burning, symptoms of exhaustion manifest themselves immediately. If green crops were grown on the pared and burned ground, and these crops consumed on the farm, the practice would not be quite so objectionable. If some manure were applied to the green crops, or to the subsequent grain crops, the practice may be excusable in some cases. But it cannot be too often impressed on the attention of landed proprietors and farmers, that the practice of burning, as a substitute for manure, is sure to end in the ruin of light land.

SECTION III.

SANDY AND CALCAREOUS SOILS.

LESSON VII.

Soils which are easily tilled are said to be *light*. Sandy, gravelly, calcareous, and peaty soils come under this denomination.

Sandy soils cover a large area; and are of all degrees of fertility, from the barren wastes of Central Africa to the kindly, loamy sands of our own country.

A pure sandy soil possesses little value. When wet, it feels firm under foot, and ploughs with a pretty firm furrow slice. It cannot be compressed into a ball with the hand. When rubbed between the fingers it is rough and grating; when dry it feels soft, and is so yielding to pressure that an object of any weight sinks into it. Most pure sands are easily drifted by the wind. They are also very poor, and have a very scanty herbage; a character which they possess in common with the inferior gravels. We have already explained that a gravel may be said to be sandy soil, mixed with a quantity of pebbles or stones; and may, therefore, expect to find the defects of sands aggravated in gravels.

Sand, without losing its distinctive character as a soil, may naturally possess a certain degree of cohesiveness in its particles; and it then acquires value. By skilful management soils of this kind, which are naturally dry and early in maturing their crops, are capable of being made very productive.

The quantity of silica* in sandy soils varies very considerably. Two soils from the neighbourhood of Cirencester, recently analysed by Dr. Voelcker, contained respectively, 82 and 88 per cent. of it. Both are deficient in phosphoric acid, potash, soda, and all the more valuable constituents of soils. Lime is also contained in them in too small quantity; and so is sulphuric acid. "Both are poor soils that require to be well manured before they can be made to yield remunerative crops."

All sandy soils are light in texture. They are loose and porous, and easily worked. These properties are the very opposite of those possessed by clays. And, again, while clays are habitually wet, sandy soils are naturally dry. When a sandy surface soil rests on a porous subsoil, from which the water can escape, it never requires drainage. It can be ploughed without injury soon after rain.

As clays and sandy soils are so different in their properties, it is manifest there must be many points in which their general treatment should vary.

Next to their defective chemical composition, which is noticed further on, want of moisture is, perhaps, the greatest defect of light soils. Their extreme poverty, and want of attraction for water, render it exceedingly difficult to grow good crops on them.

When these soils are under root crops, the moisture is so easily dissipated that every precaution must be taken to retain as much as possible of it. One of the causes of the many failures that occur in growing root crops on very light lands is the undue exposure of the soil immediately before the time of sowing the seed. "Some years ago the practice was general, and, in some districts, is still continued, of ploughing turnip-fallow, even when clean, three or four times in spring and summer, for the purpose of pulverizing the soil, and making it work well. Such a practice is against the economy of labour and the chance of procuring a turnip braird,

* The common substance flint is composed of silica. It is capable of acting the part of an acid in combining with bases, and is therefore called silicic acid.

as it dissipates the moisture of the soil." In the case of clays, we may expect some beneficial result every time we expose a fresh surface to the air, unless the ground is wet; but every time we turn up a fresh surface of very light land in May or June, some of its scanty supply of moisture is liable to be evaporated. We must not, therefore, expose it at this season of the year oftener than is absolutely necessary. In spring the grubber should, as far as possible, be substituted for the plough in the tillage of these lands. The plough turns over a fresh surface, while the grubber loosens a large body of soil without inverting any of it. The grubber, too, enables us to prepare the land more expeditiously and cheaply than the plough.

If the land is foul in spring, the plough may facilitate the removal of the weeds by bringing them to the surface. But good farmers, now-a-days, rid their lands of weeds in autumn. A scarifier, broadshare, or grubber, is run through the stubble land, loosening the weeds, and enabling us to collect them by a drag or harrow. After the weeds are removed the land may be ploughed or grubbed, to permit the air to act upon it. If the soil is very loose and open in texture, it may not be necessary to stir it till spring. It is naturally porous enough, and by making it more so we run the risk of having some of its constituents washed into the subsoil by the rains of winter.

Manure should be covered in as fast as it is applied to light land, and especially when used for green crops in spring. The opening of the drills, the spreading of the manure, the covering of the manure by splitting the drills, and the sowing of the seed, should follow each other as rapidly as possible; for, on light soils, the evaporation of the moisture, both of the dung and of freshly turned soil, in a few hours may seriously affect the braird. The manure, too, may suffer injury from exposure in hot weather; but, on light land, far more injury is done during a hot day by loss of moisture than by any loss of the other constituents of the manure.

It is upon sandy soils that liquid manure produces the greatest effects. It is partly by the aid of the large quantity of liquid and solid excrements voided by their house-fed cattle, that the small farmers of Belgium have been enabled to convert sterile sand into fruitful soil. And many patches of sandy land, now yielding poor crops in the hands of the small farmers of this country, may, by the same aid, be made to yield luxuriant crops.

There are two reasons why liquid manure produces better results on light than heavy soils. First, it supplies a large quantity of moisture, of which, as already shown, those soils are deficient; and secondly, light soils are generally so deficient in plant-food that "they are grateful for any manure (such as liquid manure) that contains even a small quantity of phosphoric acid and alkalies."

When well managed, sandy soils yield good crops of all our useful farm plants. They are not, however, equally well adapted to all. It is seldom we find them adhesive enough to give support to a heavy crop of wheat or beans, which find all the condition for their full development only in clay land. Bulbous rooted plants, such as turnips, carrots, &c., thrive much better in light than on heavy soils, as the latter, owing to their tenacity, retard the growth of the bulb. Oats and barley are the cereals most extensively grown on light soils; and when the ground is poor, and situated at a considerable elevation, rye is partially or wholly substituted for them.

LESSON VIII.

Wider areas of light land have been improved in these countries than of any other class of soil. And a more striking increase of fertility has been produced by the improvements effected on light land than even on clays. The reader will readily understand the causes of this as we proceed.

The main objects to be kept in view in the improvement of clays and light soils are very different. Clays generally contain within themselves an abundant supply of plant-food; and the business of the land improver is to make it available. Light soils, on the contrary, are generally deficient in the more important constituents of the food of plants, such as phosphoric acid, and the alkalies, potash and soda. To effect the permanent improvement of light land, we must, therefore, add to them manures containing more or less of these constituents, and at the same time improve their want of cohesion. In short, we must increase their store of plant-food, and render them more capable of retaining it, as well as of absorbing and retaining moisture. The means to be adopted for effecting these objects must vary with the nature of the soil. Some light soils are very much improved by "green manuring," which consists in growing rape, buckwheat, or any other fast-growing crop, with an abundance of foliage, and ploughing it in where it grows before it comes into flower. In this way a large quantity of organic matter derived from the atmosphere is added to the soil. Where the soil is likely to be improved by the addition of organic matter alone, this is an excellent system. It does not, however, add any inorganic matter to the soil, and cannot, therefore, become a general system of improving such lands as we are now considering. At best, it can only be resorted to occasionally as a convenient way of adding organic matter to the soil. Peat, when it can be had within convenient distance, is applied for the same purpose. As it exercises little effect in its crude state, it should undergo a certain degree of decomposition before it is applied; and as it contains too little inorganic matter, it is much improved by being made into a compost with earthy matters. When prepared in this way, peat is an excellent manure for light soils; but as it cannot everywhere be had within convenient distance, its use must be limited.

The great means by which light lands have been improved are, first, the application of farmyard dung and artificial manures; second, sheep folding; and third, the application of clay and marl to the very light and drifting sands. As good farmyard manure contains all the constituents (organic and inorganic) required by farm crops, the application of a sufficient quantity of it must at once improve the character of light land.

By folding sheep on turnips many tracts of light land have been greatly improved. The sheep consolidate the ground, and enrich it with their excrements. So marvellous has been the effects of folding on light land, that farmers have styled the sheep the "golden"-footed animal. It was by turnip husbandry and sheep-folding that thousands of acres of the light land of Norfolk and other English counties were raised from barrenness to high fertility.

Some light lands are so light and loose that their permanent improvement cannot be effected without adding clay or clay marl to them. Such is the case with blowing sand and peats, both of which are deficient in alumina, which the clay contains in abundance.

The beneficial effect of a dressing of clay is not confined to the adhesiveness and the power of absorbing moisture and the constituents of manure, which its alumina imparts to light soils. For, as it contains a higher proportion of alkaline matter, phosphates, and all the more valuable constituents of plants than that class of soils, it must also increase their fertility by increasing their supply of the mineral food of plants. The quantity of clay which it is necessary to apply in order to correct the defective qualities of loose sand must, therefore, vary, not only with the nature of the soil to be improved but also with the quality of the clay. The more alumina it contains the greater the firmness and retentiveness which a given quantity of it will impart. Marly clay adds both calcareous matter and alumina to the soil.

When clay contains ochry or ferruginous matter, it will only injure and poison the soil. Clays, which are more or less unctuous, and of a solid consistency, may be applied with safety, but those of a whitish colour and sandy character are generally bad.

One hundred and thirty-four cubic yards of clay cover an imperial acre to the depth of one inch; and when it is considered that the ordinary depth of cultivation does not exceed eight or nine inches, and very often it is less, this will appear a pretty heavy dressing. In practice, the quantity applied varies from 40 to 120 loads and upwards, the average being about 80; and autumn or early winter is often selected for putting it on, as the frost is then likely to pulverise the clay or marl, by which it is evenly distributed over the ground.

The cost of claying or marling will vary with a variety of circumstances, but chiefly with the distance it has to be carried, and the depth below the surface at which it is found. Before undertaking a heavy work of this kind the farmer or proprietor should carefully estimate the cost of the improvement and the probable increased value of the land improved. We have known one case in this country where clay was carried such a long journey that the improvement effected did not cover the heavy outlay expended upon it.

In many cases the clay or marl is procured so conveniently that its application to blowing sand is sure to pay well. "In some cases that which is most required lies buried under the very soil, and the value of many millions sterling is buried under what is now comparatively unproductive soil."

Mr. Keppel of Lexham Hall, Norfolk, effected a great improvement in his light sandy land, by claying it at the rate of fifty loads per acre. Mr. Cambridge of South Runcton, clayed 285 acres at the average rate of 188 loads per acre, the greater portion of the land being a white blowing sand when he took it. Some of the best Norfolk farmers consider that it is better to put on a small quantity of clay twice or three times than to run the risk of putting on the whole at once.

Calcareous soils have been defined in a former chapter as those which contain more than the average quantity of carbonate of lime. Both calcareous and marly soils have derived their calcareous matter from the disintegration of limestone. When the soil is formed from the disintegration of the underlying limestone rock, the per-centage of carbonate of lime is very high and the soil is calcareous. When the disintegrated limestone is drifted to other places it becomes mixed with clay and siliceous matters, forming a marly soil, in which there is a less quantity of lime. This explains why *marly* soils are generally heavier and less open and porous than calcareous soils. Both classes vary very much in composition and texture; but there are clay marls which are extremely heavy and capable of growing all our cultivated crops, beans and wheat included.

Calcareous soils rarely contain an excess of moisture; they are generally porous, light in colour, and not unfrequently rest on an open subsoil. When the soil is shallow the crops are liable to burn up or suffer from want of moisture in hot weather; for though limestone soils absorb moisture pretty freely, they part with it easily, owing to the want of adhesive force among their particles. Many of the calcareous soils on the mountain limestone are pretty deep, and are not so liable to injury from drought as light sandy soils.

There is a considerable area under calcareous soils in Ireland; one-half of the soil of the island rests upon the mountain limestone, from which was produced the soils of this class in the central parts of the country. They form for the most part sharp, kindly and productive soils, well adapted to the growth of turnips and grass, and other useful crops. They are not naturally so well adapted to the growth of beans or wheat as good clays; and they are said to contain too much lime for the flax plant. They are well fitted for turnip husbandry and proverbial for producing sweet grass and forming sound sheep walks.

SECTION IV.

LOAMY AND PEATY SOILS.

LESSON IX.

The last of the four great groups into which we have divided soils remains now to be considered; namely, loamy and peaty soils whose characteristic properties are derived from their organic matter.

It has been suggested that the term loam should be restricted to soil containing from 5 to 10 per cent. of organic matter, that soils containing 10 to 20 per cent. of it should be called vegetable moulds, and that when the quantity of organic matter exceeds 20 per cent. the soil should be called peaty.

According to this nomenclature we have clay loams, sandy loams, and calcareous loams, when clay, sandy, and calcareous soils contain from 5 to 10 per cent. of organic matter.

Well drained clay loams are said to belong to the most valuable soils we possess, and are the best and most widely extended wheat soils in all well cultivated districts in these countries.

A clay loam forms a lump by the squeeze of the hand, but soon crumbles down again. It is easily wetted on the surface and then feels soft and greasy, but the water is soon absorbed, and the surface again becomes dry. It is easily wrought at any time after a day or two of dry weather. It is generally of some depth, forming an excellent soil for wheat, beans, Swedish turnips, and red clover—in short every farm crop.

Sandy, and even the better kinds of gravelly loams, are very useful soils, being neither too wet on the one hand, nor too dry like ordinary sandy and gravelly soils. It is true, that abundant manuring and judicious management are required to render them capable of producing good crops of wheat or beans; but so long as they are maintained in a state in which the term loam can be correctly applied to them, they yield excellent crops of turnips, barley, and grass.

According to the foregoing classification, a vegetable mould is a soil containing from 10 to 20 per cent. of organic matter. The term mould, as applied to soils, is a very vague one, and often leads to confusion; if the term mould is to be retained in agricultural phraseology its use should be restricted in the above restricted sense.

We come next to "peaty" soils, or those which contain too much vegetable matter. Under this denomination we may class Irish bogs and several English moors. The term bog, like many others, is not always used in the same sense. Thus, if water is pent up near the surface of the ground and issues out in springs, the soil becomes shaky or boggy, or what is called a quagmire. This kind of bog, if bog it can be called, occurs in isolated patches which are permanently improved by efficient drainage.

The true Irish bog is composed of a vegetable formation called "peat," of varying depth and quality. Our bogs have been divided into two classes—red and black. The first includes most of our flat bogs, such as the great Bog of Allan in Ireland, and Chatmoss in Lancashire. They are of a reddish hue, light in texture, and composed of the remains of bog plants in a state of imperfect decay.

Black bog is in a more advanced state of decay than red bog, and, as the name indicates, it is also of a darker colour. It is commonly called mountain bog, because it is often met with at higher elevations than the red bog; but it is also often met with on the plains, and not unfrequently in isolated patches through the red bog.

In its origin, chemical composition and physical properties, peat differs from every other kind of soil. Clays, sands, and calcareous soils are composed of the disintegrated fragments of rocks; while peaty soils are composed of dead plants and the remains of dead plants. The substance of peat may not inaptly be compared to the organic matter of other soils. The peat of our bogs and the organic matter of our cultivated soils differ, however, in several respects, some of which it is well to point out. In the first place, the organic matter of ordinary soils is composed either of the parts of the cultivated plants not removed from the soil, or the manure produced from the animals fed on them; while peat is composed of plants, or the remains of plants low in the scale of vegetation, such as sphagnums, reeds, confervæ, equisetums, &c., which differ in composition from the cultivated plants. But the most essential difference between the organic matter of ordinary arable land and peat arises from the different circumstances under which it was formed.

We have seen that organic matter increases in the driest, most fertile, and best managed soil, and within certain limits which we have already considered, its accumulation is beneficial. On the other hand, the existence of peat, or of those plants which compose peat, is a sure sign that all the conditions necessary for the growth of more valuable plants do not exist in the soil. Thus, wherever water accumulates and stagnates there peat is liable to be formed. An excess of water in the soil is injurious to farm crops; but an excess of water is one of the conditions essential for the formation of peat; and if from any cause water were to accumulate in excess, and stagnate on the surface of the most productive soil, races of bog plants would soon make their appearance, and the soil would, in due time, become covered with a layer of peat.

In ordinary soils organic matter is decomposed as fast as it is formed, else it would accumulate to an injurious extent. In the presence of air and moisture, and at a certain degree of temperature, animal and vegetable substances undergo decomposition. These conditions exist in arable land of ordinary porosity. As rain water percolates through their pores it supplies the moisture, atmospheric air follows, and these at a certain degree of heat gradually convert the organic matter of soils into carbonic acid, water, and ammonia, and other substances capable of ministering to vegetable nutrition.

When, as in peat, water is in excess, and has no outlet, it fills the pores of the soil and excludes the air; and the result is that "decay is arrested after it has proceeded only a very little way, and the remains of the plants, in place of being more or less transformed into carbonic acid and ammonia, are converted into humic, ulmic, and analogous acids; and there the decomposition stops, not only leaving these substances in forms which are incapable of acting as the food of plants, but preventing the useful mineral matters from being made available." The antiseptic properties of peat which arise principally from the presence of humic, ulmic, and similar acids, are well known, and strikingly manifested in cutting away bogs, in which are occasionally found animals and plants in a state of almost perfect preservation.

LESSON X.

In the improvement of peat, the first step to be taken is to give egress to the excess of moisture it contains, so as to permit the regular decomposition of its substance and its conversion into food for plants. This is effected by drainage. The urgent necessity for draining peat and bog land is proved by the fact that of all soils they possess in the highest degree the power of retaining water. Schübler has shown that while ordinary arable land never retains by capillary attraction more than half its weight of water, the organic matter of the soil, or humus, is capable of retaining twice its own weight of water. And Dr. Anderson has found that a specimen of peat upon which he experimented, retained six times its own weight of water, and, after being squeezed between the hands as forcibly as possible, it still retained three times its own weight of that liquid.

The drainage of some bog lands is very expensive, especially when a main outlet has to be cut a long distance. The "arterial" drainage executed by the government facilitates and cheapens the drainage of many of our bogs. Starting from the main outlet the main drain is cut, and, if a considerable area of bog is to be improved, a few open channels are cut to allow the surface water to flow off in the first instance, and these channels may afterwards serve as sub-main drains. In cutting drains in deep peat it is necessary to make the opening at the surface three or four times as wide as at the bottom, so as to give the sides a considerable slope and prevent the lateral pressure of the water from pressing the peat into the drains too quickly. As the water makes its escape from the surface the peat or bog begins to sink, and it is usual to wait some time not only to allow the bog to sink and consolidate, but also to permit the escape of surface water, before the minor drains are opened.

It may be deduced from all this that in the reclamation of peat, drainage should precede all other operations. In the steps to be subsequently taken it is of essential importance to be guided by a few elementary principles, which may be explained in a few words. In the first place it will be instructive if we contrast the composition of peat with that of ordinary soil.

In round numbers good arable land contains in a dry state about 5 per cent. of combustible matter and 95 per cent of mineral matter, or ash. In a peaty soil these numbers are reversed.

Before such a soil can be made to yield good crops the ratio between the combustible and inorganic constituents must be altered; in other words, we must establish an equilibrium between these two classes of constituents somewhat approaching that which nature provides in her more fertile lands. In effecting this object we must consider, by a variety of circumstances, such as the depth and quality of the peat, the nature of the stratum on which it rests, and its proximity to manures well adapted for improving it. In order to establish a proper balance between the constituents of peat we must either diminish the organic matter, or add to the soil some earthy substance that will increase the per-centage of inorganic matter. Besides the indispensable necessity of establishing a proper ratio between the organic and inorganic constituents of such a soil, it cannot be too clearly understood that while peat contains generally all the elements required by plants, yet they are so locked up in the structure of the dead plants as to be unavailable to cultivated crops. Again, peat wants that solidity and adhesiveness without which a soil cannot afford the necessary support to some of the farm crops. To convert peat into a fertile soil, therefore, we must render available the materials of which it is composed, or supply plant food from without, and, at the same time, give weight and firmness to the soil.

After drainage, the means usually adopted by intelligent farmers for improving peat are: first, the application of lime; secondly, burning a portion of the surface; thirdly, the application of clay or sand.

By burning, we can speedily dissipate some of this excess of vegetable matter, and at the same time obtain a quantity of ashes of high fertilising power. But if we burn even a layer of some thickness, the ashes so obtained will not materially alter the ratio between the combustible and inorganic matter of another layer of the same depth. Thus, it has been shown that the uppermost ten inches of an acre of good arable land weigh at least 1,000 tons, which contain about 900 tons of mineral matter; while the same depth of the peat referred to as having been examined by Dr. Anderson, weighed only 100 tons and contained only about 4 tons of mineral matter! Supposing a layer of that peat, ten inches thick, were burned, and the ashes distributed through an underlying layer of the same depth, the per-centage of mineral matter would be nearly doubled; but it would still fall infinitely short of the per-centage in ordinary land. We must not, therefore, expect any striking change in the texture of deep peat by burning a layer of it. As the ashes make very powerful manure, and even promote in some measure the decomposition of the peat with which they come into contact, they have often enabled the farmer to raise good crops. The process of burning peat is, however, an expensive one, and this, together with the circumstance of its not altering the texture of the soil, may explain why it is not now as often resorted to as formerly. "Paring and burning" will always be found the most immediate way of rendering available for our cultivated crops the mineral matter locked up in peat; but it does not follow that it will always be found judicious or economical. When the peat is not too deep nor yet too shallow, and when the surface is covered with coarse plants, burning may occasionally be resorted to with advantage.

LESSON XI.

Sand and clay have been largely employed in the reclamation of peat. They impart firmness and weight to the soil, and increase the per-centage of inorganic matter. The effects of a dressing of sand or clay will vary with its quality. Poor sand will do little more than add silica to the peat and increase its weight; rich good clay, on the other hand, will not only impart weight to the peat, but will also add to it alumina, and some, or all of, the other more valuable mineral constituents of land. While sand may contain little or nothing else than silica, clay always contains not only alumina but silica and all the constituents of plants.

Other things being equal, it follows that clay is better adapted for the reclamation of peat than sand. Indeed, if alumina is to be regarded as an essential constituent of soils, the mere addition of a substance like sand, which contains no alumina, to peat, which is also destitute of alumina, cannot be said to produce a fruitful soil. Sand has, however, been usefully employed in reclaiming peat; and it is not beyond the range of probability that one of the causes of the success attending its application is that some or all of the most essential functions of alumina, such as absorbing and retaining the food of plants, may be discharged by the porous organic matter of the peat.

Having thus laid down the elementary principles to be observed in the reclamation of peat, we proceed to give a few examples of their practical application. In the Report of the Devon Commission bog is divided into four classes, to show the variety of treatment brought forward in the evidence offered on this subject to that Commission. The first class consists of bog not exceeding one foot deep, resting upon clay, sand, gravel, or rock; 2nd, bog from one to three feet deep; 3rd, those which are from three to six feet deep; and the 4th class includes all bog more than six feet deep. We will follow this classification.

The first class of bog is easily reclaimed when it rests on a substratum of earth. If the subsoil be clayey the land must first of all be drained with pipe tiles or broken stones; if the subsoil be a loose gravel from which rain water finds an outlet, thorough drainage may be unnecessary, the excess of water in the peat being removed by a few drains, which may be left open for some time. The ground is next to be trenched to a depth of about eighteen inches, so as to mix six inches of the subsoil with the peat. The trenching should be performed before winter, in order to expose the freshly turned-up soil to the ameliorating influence of winter weather. When the subsoil contains stones fit for constructing drains, the two operations of draining and trenching may be carried on together. In spring the land should be grubbed, and from fifty to eighty barrels of quicklime per acre applied to it. As soon as the lime is slaked it should be evenly spread on the surface, lightly ploughed in, and the ground then planted with potatoes, which will generally be found the most profitable plant to grow as a first crop on reclaimed land. Should the earth brought up from the subsoil be calcareous, the application of quicklime may be dispensed with; and if the farmer can afford it, and wants to alter the character of the soil speedily, it should be manured with twelve or fifteen loads of well-rotted dung and three or four cwt. of good superphosphate of lime, after which it will never revert to its original condition. Land so treated will yield a heavy crop of potatoes the first year; at present prices the crop may pay all the outlay on the improvement. An excellent crop of turnips has been obtained as a first crop, on land reclaimed in this way.

In improving bog, varying in depth from one to three feet, drains should be opened at the proper distances; the bog in the site of these drains should be removed by cutting for fuel to the depth of the subsoil; and the quantity of clay or gravel, as the case may be, required for the surface, can be taken from the drains and spread on the land after the surface is dry. The drains may be then covered in and other manure applied. When turf is dried in this way it will not be removed in time to plant potatoes; but the land may be cropped with rape, which grows well on reclaimed bog, and which may be used for cattle feeding or allowed to ripen its seed. For this crop superphosphate is also an admirable manure. On the fen or moory lands of England, and similar soils on the Continent, rape is extensively grown for its seed, and proves a most remunerative crop; and there is no reason why the same thing should not be done occasionally on the peat lands of this country.

As the depth of the peat increases so does the depth of bringing up clay from the subsoil. When the depth exceeds three feet, and if it be fit for fuel, it should, as far as possible, be cut away to within a foot or so of the subsoil and made into turf. Failing in this, and when the depth of the bog is from three to six feet, it may be improved by the method recommended above for the second class of bog.

Where the depth of the bog exceeds six feet, the cost of reclaiming it is so heavy that it becomes necessary to enter into a careful estimate before embarking capital in the work. Among other things, we have to consider whether it will be cheaper to sink into the subsoil for the clay, sand, and gravel, or bring it from a distance; and also, whether the enhanced value of the land will cover the outlay. In very deep bog it will often be found cheaper to bring the earth from a distance than to sink for it.*

LESSON XII.

THE instances are very numerous in which deep bog has been reclaimed both by sinking into the subsoil for clay, and by bringing it from a distance.

The improvement of the fens of England presents us with a striking illustration of the results achieved by British skill and capital on this class of land. "The greater part of the Norfolk fens has a substratum of clay, the overlying part varying in thickness from two to twenty feet. Even at the *latter* depth clay is raised to the surface by means of deep trenches. It often happens that the peat by being weighted and well drained is so compressed, that in a few years the clay is nearer the surface, and consequently more accessible for a second dressing. The border fenny peats, skirting higher ground, have been improved by expensive dressings of clay, marl, chalk, and sometimes sand. Extraordinary dressings of these earths, viz., from one hundred to three hundred tons per acre, are applied, and a rush-growing morass has, by these means and by draining, been speedily converted into fruitful corn fields. Such dressings may be considered too much at once; but they are required to consolidate the peat, some of which is so light that on losing water it blows away."

Between Castleconnell and O'Brien's Bridge, in the

* Mr. (now Sir Richard) Griffith conceives that, in general, reclamation would not repay the cost of bringing the clay or gravel from a distance greater than half a mile, even by the assistance of railways.—Digest of Evidence, vol. i., p. 672.

neighbourhood of Limerick, lies what is now called Mona Lodge Farm, and which a few years ago was a deep bog. The peat was gradually converted into turf and conveyed to Limerick, a distance of about eight miles. The surface was levelled at a cost of about £3 15*s.* per imperial acre. Cuts were next made into the subsoil at from twenty to twenty-six yards apart; when the remains of the bog did not exceed two or three feet in depth, a sufficient quantity of subsoil was got out of these cuts to cover the intermediate spaces to the depth of four or five inches. When the subsoil lay so deep that it could not be conveniently reached, which it did in some parts of the land, a substitute was found in two veins of sand which ran across the bog, and which answered well for mixing with the peaty soil. The cuts from which the subsoil was lifted were afterwards filled up with scraws, branches of trees, &c., and have since served as leak drains, keeping the soil dry. The cost of bringing up the subsoil and spreading it over the land, is stated to be about 7*s.* 6*d.* per acre.

The first crop raised on this land was invariably the potato. It was grown in lazy beds, as the land was not dry enough to carry horses; and, being manured, it yielded well and paid all the outlay on levelling and claying, besides leaving the land in a fit condition for growing other crops. The potatoes were followed by oats, which was also found to be a productive crop; and then followed grass, the seeds of which were sown along with the oats. The land is not heavy enough to bear wheat.

A tract of twenty acres of very inferior bog land was most profitably improved at Drishane Castle, which is close to the Mill-street station of the Killarney Railway. Before the improvements were commenced the land was worth from 3*s.* to 5*s.* per acre. In the summer of 1856 it was drained with pipes at a cost of £4 15*s.* per acre. In some places the subsoil was a bluish clay, not many feet below the surface; in other parts the bog was so deep that a floor of stones had to be put in the bottom of the drains, on which the tiles were laid.* After being drained, six acres of it were "grafted"—an operation which consists of skimming the surface by a manual implement somewhat like a carpenter's adze—and burned, and sown with winter vetches, which yielded, after getting a top-dressing of two cwt. of guano, twelve tons per acre the following June. These vetches were followed by a crop of turnips, manured with fifteen tons of farm-yard dung and two cwt. of guano. The remainder of the bog was ploughed with three horses abreast, after being drained, and prepared for turnips the following spring. Some of the heath and rough surface matters were burned, and any that could not be so treated were made into a compost. Half the turnips, which yielded twenty-six tons per acre, were carted home for fat cattle, and the other half were eaten off where they grew by sheep. It was then sown with oats and grass seeds, the oats producing twelve barrels per acre, and the grass being topdressed with forty barrels of lime per acre. And after this course of management, which amply repaid the spirited proprietor as the work proceeded, the soil is worth at least six times its former value.

* As broken stones and even pipe tiles sink in soft boggy land, a convenient and economical conduit is formed by fitting into the cut drains sods cut out of the rough heathy or sedgy surface soil, like the frustrum of a wedge, leaving underneath an opening a few inches deep.

A tract of bog land belonging to the late Sir Robert Ferguson, Bart., was drained in this way at a cost of 10*s.* 4*d.* per Cunningham acre. *Vide* Digest of Evidence, vol. i., p. 611.

SECTION V.

MANURES.

LESSON XIII.

The term manure is applied to any animal, vegetable, or mineral substance capable of increasing the productive powers of the soil. It is a comprehensive word, embracing a great variety of materials, simple and complex; and does not convey to our minds the existence of a distinct object or a distinct quality.

Chemical science has established the existence of a most intimate and beautiful law of connexion between the soil and the plant. We have already seen that fertile soils invariably contain certain mineral substances; and, with the exception of alumina, these are invariably present in, and are, therefore, regarded as essential constituents of, the ash of plants.

The great bulk of our crops is made up of combustible or organic matter,* the ash generally amounting only to three per cent. of their dried substance. Now, the food of plants consists of these two kinds of matter—mineral, for their ash constituents, and organic matter, to supply the organic portion of their substance. The sources whence the food of vegetable is derived are the soil and air; and as the latter contains only gaseous elements and gaseous compounds, all proceeding from organic matter, it is evident that plants must derive all their mineral food from the soil. No difference of opinion can, therefore, exist as to the source whence plants derive

* As the words organic and inorganic, as applied to soils and manures, have often led to mistakes, we may explain that the term organic, strictly speaking, is applicable to substances in which we can trace a living structure. Substances produced by living organs, such as starch, sugar, &c., are also regarded as organic. "The solid rocks, the incombustible part of soils, the atmosphere, the waters of the seas and oceans, everything which neither is nor has been the seat of life, may generally be included under the head of inorganic matter."

their mineral constituents; but the source whence they derive the organic elements has long formed a subject of controversy.

Liebig's theory of vegetal nutrition is simple and rational. Animals derive their nourishment from animal and organized substances, that is, substances elaborated into organized forms by the vital agency of animal and vegetal life. In other words, no purely mineral substance can minister to the nourishment of animals. Plants, on the contrary, feed on mineral substances; and before the combustible matter of the soil can afford nourishment to plants, it must undergo decomposition, and be resolved back from the organized state into purely mineral compounds, such as carbonic acid and water and ammonia. According to this view, which reduces vegetal nutrition to a very simple law, plants cannot assimilate humic and similar acids which are always present in soils containing humus. These bodies are neither organic nor inorganic, but half way between these two conditions.

That plants can grow in a soil free of organic matter is a fact well known to every person who has any acquaintance with vegetation. The earlier vegetables probably grew in soil free from organic matter. We daily see plants strike root into solid rocks. Several weeds grow plentifully in light soils, destitute or nearly so of combustible matter; and even the corn crops *can exist* in land far from it, but under such circumstances their growth is stunted.

There is, then, in this respect a manifest distinction between the requirements of cultivated crops and wild plants. The latter may, and do often derive all their combustible from the air; but practical experience tells us that heavy farm crops are never obtained unless the soil contains a fair proportion of this sort of matter. Direct experiments prove that applications of manures containing only the organic elements of plants (such as nitric acid and ammonia), give a large increase to the yield of crops, and as we shall soon see the efficacy of several manures depends on the presence in them of nitrogen in an available and active form.

LESSON XIV.

As soon as Liebig established that plants always contain certain mineral substances, he propounded his celebrated "mineral theory" of manuring, the principle of which is, that every plant showed by the analysis of its ash the proportion in which the mineral constituents essential to its growth should exist in the soil. According to this theory it is, also, necessary, in order to keep up the fertility of the land, to restore to it, in the form of purchased manure, every mineral constituent sold off the farm in crops, milk, and live stock; and the farmer who wishes to increase the fertility of his land, must add more than he sells off.

In a scientific point of view nothing could be more correct than to advise farmers to replace in manures the mineral matters sold off the land. Practical experience tells us that if we keep continually selling off the produce, without making an adequate return in the shape of manure, the ground becomes exhausted.

The quantity of the mineral constituents of the soil sold off any farm depends on the system pursued upon it. When, as in the case of market gardens and town farms, the crops are all sold off, the quantity of mineral matter removed is very considerable, and the quantity of manure which has to be purchased is correspondingly large. In this case, too, as the produce sold contains all the constituents of crops, so the only manure that can prevent the exhaustion of the land is farmyard or town manure containing the same constituents. In other cases the soil becomes exhausted of only one or two substances. Thus, in pastoral districts devoted to dairy husbandry or the rearing of stock, the soil after the lapse of time becomes exhausted of phosphate of lime; and its fertility is again restored by the application of bones, or some other manure rich in phosphates. In pastures devoted to the fattening, as distinguished from the rearing of stock, the demand in the soil for mineral matter is almost inconsiderable. The animals are grown when put upon the land, and while there they chiefly put on fat which contains no mineral matter. This explains why the rich grazing lands of Meath, Limerick, Roscommon, and elsewhere, are as rich now as they were fifty years ago, although depastured every year. The same lands, if meadowed consecutively for a few years, would soon deteriorate.

Liebig says the inorganic constituents of the soil are "like the links of a chain placed round a wheel: if one link is weak the chain is soon broken, and the missing link is always the most important." Science and practice show that in most soils phosphoric acid is the weakest link in the chain of fertility. The quantity of silica in all soils is so abundant that it may be regarded as practically inexhaustible. In clay lands the potash annually liberated may equal and even exceed the quantity removed in farm produce; and the total quantity of it in those soils is so large compared with the quantity sold off, that it may be regarded as inexhaustible. In light land the case is different, the potash being generally deficient, and liable to be exhausted by the sale of crops. When the land is well tilled, a judicious rotation of crops carried out, and a fair supply of good farmyard manure annually made, the exhaustion of the other constituents of the soil is very inconsiderable. Under the four-course rotation of (1) turnips, (2) wheat, (3) grass and clover, and (4) oats, the sale of the grain would cause a loss of about $6\frac{1}{2}$ lbs. phosphoric acid per acre; and the quantity of it removed by the sale of farm animals, particularly when no breeding stock is kept, would be less.

Under the same circumstances, the quantity of potash removed by the sale of grain would be about $5\frac{1}{4}$ lbs. per statute acre, and by the sale of animals about one-fourth less than the quantity of phosphoric acid. In soils containing a good proportion of potash, the quantity of it annually liberated or made available for crops by tillage would exceed this; and when cattle food is purchased to any amount, the quantity of available potash in the soil would, in the opinion of Mr. Lawes, increase when only grain and meat are sold.

SECTION VI.

FARMYARD MANURE.

LESSON XV.

FARMYARD manure is made up of the excrements and litter of farm animals, the dung and urine of which contain all the inorganic constituents of the food on which they live, except what is stored up in the body or carried off in milk. Farmyard manure, therefore, contains every mineral substance found in plants. It also contains organic matter, which on decomposition is capable of supplying the elements which compose the combustible part of plants.

Farmyard dung is the most perfect manure we possess. The success of the farmer greatly depends on the care and skill he bestows on its management. The quantity of it produced depends on the number and kind of animals kept on the farm; and this, again, varies with the quantity of cattle food raised or purchased. The collection and preservation of farmyard manure are wofully neglected by the small farmers of this country. The quantity produced is utterly inadequate, and must continue so until they grow more roots and forage crops; and the quality of the small quantity of it that is made is wretched, owing to the defective way in which it is preserved.

Like all other substances of animal or vegetable origin, farmyard manure, in the presence of air and moisture, and at a certain degree of heat, undergoes chemical changes; the rapidity with which these changes proceeds depends on the quantity of air and water present, as well as on the degree of heat.

When air is in excess the change is too rapid, while if it be deficient decomposition goes on too slowly. The relations of air to decomposition are analogous to those which it bears to combustion: in both cases its oxygen is consumed by oxidizing the carbon of the body decomposed or burnt.

"If we place a lighted taper in a bottle or other enclosed vessel, it burns for a short time, and then it gradually ceases, because the air has been deprived of the matter (oxygen) which is capable of supporting combustion. In like manner, if we compress a manure heap so as to exclude fresh supplies of air, the quantity within the heap will soon be exhausted, and then fermentation will cease." When, therefore, we want farmyard manure to ferment rapidly, it should be left in a loose state or turned frequently; on the other hand, when the farmer prefers that it should rot slowly, he compresses it.

The presence of moisture, like the presence of air, is one of the essential conditions of decomposition. If the quantity of moisture be too little, the temperature rises too high, and the manure is liable to take fire. If, on the other hand, the quantity of moisture be in excess, it keeps the temperature too low, retards decomposition, and brings about unfavourable changes similar to those which take place in peat.

The influence of temperature in promoting decomposition is made manifest in several ways. In winter the average temperature is about 45° F., at which manure undergoes no perceptible change. It is only when the heat rises to about 65° that the structure of the fibre of the straw, &c., in farmyard manure, begins to break up. It is not desirable to allow the temperature to rise higher than 90° at any time.

LESSON XVI.

We have already seen that the combustible part of farmyard manure, like the combustible matter of any animal and vegetable substance, must be converted into carbonic acid, water, and ammonia, before it can afford nourishment to plants. It is not, however, desirable that decomposition should reach this ultimate stage in the manure heap: for when carbonic acid and ammonia are simultaneously found, they unite, forming carbonate of ammonia, which soon vaporises or passes into the air. This always takes place when water or air is in excess, and when the temperature rises too high. When the quantity of air and moisture and the degree of heat are moderate, humic and ulmic acids are formed, and these uniting with ammonia produce humate and ulmate of ammonia, which are fixed salts, and not liable, like carbonate of ammonia, to pass into the air.*

When the manure is afterwards applied to the ground, those compounds are broken up, and the humic and ulmic acids easily converted into carbonic acid and water.

Humate and ulmate of ammonia are very soluble in water, and consequently easily washed out of manure heaps by rain. The dark colour of the oozings of

* Ammonia being the most costly constituent of manure, it has been recommended to add some substance to the manure heap, which would effectually fix it and prevent its escape. Applications of the following substances have been used for this purpose:—

1. Acid substances—sulphuric acid and muriatic acid. 2. Sulphate of the protoxide of iron (commonly called green vitriol), gypsum or sulphate of lime, and common salt. Of these, green vitriol is the best. It is not so dangerous as the sulphuric acid, which has a powerful corrosive action. It also acts as a deodorizer of sulphuretted hydrogen, which it completely absorbs, and with which it forms insoluble black coloured sulphuret of iron. When sulphate of iron is added to a decomposing manure heap, evolving volatile carbonate of ammonia, double decomposition takes place; the sulphuric acid combines with the ammonia, forming sulphate of ammonia, and the carbonic acid forms with the iron of the green vitriol a carbonate. Gypsum does not act as a deodorizer; nor does it fix the ammonia well, except in liquid manure, or when there is a sufficiency of moisture. "In manure heaps and stables, where the quantity of moisture is comparatively small, gypsum will lose its effects as a fixer of ammonia; and it is for this reason that we would confine its use, as a fixer of ammonia, to the liquid manure tank, where it can be applied with advantage." Common salt has also been applied to dung heaps, under the false impression that it fixes the ammonia. It does not possess this power; but from its antiseptic property, or power of arresting putrefaction, it prevents the formation of ammonia, and may be applied with great advantage to prevent further change in manure heaps already sufficiently decomposed.

manure heaps, so frequently allowed to go to waste in this country, is owing to the presence of these valuable compounds. Mineral matters (such as salts of potash and soda and soluble phosphate of lime) liberated during the decomposition of farmyard manure, are also soluble in water, and liable to be washed away by every shower of rain that falls, unless proper precautions be taken to prevent it.

The oozings of dung heaps are, therefore, particularly rich in plant food, and should be preserved with great care.

All the manure produced at the farmyard should be daily added to the manure heap, and proper precautions taken to prevent the loss of any of its fertilizing constituents.

The arrangement of the farmyard and offices should be made subservient to its collection and preservation. A proper receptacle should be formed for the solid dung, and, if possible, it should be placed on the north side of the farmyard. With the view of economizing labour, it should be as near as possible to the byre, stable, and piggery; and for obvious reasons, it should be as remote as possible from the dairy. It should also be on level ground; for, if placed on sloping ground, there would be a great loss of the liquid, which would make its way down the slope; and if placed in a hollow, it becomes too much diluted or saturated with rain water. In either of these extremes, too, there is a large expenditure of unnecessary labour. It is not unusual to excavate the site of the manure heap, and to puddle the bottom with strong clay, or to pave it. The pit may be surrounded by a well-made channel of paving stones, or tile pipes, &c., which should incline to a common point, where a liquid manure tank ought to be constructed. It is recommended to slope the bottom of the pit so as to permit the liquid to escape the more freely into the tank; but this appears quite unnecessary when the bottom of the channel is a few inches under the bottom of the manure pit; and more especially if a layer of peat mould, or common earth, say to the depth of twelve inches, is placed underneath to absorb the liquid that percolates through the heap.* When some provision is not made for absorbing or removing it, the liquid is apt to collect in too large quantity in the bottom of the heap, preventing regular fermentation in that part of it.

Many farmers have a slovenly and wasteful practice of allowing the manures of the byre, stable, and piggery, to lie for days and weeks in small loose heaps, exposed to the deteriorating influence of air and rain. Some idea may be formed of the enormous loss which this practice entails from the results of an inquiry instituted in England. A heap of manure, weighing 1,652 lbs. on the 3rd November, 1854, was left exposed in an open yard till the 23rd August, 1855. It weighed 1,429 lbs. on the 30th April, and 1,012 lbs. on the 25th August, 1855. It contained 11·42 lbs. of ammonia on the 3rd November; 9·34 lbs. on the 30th April, 1855, and only 5·02 lbs. on 23rd August. It lost, therefore, 6·40 lbs. of ammonia from 3rd November to the 23rd August; and as ammonia is worth at least 6d. per lb. as a manure, this is equivalent to a loss of upwards of 3s. in the substance of the heap.

* In some of the best (cultivated) agricultural districts on the Continent the manure-stead is separated into two divisions by a tank, usually about four feet deep, and of breadth proportionate to the size of the heap. The sides and bottom of this reservoir are well puddled with clay and lined with masonry; and the more effectually to convey into it all the drippings from the manure, the sides of the heap are surrounded with a paved channel. At one extremity of the tank a strong wooden pump is fixed, by which the liquid can, at pleasure, be discharged over the manure, by means of a canvas hose, or wooden spouts, or pumped into casks to be conveyed to the field. . . . . To prevent any loss of space, the tank, when placed across the manure stead, may be covered with a close wooden grating, and the dung piled upon it, by which means the evaporation of the liquid will be prevented, and any escaping gases absorbed by the manure."

LESSON XVII.

The manure heap should be covered occasionally, and particularly in summer, with a layer of peat, vegetable mould or earth, to absorb ammonia and other soluble products of decomposition. When peat exists on the farm, or in the neighbourhood, it is one of the best substances to use for the purpose: the dung and urine of the cattle induce the decay of the peat, and thus convert it into good manure. In the absence of peat, a supply of earth should be provided for that purpose during autumn, by cutting shallow and narrow trenches in the field or fields intended for roots the ensuing year. It should be stored in a heap convenient to the dung-pit, and spread on the manure when necessary. The following plan of using it has been successfully practised by the writer on the small farm attached to the Glasnevin establishment. The site of the dung heap is made level. There is no channel surrounding it. The earth is placed round about the heap as soon as any manure collects in it; and when this is saturated with the oozing from the manure, it is shovelled on top of the heap, and fresh earth put in its place, and this, when saturated, is again put on top of the fresh dung added; and the urine of the cattle is regularly poured on the whole. In this way the earth itself is converted into a powerful fertilizer, not only by the absorption of some of the products formed by the decomposition of the manure, but also by the conversion of some of its own dormant constituents into active food for plants.

It is usual to turn farmyard manure a month or so before using it in spring. This promotes its decomposition, and as the different parts are better mixed, it becomes more uniform in quality. Some farmers turn it over two or three times; but for ordinary use this is not only unnecessary but injudicious, as the frequent turning promotes too rapid decay, and thus causes a waste of the combustible constituents of the dung. For crops like turnips, which have small seeds, and require well-rotted dung to force them on, it is sometimes necessary to turn manure twice; and the mere act of turning does not necessarily cause any material loss of fertilizing ingredients, if the heap be properly rebuilt and covered over at once with a little clay.

Farmyard dung should be covered in as fast as it is applied. In the absence of rain, and in warm weather, all the free ammonia would escape. Now, the per-centage of free ammonia in farmyard manure is small; but the amount of it contained in the quantity of farmyard manure usually applied to an acre of land is well worth preserving. Thus, in 20 tons of fresh farmyard manure, which is a moderate dressing per acre, there are 15 lbs. of free ammonia, which, at 6*d.* per lb., comes to 7*s.* 6*d.* The loss of nitrogen by the exposure of farmyard manure is not confined to the free ammonia or the ready formed salts of ammonia. By the decay of the dung, more ammonia is formed, some of which is liable to be dissipated. It is extravagant folly to waste a substance for which we pay 6*d.* per lb. in Peruvian guano, and of which it has been estimated that 5 lbs. are competent to produce a bushel of wheat.

The dimensions of the manure heap should be determined by the quantity of farmyard manure that can be made. Its height should not be permitted to exceed five feet; for, when it rises too high the temperature becomes too great in the middle of the heap during the heat of summer.

To prevent any of the constituents of farmyard manure from being washed away by rain, it has been proposed to roof the site of the manure heap along with the offices. This arrangement has provoked a good deal of discussion. On the one hand, it is contended that the manure by being covered and completely protected from the weather must be richer and better. On the other hand, it is said manure made under cover does not contain an adequate quantity of moisture for regular decomposition, and that the roof involves an unnecessary outlay of capital. Excellent manure can be made without putting it under cover; at the same time, the "covered steading," as this system is called, deserves to be fully tested by landed proprietors and others who are willing to expend capital in trying experiments.

When all the manure is allowed to accumulate at the farmyard, a difficulty is often experienced in carting it out expeditiously enough at the seed-sowing season in spring, owing to the pressure of horse-work and other farm labour at that season. With a view of obviating this inconvenience, it is usual to cart out the manure during winter when the roads are dry, and make it into one or more field heaps. The site of those heaps should be selected with every regard to economy of labour in the subsequent application of the manure to the crop. Each should be excavated to the depth of at least one foot, and covered with six inches of vegetable mould or clay, to absorb the oozing. Over this the manure is deposited from the carts, which are permitted to pass over the heap till it rises too high; in this way the manure is compressed, but it has time to decompose before spring. The heaps must vary with the size of the fields and other circumstances. One of the best ways of forming field heaps which we have seen particularly on light land, for which it is desirable to preserve as much as possible of the combustible matter of the manure, is that practised by Mr. Laurence, of Cirencester. As soon as the manure rises about a foot above the surface of the ground, the heap is gradually gathered in, until it is completed in the form of an ordinary roof, slightly rounded at the top. In a day or two after the heap is completed, and when it has settled it is covered over with a thin layer of earth. The base may be from ten to twelve feet wide, and the ridge about nine feet from the base, which, as the manure settles down, becomes reduced to about seven feet.

LESSON XVIII.

The urine of the domestic animals is commonly called liquid manure, a name which is also given to the drainage of dung heaps, town sewage, &c.

The quantity and quality of the urine of any animal depends on several circumstances, such as the quantity and quality of its food, the amount of exercise it receives, its age and health.

The most profitable way of disposing of the urine of the domestic animals, is that in which the greatest quantity of it is absorbed by the solid or farmyard manure. We can adduce several reasons in support of this statement. First, as the liquid and solid excrements of animals differ in composition, the most perfect manure is obtained when they are mixed together. Secondly, as urine soon begins to ferment, it promotes the decomposition of the solid manure. Thirdly, as a good deal of the water of liquid manure is evaporated, the cost of conveying it to the land is kept as low as possible.

When liquid manure is disposed of in this way, the litter is made to absorb a good deal of it; the quantity so absorbed depending on the quantity of litter used, &c. A covered channel or drain should convey the remainder of the urine to a tank, which should be placed so as to receive the liquid that oozes from the solid manure. A good barrel or two, or distillery vats, will answer the purpose of the small farmer very well. The large farmer must construct a tank of brick or stone. It should be well lined with cement inside, and drained all round, to prevent the water that would otherwise accumulate in the surrounding soil to press in the wall.

Some or all of the urine and oozings that accumulate in the tank should be occasionally pumped over the manure heap; and any of it that cannot be disposed of in this way should be applied to the nearest field of grass. It is usually conveyed to the land by a liquid manure cart or barrel, the construction and cost of which will vary with the means and taste of the farmer. For rent-paying farmers, and especially small farmers, it should be as simple and cheap as possible. We have had constructed on a farm of about eighty acres, where all the available liquid manure is applied to a five-acre grass field adjoining the farmyard, a very simple apparatus, consisting of a large porter or beer barrel capable of containing seventy-two gallons, and having a small distributing-tube fixed to one end. When required for use it is placed in a small cart worked by a jennet.

The changes that take place during the fermentation of urine are very interesting, and throw light on many points in connexion with its practical application. Fresh urine has a yellowish colour, arising from a small quantity of resinous matter; on exposure to the air the colour becomes brown, and ultimately black. The change of colour has been attributed to the formation of humic acids. In its fresh state urine also contains a considerable quantity of urea, a highly nitrogenized compound. In summer a small quantity of ammonia is found in fresh urine, the result, it is thought, of the decomposition of some of the urea. In winter it is said to contain no free ammonia. "A solution of pure urea shows no tendency to change by keeping. In the urine, on the other hand, when it is associated with putrefiable organic matter or mucus, the case is different." When urine collects in the tanks, its urea begins to decompose, the products of its decomposition being ammonia and carbonic acid, or carbonate of ammonia; and as carbonate of ammonia is very volatile, it is necessary to adapt some means of fixing the ammonia. The cheapest and most common way of doing this is by adding to the urine a quantity of water, which is easily done by causing the rain water to pass from the gutters of the several houses to the tank. It is said that, by adding to the urine its own bulk of water, its capacity for absorbing ammonia is increased fourfold. When, therefore, urine is diluted with twice its own body of water, in a well-constructed tank, the loss of ammonia is very insignificant. The longer the urine is allowed to ferment, and the warmer the weather, the greater the quantity of water which should be added to it.

Urine is usually allowed to remain in the tank for some time before it is applied. Grass is often burnt in summer where cattle drop their urine. It is believed that if the urine is applied to growing crops while the urea is undecomposed, or the ammonia is in a caustic state, it is injurious to vegetation. The length of time which it is supposed urine takes to "ripen" or become fit for application, has not been very definitely fixed. The proper time to apply it, according to Mr. Stephens, is when it contains neither urea nor caustic ammonia.

SECTION VII.

ARTIFICIAL MANURES.

LESSON XIX.

When the husbandman first plants on a maiden soil he reaps luxuriant crops without the aid of any manure. Such was the case in our own country, in which no manure was required for centuries. As time rolls on the nutrient particles of the soil gradually decrease, and man soon discovers that fallow and rest for a year or two temporarily restore fertility. A second stage in the exhaustion of the soil arose when the store of inactive matter in the soil having been, through the agency of fallowing, converted into active food, the farmer intuitively, as it were, and long before chemistry expounded the cause, found out the utility of collecting and applying farmyard manure. It remained for the present generation to witness another phase of the same phenomenon, in the importation and domestic manufacture of artificial manures, for maintaining the soil in a productive state.

The agriculturist of the present day restores to his land the elements removed from it by the sale of farm produce in two ways: first, by the purchase of artificial food;* and secondly, by the purchase of artificial manures—which we are now to consider.

An artificial manure is, literally speaking, one made by the art or hand of man, such as the several kinds of superphosphate. At present the title is synonymous with concentrated manures, and includes such natural products as Peruvian guano, nitrate of soda, and all substances that contain in a small bulk a large amount of one or more of the most important of the elements of manures. A more correct nomenclature would substitute the term concentrated for artificial, and divide concentrated manures into natural and artificial.

This is the most appropriate place for offering a few remarks on what are called *special manures*. Strictly speaking, special manures may be defined as a variety of the class artificial, and are prepared for the purpose of meeting the special requirements of particular crops or soils. Special manures have been prepared on two very different principles: 1°. In accordance with the analysis of the ash of crops; 2°. In accordance with the united aid of science and practical experience.

1°. In the present state of agricultural science we

* The following is Mr. Lawes' estimate of the money value of the excrements obtained from a ton of the several substances employed in feeding stock. The estimate assumes that each food is of good quality of its kind:—

1. Cotton Cake, (decorticated.)	£6	10	0	13. Indian Corn,	£1	11	
				14. Malt,	1	11	6
2. Rape Cake,	4	18	0	15. Barley,	1	9	6
3. Linseed Cake,	4	12	0	16. Clover Hay,	2	5	0
4. Malt Dult,	4	5	0	17. Meadow Hay,	1	10	0
5. Lentils,	3	17	0	18. Oat Straw,	0	13	6
6. Linseed,	3	13	0	19. Wheat Straw,	0	12	6
7. Tares,	3	13	6	20. Barley Straw,	0	10	6
8. Beans,	3	13	6	21. Potatoes,	0	7	0
9. Peas,	3	2	6	22. Mangels,	0	5	0
10. Locust Bean,	1	2	6	23. Swedish Turnips,	0	4	3
11. Oats,	1	14	6	24. Common Turnips,	0	4	0
12. Wheat,	1	13	0	25. Carrots,	0	4	0

—*Agrl. Gaz.* 1860, p. 56.

have little faith in manures based on chemical formulæ alone; but knowledge is progressive, and every year witnesses some new and successful application of theory. And although the manures prepared in this way have failed to produce an adequate increase of crops, we are not to condemn altogether the principle on which they are prepared. The effect produced by these manures on soils of average productiveness may be imperceptible, yet they may help to prevent the exhaustion of the land. While admitting this much, we consider it delusive to hold out to the farmer, as some have done, any hope of an immediate return in all cases from manures compounded in accordance with the analyses of soils or crops. And yet a manure manufacturer says, in a pamphlet which he has published, that "by sending a sample of the soil (a few pounds weight, taken from various parts of the field), with a description of the crops intended for cultivation, a suitable manure will be compounded." It is easy to show that this theory is fallacious. If we divide a sample of soil, reduced by previous mixing to a homogeneous state, into two portions, and mix one of them with ammonia or biphosphate of lime, at the rate at which we usually apply them in artificial manures, and then send both samples to a chemist, the per-centage of ammonia or biphosphate added to the one is so insignificantly small, that with all the nicety of the modern balance he will give the analyses of both precisely the same. The percentage, *e.g.*, of phosphoric acid added to an acre of soil by a wheat manure containing 15 lbs. of that substance, is too small* to be appreciable in the most delicate balances. It is for this reason that Lawes and Gilbert, in all their experiments, repudiate chemical analyses of soils as means of ascertaining the manures that ought to be applied for the production of crops.

2°. The majority of our artificial manures are based on more rational principles, namely, the united testimony of science and practice. There are, however, several reasons why they must, to some extent, be

* ·0003.

special in their character. Plants vary much in their habits of growth. Some have tap-roots as the principal absorbents of nourishment; others have several rootlets. Winter wheat remains ten months or so in the ground; barley about half that period. Green crops, again, have large leaves, which suck in a large quantity of carbonic acid from the air. The corn crops have a small system of leaves, and cannot, in the short period in which the seed is formed, obtain nitrogen enough from the air; and the presence of ammoniacal salts or nitrates in the soil at the same period, is of essential use in rendering soluble, and introducing into plants, the phosphate of lime which so largely enters into the composition of the seed. Crops, too, vary in composition; and their chemical effect on the ground must also vary with this difference, and the mode in which they are disposed of. Crops also exercise unlike mechanical effects on the ground. All these reasons show that artificial manures must be more or less special, according to the class of crop to which they are to be applied and the condition of the soil.

The reader will understand from what has been already explained, that phosphate of lime is, in the practice of modern agriculture, constantly withdrawn from the soil, and must be restored by applications of manures. The substances used for this purpose are farmyard and town manure, which we have already considered, and bones, guano, and other concentrated fertilizers, of which we have now to treat.

The artificial manure first used for restoring phosphates to the land were bones.

The use of bones as a manure for turnips forms a new era in the history of agriculture, marking as it does the commencement of the modern system of applying the elements of fertility in a portable and concentrated bulk—a system which has brought into profitable cultivation thousands of acres of hilly and waste lands, which could never have been economically improved or reclaimed by the bulky farmyard manure, whose application under such circumstances would involve too heavy an outlay of horse labour.

The fertilizing effects of bones were first successfully tried on the pastures of Cheshire, which had been gradually deteriorated by the removal of the phosphates of the soil in dairy produce and the bones, &c., of young stock. Bones which were applied in a crushed state and at the rate of from 35 cwt. to 2 tons per acre, returned these phosphates and restored the productiveness of the land.

Bones having proved successful in restoring the fertility of grass, were, towards the close of the last century, applied to turnips, and found exceedingly profitable. They are said to have been first used for raising this crop in Nottinghamshire, in the state of bone dust; and they continued to be used for this crop in the state of bone dust, and at the rate of about fifty bushels per acre, until Liebig suggested, in 1839, the propriety of rendering their phosphates more soluble and available for crops by dissolving them in sulphuric or muriatic acid.

LESSON XX.

It is necessary to explain before we proceed any further that bones, and all manures which contain combustible as well as mineral matters, not merely restore to the land some of the constituents taken out of it by crops, but perform several other useful functions in the soil.

1°. The combustible matter of manures (including any mineral compound of the elements of combustible matter, such as carbonic acid and ammonia) is capable of supplying the materials of which the combustible part of plants is composed.

The efficacy of the organic matter of manures depends on the readiness with which it passes into carbonic acid, water, and ammonia. Some combustible substances, such as coal, are practically worthless as manures, because of the extreme slowness with which they decompose; while the combustible nature of Peruvian guano, and the excrements of animals which readily undergo decomposition, is highly efficacious.

The combustible matter of farmyard manure and similar substances has been fixed at 10s. a ton; but when, as in Peruvian, it contains a high per-centage of nitrogen, it is supposed to be worth £1 a ton.

Nitrogen exists in manures in three states, which it is well to distinguish:—

First, immediately available, as in the state of ammonia, a salt of ammonia, or in the state of nitrate of soda, &c.

Secondly, in combustible matter which would readily undergo decomposition; such as in the excrements of animals, &c.

Thirdly, it may, as in coal, be so locked up in the structure of the substance containing it, that for all practical purposes it may be overlooked.

It is estimated that the nitrogen in the first of these states is one-third more valuable than in the second.

As regards the third, it may be remarked that several specimens of coal contain two per cent. of nitrogen, which, if available, would make their value as manure £1 a ton. But coal, owing to its physical structure, is not worth the cost of carriage as manure.

2°. Any alkaline salt is capable of imparting to water the power of dissolving substances which are otherwise insoluble, or only slightly soluble in it. All the salts of ammonia, of potash, and of soda possess this property. And when the combustible matter of bones, farmyard manure, or any similar manure decomposes in the soil, the ammonia, or salt of ammonia, as the case may be, produced, helps to dissolve the otherwise insoluble phosphates of the soil.

It is well known that carbonic acid imparts this property to water; and that rain water, which is charged with carbonic acid, is the great agent which nature uses in dissolving and conveying into plants their mineral constituents. During the decay of the combustible matter of bones, farmyard manure, etc., in the soil, carbonic acid is produced, and aids in dissolving the insoluble mineral constituents of the soil.

Bones, therefore, act in three ways:—first, they supply phosphate of lime and other mineral substances to the soil; secondly, by the decomposition of their combustible matter, carbonic acid, water, and ammonia are produced, and these compounds are capable of supplying the elements required to build up the combustible matter, or organic matter of plants; thirdly, the ammonia and carbonic acid thus formed aid in dissolving phosphates and other mineral substances, which are either insoluble, or slightly soluble, in water.

This explains why a given weight of bones produces a greater effect than the ashes which they leave on being burnt, or the animal charcoal produced by charring them.

The farmer can purchase phosphate of lime in several substances besides bones. The ashes obtained by burning them is sold under the name of "bone ash," at prices varying with the per-centage of phosphates they contain. Bone ash, containing 70 per cent. of phosphate, can be bought at about £6 a ton, which gives £8 10*s*. as the cost of a ton of the phosphates.* In animal charcoal phosphate of lime can be had about the same price. Sometimes, again, bones are boiled, the fatty matter extracted, and the residue sold as boiled bones; and as the fatty matter is not supposed to possess any manurial value, but is useful for a variety of other purposes, this is the cheapest way of purchasing the phosphates of bones.

Phosphate of lime also exists in several mineral and fossil substances, such as the *apatite* found in Estremadura in Spain, and in *coprolites*, which are met with in Suffolk, Cambridgeshire, and other parts of England, and which are generally supposed to be the dung of extinct animals. We have purchased finely ground coprolites at £3 10*s*. per ton, containing 56 per cent. of phosphate, which (assuming that the other constituents possess no money value) gives £6 per ton for the phosphate of lime. It is necessary to remark here, that

* The value of bone ash, as a manure, may be said to depend altogether on the phosphate of lime, therefore, as 70 : 100, £6 (£8 10*s*.)

while this substance can be purchased at a cheaper rate in coprolites than any of the other substances named, yet, inasmuch as it is so locked up in their hardened structure as to be much more slowly dissolved in the soil, than the phosphates of bones, of bone ash, or of animal charcoal, the farmer never applies coprolites in a raw state to his land.

Phosphate of lime (called also neutral phosphate and insoluble phosphate), being insoluble in or nearly so in water, but capable of being converted into biphosphate of lime (called also superphosphate of lime), which is soluble, when brought into contact with sulphuric or muriatic acid, Liebeg suggested in 1841, the propriety of bringing about this change in bones, and other phosphatic manures, "by dissolving" them in either of these acids. This suggestion, or discovery, as it may more appropriately be named, laid the foundation of the system of manufacturing the class of artificial manures, called "superphosphate," which forms one of most prominent features of modern agriculture.

In chemical language the terms biphosphate and superphosphate are synonymous; but the term superphosphate, as commonly used by farmers and manure vendors, is applied to the artificial manure produced when bones or coprolites, &c., are acted on by acid.

It is worthy of remark here, that muriatic acid converts phosphate into superphosphate of lime, and is much cheaper than sulphuric acid; but the resulting superphosphate is apt to absorb moisture so largely as to become fluid, or semifluid, in which state its carriage and application are inconvenient. Manufacturers of superphosphate, therefore, invariably use sulphuric acid.

Superphosphate, like bones, and all phosphatic manures is better adapted to light than heavy soils. It is used chiefly for roots; and is applied at the rate of six cwt. per statute acre to good turnip land, and at a less rate to poor light soil.

A superphosphate for turnips should contain from one to two per cwt. of ammonia, or be capable of giving out on decomposition that quantity of ammonia.

Mangolds require a manure containing more ammonia than turnips. A mixture of two parts of a first-class superphosphate and one part Peruvian guano makes an excellent mixture for mangolds.

Superphosphate has been occasionally applied to corn and grass, but its effects on these crops are not so certain or so striking as on roots. Of all the corn crops barley is probably most benefited by it. In common with all phosphatic manures it encourages the growth of the finer rather than the stronger growing grasses; it also hastens the maturity of plants, and brings in the harvest earlier.

LESSON XXI.

GUANO is one of the most important concentrated manures we possess. It is generally supposed to be the dung of sea fowl, which has accumulated in some parts of the globe.

There are two principal kinds of guano in the market. The best is obtained from the rainless districts of Upper Peru, whence it takes the name of Peruvian guano.

The average composition of seventy samples of this manure, analysed by Way, was as follows:—

Water,	13·67
Organic or combustible matter,	52·05
Phosphate of lime,	22·78
Alkaline salts,	9·67
Sand,	1·83
	100·00

The organic matter was capable of affording,	16·52 parts of ammonia.
The alkaline salts contained,	3·34 parts of phosphoric acid.

There has been a great diversity of opinion as to the way Peruvian guano benefits the soil. Some looking to the fact that phosphate of lime exists in the soil in very limited quantity, and is, at the same time, constantly withdrawn from it, ascribed the beneficial action of guano to the large quantity of this substance it contains. There is no room whatever for doubting that the phosphates of guano are as useful as the phosphate of any other manure; yet it has been demonstrated, that the full value of this manure does not depend on its phosphates.

Nitrogen is the constituent which imparts to Peruvian guano its greatest value. Experience has shown that all productive soils contain nitrogen in an active state. It has been said already, that within certain limits soils become productive in proportion as they approach the state of loam, that is, in proportion to the quantity of combustible matter in a finely divided state, capable of undergoing decomposition, they contain. Now, the efficacy of this matter greatly depends on the quantity of nitrogen present in it, or the quantity of ammonia it is capable of producing. This ammonia supplies nitrogen to build up the nitrogenized constituents of plants, and, as already explained, aids in rendering soluble and conveying into plants insoluble mineral constituents.

All enlightened experience is in perfect accordance with this explanation. Ammoniacal manures, *i.e.* manures containing ammonia or nitrogen, are found to increase the produce of all our farm crops; and more especially of the grasses and corn crops. Experiments conducted at Rothamstead, by Lawes and Gilbert, go to show that every 5 lbs. of ammonia judiciously applied to wheat produce a bushel of grain. If the soil always contain nitrogen enough in a sufficiently available state, ammonial manures would produce little or no effect; but when this is not the case, application of these manures are most beneficial.

Peruvian guano is applied with advantage to all our cultivated crops. It may be stated generally, that phosphatic manures are best for roots, and ammoniacal manures for corn and grass. This proposition, however, requires several qualifications.

Peruvian guano produces a better effect on strong clay than light or sandy land. The probable explanation of this is, that the clay is capable of absorbing the large quantity of ammonia it contains, and of retaining it until plants require it, while light land does not possess this power in the same degree. As a topdressing for corn and grass, Peruvian guano produces a better result on a greater variety of soils, and under a greater variety of circumstances than any other manure. It is applied to these crops at the rate of from one to two cwt. per statute acre. Numerous experiments have shown that, when from any cause corn is not thriving, an application of one and a half cwt. of this manure, at a cost of about £1, increases the value of the crops from 30s. to £2. It is found also profitable as a topdressing for grass, especially in spring. In common with all ammoniacal manures it encourages the growth of the stronger grasses, such as cocksfoot; and by enabling plants to continue growing longer, retards both the harvest and the hay making. It is seldom applied for roots or light land; but many farmers consider it superior to superphosphate on clay land, and equal to it on clay loams. On the latter class of soils we have found a mixture of Peruvian guano and superphosphate of lime to give better results than either manure used alone.

The relative merits of Peruvian guano and superphosphate of lime for roots depend on the nature and condition of the soil, the climate, &c. It was suggested by the writer some years ago that, while Peruvian guano may exceed superphosphate as a manure for turnips on a given soil in a given year, superphosphate may at another produce a heavier crop than Peruvian guano. This view is supported by direct experiment. If a soil contain a large quantity of rich vegetable matter, and if proper steps be taken (by tillage, liming, &c.) for converting this matter into food for plants, the application of a manure like Peruvian guano, rich in ammonia, would be a waste of money.

Peruvian guano being one of the principal concentrated manures in which ammonia is applied to the land; its price greatly influences the price of other manures, such as the salts of ammonia. It is important, therefore, that the farmer should be able to ascertain the price he pays for ammonia in this substance.

A ton of Peruvian guano at present costs £13.

If from this we deduct the value of the other constituents except ammonia, viz:—

	£	s.	d.			
Phosphate of lime, . . .	1	16	5			
Organic matter, . . .	0	10	5			
Alkaline salts, . . .	0	1	11			
Phosphoric acid in do., .	1	14	5			
				4	3	2
				£8	16	10

We get the value of the ammonia in a ton of this guano to be £8 16*s.* 10*d.*, which gives as the price of the ammonia itself £53 1*s.* 9*d.* per ton, or less than 6*d.* per lb.*

When guano is subjected to the influence of heat, air, and moisture, it undergoes decomposition like all other substances of animal and vegetable origin. In the Chinca islands, from which the principal supply of Peruvian guano is obtained, no rain falls, and one of the three conditions essential for decomposition (namely, moisture) is absent; hence the high per-centage of nitrogenized matter it contains.

In Patagonia, in several parts of Africa, and in other parts of the globe, guano is also obtained; but as rain falls in all those countries, the combustible matter has, in the course of time, undergone decomposition, its ammonia has been dissipated, and there remains only the phosphate of lime—a circumstance which explains why this species of guano is often called phosphatic.

A good specimen of phosphatic guano may contain as much as seventy per cent. of phosphate of lime. Several kinds of it are at present in the markets; but as their phosphates are in the insoluble state, they are not now applied directly by the farmer. Large quantities of this kind of guano are now used in the manufacture of superphosphate of lime.

* Peruvian guano contains 16½ per cent. of ammonia. The proportion, therefore, is as 16½ : 100 : : £8 16*s.* 10*d.* = (?) £53 11*s.* 9*d.*

LESSON XXII.

Sulphate of ammonia—a compound of sulphuric acid and ammonia—is used in considerable quantity as a manure. It is the cheapest salt of ammonia, and the only one whose price admits of its profitable application to land. The principal supply of it is obtained by mixing sulphuric acid with the liquor of gas works, which contains carbonate of ammonia.*

Every 100 lbs. of pure sulphate of ammonia consist of—

Ammonia,	22·7
Sulphuric acid,	53·3
Water,	24·0
	100·0

The salt of commerce contains about ten per cent. of impurities, and may be assumed to contain in every 100 parts—

Ammonia,	20·4
Sulphuric acid,	48·0
Water,	31·6

If from the price of one ton of agricultural sulphate of ammonia, say £15, we deduct the value of 1,075 lbs. of sulphuric acid contained in the ton, which would be supplied by the sulphuric acid in about one ton ($20\frac{3}{4}$ cwt.) of sulphate of lime, or gypsum, for about £1 10*s.*, there remain £13 10s., as the cost of the 457 lbs. of ammonia in a ton of the manure, which is £65 6*s.* 4*d.* per ton, or a fraction over 7*d.* per lb.

This salt principally depends for its efficiency on the ammonia it contains. It is chiefly used as a topdressing for corn and grass, to which it is applied at the rate of $1\frac{1}{2}$ cwt. per statute acre.

* The liquor of the gas works is a solution principally of the carbonate and hydrosulphate of ammonia, and, in a smaller degree, of muriate, hydrocyanite, sulphate, and other salts of ammonia. It is found that 100 gallons of this liquor contains from 20 lbs. to 40 lbs. of ammonia in all states of combination.

Mixed with superphosphate of lime, in the proportion of three or four parts of superphosphate to one part of sulphate of ammonia, we get good mangold manure.

Nitrate of soda, a compound of nitric acid and soda, is one of the most concentrated nitrogenized manures we possess. It is generally called an ammoniacal manure, notwithstanding that its nitrogen exists in the state of nitric acid; but as the nitrogen of both salts (sulphate of ammonia and nitrate of soda) is active, no practical inconvenience can arise from classing nitrate of soda with the ammoniacal manures.

Nitrate of soda occurs as a mineral deposit in Chili, Peru, and parts of India. Dr. Daubeny, in accounting for its origin, says it occupies the site of salt lakes; the common salt of which, on drying, decomposes, giving out bicarbonate of soda; and if from any cause (such as the presence of animal matter) nitric acid happens to be produced, it decomposes the carbonate of soda and the nitric acid combines with the soda forming nitrate of soda.

The composition of the nitrate of soda of commerce varies very considerably. We have recently purchased a sample at £15 a ton, containing sixty per cent. of the pure nitrate and forty per cent. of foreign bodies, which give £25 as the price of the pure nitrate of soda. Every 100 lbs. of the pure salt contains 63·3 parts of nitric acid and 36·7 of soda, which, overlooking the soda, gives £39 10*s.* per ton for the nitric acid.

The use of nitrate of soda as a manure is confined to topdressing corn and grass, to which it is applied at the same rate (about $1\frac{1}{2}$ cwt. per acre) as sulphate of ammonia. For spring use it is not equal to Peruvian guano or sulphate of ammonia; but for topdressing grass during the middle of summer, we have generally found it superior to either of these manures. Under the influence of the heat of the sun's rays at this warm season, it promotes the growth of grass more rapidly than either guano or sulphate of ammonia. Some of the nitrogen of Peruvian guano is liable to be dissipated at this season, which is not the case with the nitrogen of nitrate of soda.

LESSON XXIII.

LIME is the most important mineral manure we possess. Prior to the introduction of artificial manures, it was more universally used than it has been since.

Lime may be applied to the land in any of the states in which it is met with in nature; such as common limestone, gypsum, &c. Limestone is the cheapest and best.

Common limestone is principally composed of carbonate of lime; its composition varies considerably, as the following table shows:—

	Glendun, County Antrim.	Larne, County Antrim.	Calp limestone, County Dublin.	Brownhill, County Carlow.
Carbonate of lime, .	95·03	71·66	68·00	95·00
Carbonate of magnesia, .	0·55	2·67	–	–
Phosphate of lime, . .	0·18	0·49	–	–
Oxide of iron and alumina,	2·00	9·42	9·5	–
Silica and insoluble clay,	1·20	14·61	18·00	4·50

As it is difficult to grind or crush limestone, and as, moreover, its action on the soil is exceedingly slow, it is usual to burn it in a kiln with coal or culm, at the rate of five cwt. of culm to every ton of stone, so as to produce *quick* lime (so called from its more speedy action) or lime shells.

The principal effect produced by the heat of the kiln, is that the carbonate of lime is decomposed and the carbonic acid expelled. The acid being heavier than common air, often accumulates; being destructive to animal life, it has thus been often known to cause the death of persons who have slept on limekilns at night.

Several other changes are produced in the kiln. Thus, some of the sulphur of the coal unites with the lime of the limestone, forming sulphate of lime or gypsum. Again, the silica of the limestone combines with the lime after the separation of the carbonic acid, forming silicate of lime, which, being a finely divided compound, may prove useful in the soil.

The quantity of quicklime produced from a given quantity of limestone, varies with the quality of the latter, the average being about $11\frac{1}{4}$ cwt. per ton.

Lime is sold off the land in crops, stock, &c.; and, again, rain water washes lime out of the ground.

Lime produces several distinct effects or functions in the soil, all of which are important and interesting.

1°. In common with all the fixed mineral constituents of plants, lime must be present in every fertile soil. No definite rule can be laid down as to the minimum quantity of it which must be present in a soil, so much depends on the general composition of the latter, and the state in which the lime exists in it. We know some tracts of productive lands which do not contain more than ·5 per cent. of lime; but, generally speaking, fertile soils contain at least one per cent. of it. When the per-centage of lime in the soil is below this, it becomes necessary to supply it at regular intervals.

2°. Some soils contain acid substances, which keep them in a sour and comparatively infertile state. Lime combines with and neutralizes these acids, and thus fits the soil for growing better plants.

3°. In other cases, infertility or barrenness in soils arises from the presence in them of noxious compounds, such as salts of iron and copper, and lime has the power of decomposing these compounds or rendering them innocuous.

4°. Lime promotes the decay of the organic or combustible matter of the soil. Science teaches that in common with potash, soda, and magnesia, lime exercises this effect, and experience tells us that applications of lime diminish the quantity of this kind of matter in the soil. As the quantity of vegetable matter in the ground increases, so does the necessity for applying lime. This explains the old saying, "The more dung the more lime." Peaty soils, which contain a great deal of inert vegetable matter, are much improved by hot lime.

5°. Lime helps to disintegrate or liberate the inorganic constituents of the soil. If we mix lime with ground granite or with pulverized clay soil, we shall find after a time a quantity of potash and soda liberated; in other words, lime converts some of the dormant mineral matter of the soil into active plant food, or as it were forces the soil to give up to the crops some of its latent mineral constituents. This effect is produced much more speedily by quick or caustic than by mild lime (carbonate of lime).

This partly explains why lime produces the greatest effect when first applied to the land, and that the oft-repeated use of lime without any other manure, by stimulating the soil, would ultimately end in rendering it sterile. Hence the converse of a proposition stated above, which says that the more dung the more lime, is also true, namely, the more lime we apply the greater the necessity for manure—a notion well expressed in the old saying, that the use of lime without manure is sure to make the farm and the farmer poor.

LESSON XXIV.

If we mix quicklime with Peruvian guano or well rotted dung, a peculiar smell is felt, caused by the escape of ammonia. Hence lime should never be permitted to come into contact with either of the manures named above, or any other manure containing ammonia. When farmyard manure and lime are applied to the ground in the same year, the lime should be used before or after the dung.*

The state in which lime is applied to land varies with the quality of the land and other circumstances. The common practice is to cart the lime to the field, make it into a heap or heaps, cover it over with a little earth, and allow it to fall into powder, or slake spontaneously, after which it is evenly spread on the land and ploughed in, or otherwise worked into the ground.

The slaking of lime is a chemical process. The lime

* If lime be mixed with farmyard manure, animal or vegetable substances, before decay has commenced, nitric acid (NO_5) is formed

absorbs and combines with moisture, forming hydrate of lime, and causing the development of heat and a swelling of the lime shells, which soon crumbles to powder. The finer the state of subdivision into which the lime falls, the more completely is it distributed through the soil, and the more thorough and uniform its action.

When the lime is applied as above described, it absorbs moisture from the air, and is said to slake spontaneously, and for general purposes there is no better way of applying it. Some farmers who use much lime make it into a large heap or heaps, and hasten the slaking process by pouring water upon the mass. If applied immediately after slaking in this way, lime is quickest in its action, it being in the caustic or hydrate state. On the other hand, when it slakes spontaneously, part of the lime is reconverted back into the mild state of carbonate lime before it is spread. In slaking spontaneously the $11\frac{1}{4}$ cwt. of lime obtained by burning a ton of limestone, takes up $1\frac{3}{4}$ cwt. of water and $2\frac{3}{4}$ cwt. of carbonic acid; the whole is afterwards reconverted into carbonate of lime.

Sometimes, again, the lime is made into a compost with earth or peat, in which state its action is slower than in either of the preceding states.

It is evident that the propriety of applying it in one or other of these three states depends on the nature of the ground; also, on whether we wish its action to be quick or slow. When the soil is light or sandy, and deficient in vegetable matter, and its texture open, it is recommended to apply the lime in a state of compost, which contains the lime in the mild state, and also contains other materials in which these soils are deficient. It is said that lime when applied to light land in the caustic state encourages the growth of red poppy and other weeds. On the other hand, lime should be applied in as caustic a state as possible, to all soils containing

in place of ammonia; and if mixed in a compost with dung and clay, rich in potash and soda, nitre is produced. It was in this way that the first Napoleon produced nitre (which is a constituent of gunpowder) during the great wars in which he was engaged.

much vegetable matter, such as peat and moss, as well as to clays, moors, and other soils undergoing reclamation, and to all soils containing injurious substances, such as the salts of iron.

The quantity of lime applied per acre varies with the nature of the soil and other circumstances. When put upon ground for the first time, such as in the reclamation of land, a heavy dose is used. Upwards of 10 tons have been applied to heavy clay land. On ordinary land under rotation, it is best to apply small doses of from 50 to 80 bushels at intervals of twice the length of the rotation. In the four course rotation, fifty bushels per acre, every eighth year, is sufficient on such land.* When grass land is broken up and put under tillage, a dose of from 100 to 200 bushels or more is applied.

The application of lime to clay land renders the soil more friable, and, at the same time, converts some of its dormant constituents into the active state. The quantity of lime required to produce these effects will vary with the condition of the clay. When we apply lime for the first time to heavy clay land for the purpose of producing a permanent improvement in its texture, a heavy dose is always necessary. Under such circumstances, 200 bushels may produce the desired effect; and in some cases 300 bushels and upwards might be required.

An excess of moisture in the soil prevents lime from producing its full effects. Hence, wet lands require a greater quantity of lime than those which are naturally dry, or those which have been made so by drainage. In the permanent improvement of clay land, or wet ground of any kind, lime should, therefore, be applied after drainage. For the same obvious reason, good farmers put lime upon the ground in dry weather. The time of the year selected for the purpose varies according to circumstances. On those extremely stiff clays on which naked fallowing is adopted, the lime is usually applied while the land is undergoing this process—say, in the

* A bushel of lime weighs about six stones. An application of four tons of lime per acre, adds about ·5 per cent. of lime to the surface soil.

end of summer or beginning of autumn. When green crops are substituted for the bare fallow, the lime may be applied in spring, before the turn of the harrow, which prepares the ground for drilling. If this cannot be accomplished, the lime may be applied to these crops during their after culture.

Lime is applied with advantage to all crops except flax. Probably its effects on the grasses are more striking than on any other class of plants. White clover usually springs up freely after it is applied, it improves red clover and rye grasses in quantity and quality, and thickens, strengthens, and sweetens permanent pasture. It also helps to eradicate moss. It is usually applied to grass land in the state of compost, and it should be put upon the ground as early as possible in winter, so that it would be washed into the soil before the grasses begin to grow in spring.

There is a difference of opinion among farmers as to the crop in the rotation to which it is best to apply lime; some contend that it should be applied for roots, while others prefer to apply it for grain. One thing is quite certain, namely, that regard being had to its various functions, it cannot be expected to produce its full effects in the immediate season or year in which it is put upon the land. If, therefore, the farmer has good reason to suppose that one crop in the rotation requires lime more than the rest, it should, if practicable, be used a year before that crop.

Judicious applications of lime improve the corn crops: barley is said to derive the greatest and oats the least benefit from it. It has been found that while lime always increases the yield of wheat very considerably, the quality of the grain is sometimes deteriorated.

When used for grain it is usually applied to the crop which follows roots. It is carted on the ground before seed-sowing, spread with the shovel, and the ground is once harrowed; after which the seed is sown and covered in the usual way.

Lime increases the produce and improves the quality of root crops. It is even found to mitigate, if not prevent, several diseases to which these crops are liable, such as mildew, "Finger and Toe," in turnips, &c. It is noteworthy here that the effects of those diseases are comparatively small in parts of Wexford and elsewhere where the land periodically receives liberal dressings of lime.

It may be applied for roots in two or more ways. Probably the best plan is to spread it evenly on the ground when ready for drilling. If the season or other circumstances should prevent the farmer from adopting this method, it may be applied during the after-cultivation of the roots by making it into small heaps between the rows of plants, and, if not already slaked, covered with a little earth, to spread it evenly after it slakes spontaneously. This is by no means as expeditious or economical as the other method, and should be resorted to only under exceptional circumstances.

Lime has also been successfully used in the growth of potatoes. It is most beneficial for this crop on clay land, and the probable explanation of this fact is, that the potato contains a large quantity of potash, that clay soils contain a great deal of this substance in a dormant state, and that the lime makes it active or available for the crop.

It has been found that lime has a tendency to sink in the soil; and all skilful farmers who are aware of this, in applying lime, cover it as lightly as possible.

The duration of the effects of lime varies with the quantity applied and the quality of the soil, the effect being greatest at first and gradually becoming less. When compensation is given to outgoing tenants for unexhausted lime, it is usual to assume that the lime acts for a period varying from three years on light land when the dose is small, to ten years or more on clays to which a large quantity has been applied. Seven years is considered an average period on ordinary land. If in this case the farmer gives up possession three years after applying lime, he gets four-sevenths of the outlay, and so on.

PART II.

FARM IMPLEMENTS AND MACHINES.

SECTION I.

PLOUGH, HARROW, AND ROLLER.

LESSON I.

The introduction of new implements, and the improvement of old ones form most remarkable features in the progress of modern agriculture. When the agriculture of a country is in a backward state very few implements are used, and these are usually of the rudest construction. It is said that only a few generations back oxen were yoked, by the tail, to the plough and harrow in our own country. In many foreign nations at the present day, the implements are of the most primitive description. For instance, in some countries the plough is a bent piece of wood, and merely scratches the ground. As the civilization of a country advances, as the wages of labour, and the cost of producing crops increase, the farmer finds it necessary to bring to his aid implements which enable him to till the ground better and cheaper than before.

One of the greatest advantages which the large possesses over the small farmer consists in the use of machines, which lessen the cost of raising crops, of preparing them for market, as well as for preparing the food of live stock. While this is true, it must not be forgotten that the small farmer performs or directs his own labour, and in doing so is stimulated by the hope of reaping the full benefit of his exertions; while the large farmer intrusts the superintendence of labour to others, who do not always conduct it as economically as if working for themselves.

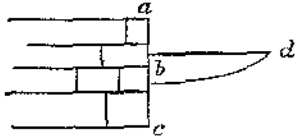
The introduction of improved machinery, such as reaping and mowing machines, steam ploughs, &c., is almost invariably opposed by labourers, who have often been known to enter into most improper and illegal combinations for destroying these machines. Economic science and experience teach us that in every branch of human industry the labouring class is benefited by the use of improved machines. It is true, that at the immediate time of the introduction of new machinery a few hands may temporarily be thrown out of employment; *e.g.*, when reaping machines are first introduced into a district the amount of wages paid to harvestmen is less; and, again, on the introduction of weaving machines, a number of weavers were thrown out of work, and compelled to seek employment elsewhere. Improved machinery, however, by economizing labour, and diminishing the cost of producing a given article, creates an increased demand for that article, which in turn reacts upon the labour market. Infinitely more labour is now employed in the cotton and linen trades than before the introduction of steam engines and spinning and weaving machines.

It is impossible to understand the construction of implements without some knowledge of the principles of mechanics, on which farmers entertain very crude and often most erroneous notions. One of the most ludicrous instances of this on record is that of a man, who in taking a sack of oats to market, dismounted his horse, put the sack on his shoulders, and remounted the horse, by which he subjected himself to a heavy weight, without giving the least relief to the animal. Numerous examples, almost as ludicrous as this, could be cited. Many implement makers are also ignorant of the elementary principles of mechanics, as we see every day in the faulty construction of the simplest machines.

Every implement and machine should be just strong enough to bear the strains to which it is likely to be exposed; and as the different parts are subjected to unequal strains, they need not all be made equally strong. Thus the strain upon all parts of the handle of a common shovel are different; it should, therefore, be thicker in the parts subjected to the greatest strain (which is the fulcrum of the lever into which the man converts the implement, as he lifts it and its contents) than anywhere else.

We may here illustrate a simple principle, which comes into play in almost all implements and machines. Let *a b c* represent a wall; *b d* a beam projecting from it, subject to downward pressure. In order that the beam should be equally strong in all its parts, it need not be equally thick

FIG. 1.



from *b* to *d*, but curve gradually with the curvature of the parabola, which is a well-known figure in mathematics. If it be made equally thick from *b* to *d* material is wasted, and the cost of the structure so far increased. Hence, the beam of the plough, whipple, or swing trees, and other parts subjected to strains need not be made equally thick, but taper or curve gradually from the point at which the resistance is centred, or what is called the centre of resistance. By observing this principle we obtain an implement or machine, well proportioned in all its parts, and as light as possible. Every pound added to the weight of an implement, over and above what is absolutely required, necessitates the expenditure of an unnecessary motive power in working it. It has been estimated, that an addition of 50 lbs. to the weight of a vehicle, which travels on an average five miles a day for twelve months, imposes on the horse an unnecessary strain, equal to the conveyance of a heavy cartload to a distance of 40 miles.

LESSON II.

A FARMER should take a great many circumstances into consideration in selecting implements; such as the size of the farm, the quality of the soil, the mode of farming he intends to follow, &c. In garden cultivation the essential implements are the spade, rake, and shovel; and these are also the implements with which the principal work is performed on small farms, or those not large enough to employ horses. On farms worked with the aid of horse-power the essential implements of tillage are the plough, harrow, and roller; and to these are added other implements and machines according to the circumstances of each case.

The plough is one of the oldest implements in use. It has gone through various modifications and improvements; so much so, that its history gives a good idea of the history of agriculture. The varieties of the implement in use at the present day are endless, each country having shaped it after peculiar fashions of its own. The English differs from the Scotch plough, and the Irish is different from either.

The accompanying woodcuts illustrate swing and wheel ploughs, as manufactured by Messrs. Howard of Bedford, England. Figure 2 represents a swing, and figure 3 a wheel plough.

FIG. 2.

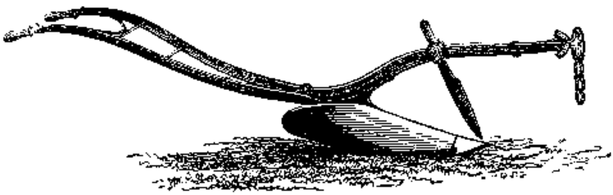
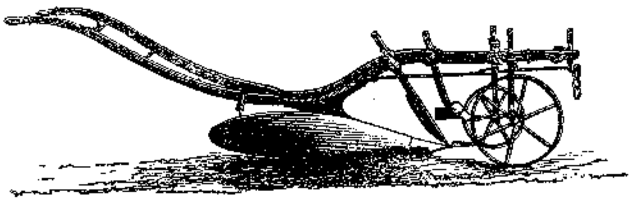


FIG. 3.



Sometimes two boards are put on the plough, converting it into what is called a *double mould board plough*, which is for making drills and for moulding potatoes and beans.

The handles of the plough enable the ploughman to control the implement, and to vary the depth and width of the sod; and in doing this he converts them into a lever, at one end of which he applies his power. It is evident, therefore, that long handles give the ploughman greater power than short ones.

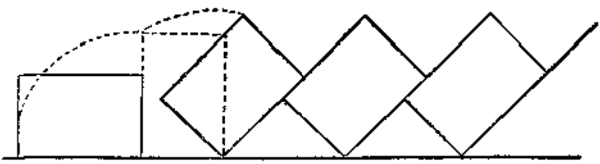
The length and shape of the beam are subject to great variation. In the Scotch plough the beam is shorter than in the Irish. The advocates of the short beam urge (among other things) that it brings the horses nearer to the resistance; but no power is saved in this way so long as the beam is made of a rigid substance; whilst, on the other hand, a moderately long beam, like that in most Irish and English ploughs, steadies the motion of the implement, and thus saves power.

When the plough is unsteady the ploughman presses on the handles; this pressure causes an increase of friction between the sole of the plough and the ground, and this increased friction must be overcome by the horses.

There is no part of the plough which has provoked so much discussion as the mouldboard (sometimes called "turnfurrow," from the circumstance of its turning over the sod or furrow slice). The mouldboard of the ploughs of Messrs. Howard of Bedford, of Messrs. Ransome and Sims, Ipswich, and of others, are as near perfection as possible. They are much longer than Irish or Scotch mouldboards, and so constructed that all parts of their surface are subject to the same friction. The greatest defect of Irish and Scotch boards is that, instead of sloping gradually, like English boards, they rise too abruptly, causing unnecessary friction and a corresponding increase of draught. When mouldboards of this description have been in use for some time, we invariably find that one part of them is worn away, while the rest is sound; whereas all parts of a well-shaped board wear equally. In order to understand the proper construction of a mouldboard, it is necessary to bear in mind that the front part of it lifts the sod, and the back part turns over the sod so lifted and packs it home against the last sod. The full elucidation of the shape of mouldboard best calculated to effect these two objects, is a very intricate mathematical problem; for the instruction of the young farmer it is enough to say, that the shape of one of the best boards in use may be compared to that presented on twisting a piece of thick leather or Indian rubber.

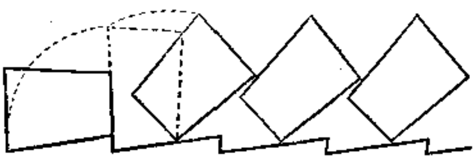
It is generally considered that a cross section of the sod or furrow slice should be rectangular, but it is frequently a trapezoid. Two kinds of ploughing, called rectangular and "crested," are shown in the accompanying engravings. In figure 4 it will be seen that all the ground is ploughed to the same depth. In order to produce the sharp angle or crest (also called "arrus")

FIG. 4.



shown at figure 5, it is necessary that the coulter and the base of the share should make an acute angle, and if (as usually happens) the plane of the former is vertical the latter cannot be horizontal; consequently the ground is not all stirred to the same depth.

FIG. 5.



A manifest objection to crested ploughing, as here represented, is that water is apt to lodge and stagnate in the lowest part of the furrows.

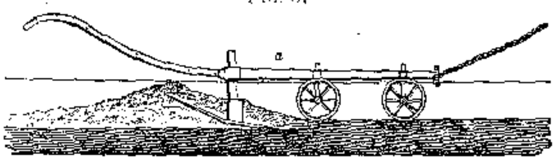
Crested ploughing has got into fashion chiefly because of the neat appearance it presents in lea or grass land; but practical farmers, who look to results rather than appearances, are opposed to it.

One of the objects of ploughing being, as already stated, to expose a fresh surface of soil to atmospheric influences, it is evidently desirable to present as great a surface as possible for the purpose. It admits of geometrical demonstration that this object is effected by turning over the sods so that their faces make an angle of 45° with the horizon. A very simple test of this (in rectangular ploughing) is that the part of each sod left exposed is equal to the depth of ploughing.

In rectangular ploughing the face of each sod lies up against the back of the one laid before it; therefore, the sods feel firm under foot. In crested ploughing the angle of one sod rests on the back of another; there is a hollow below the point of contact, which is readily detected by pressing the foot against the sods.

The *subsoil-plough* is an implement used for breaking up the subsoil. As usually constructed it consists of a strong beam with a bent coulter or tine for loosening the under soil or subsoil, and is drawn by two or more horses, in the furrow made by the common plough. In figure 6 is illustrated an excellent implement of this

FIG. 6.

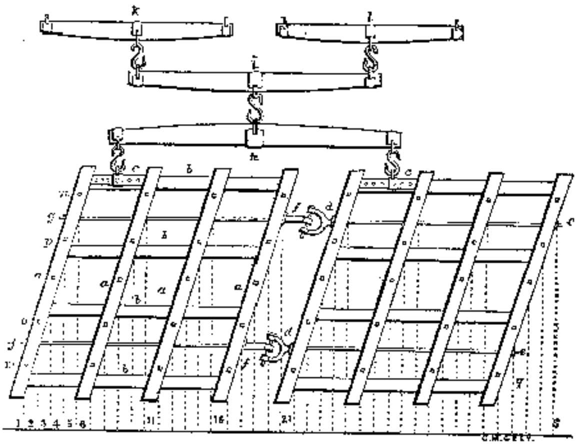


kind, introduced by the Marquess of Tweeddale, and called the subsoil trench plough, because it not only loosens the under soil, but by the tine-board *c* of the share brings up a little of the under soil, and mixes it with the surface soil.

LESSON III.

The harrow is used to prepare the soil for the reception of the seeds of our farm crops, as well as for covering them. Figure 7 represents an improved harrow of the more common or rhomboidal shape, which consists of two parts hinged at two points. Each part contains four bars and four cross-bars or slots; each bar contains five tines, which project about eight inches below the bars. This harrow covers a width of nine feet at a time. Sometimes the bars (commonly called "bulls" in this country) are made of wood,—ash, which is not as liable to split as other kinds of wood, being used for the purpose. The cross-bars are also often made of wood. Iron, owing to its greater durability, is fast superseding wood in the construction of harrows.

Fig. 7.



In a well-constructed harrow all the tines are set so that the lines in which they move are all equidistant, by which the action of all parts of the implement on the ground is quite uniform.

Viewing the harrow theoretically, the line of draught (that is, a line drawn backwards in continuation of *i h*, figure 7) should pass through its centre; there would then be an equal number of tines, and an equal weight on both sides of this line. In practice, however, it is found that the pressure of clods against the outside of the bars tends to turn the harrow round as on a pivot; and when this occurs the action of the tines is no longer uniform; or, in other words, the lines in which they move are no longer equidistant. It becomes necessary, therefore, to have a rack, as shown at *c*, *c*, figure 7, so that by shifting the point at which the draught chain is attached a little to the left this tendency would be counteracted. It is evident that the rougher the ground the greater is this tendency, and the farther does it become necessary to remove the chain to the left.

Some manufacturers, in order to obviate this difficulty, make the bars zig-zag, as shown in figure 8

FIG. 8.

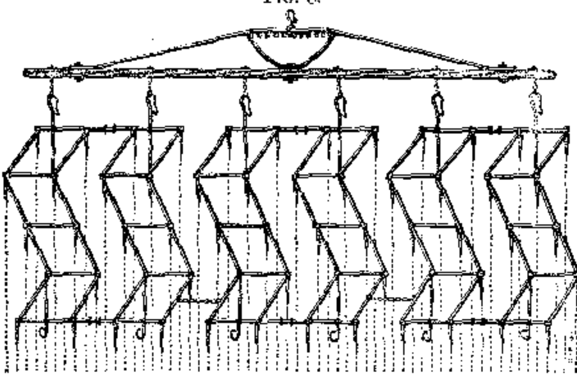


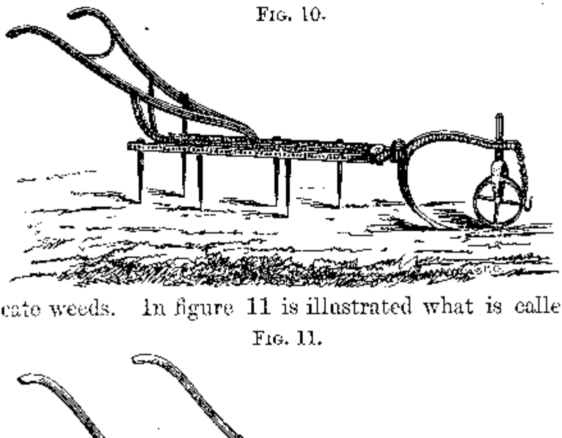
FIG. 9.

which represents one of Messrs. Howard's harrows. It is made of iron, the price of the size here illustrated being £3 10*s*. A section of the tine is square, and is set so that the angle moves in front, as shown in figure 9, by which it works most efficiently. In common harrows the tines are continually getting loose, which is a source of inconvenience and expense. In the zig-zag harrow, illustrated above, this is very simply obviated: a piece of sheet iron is placed under the nut which secures the tine, and this is turned up against one side of the nut so as to prevent the latter from turning round. The tine cannot get loose as long as the nut retains its position.

A harrow of this size, drawn by an active pair of horses, will give a single stroke to twelve statute acres in a day.

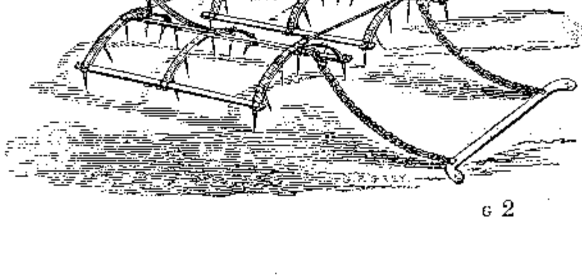
A drill-harrow, represented in figure 10, is used in the after-cultivation of root crops, to loosen the ground between the rows of plants, and to eradi-

Fig. 10.



cate weeds. In figure 11 is illustrated what is called

Fig. 11.



a saddle-harrow, which is found very useful by farmers who cultivate potatoes and beans extensively. By running it over the ground when the plants are half way to the surface it facilitates their growth.

LESSON IV.

The roller is used to crush clods and to consolidate the ground. In its simplest form this implement consists of a cylinder generally made of stone and drawn from its axis. More usually, however, a frame and shafts are fixed to the roller.

The cylinder is made of stone, wood, or metal. Stone is usually used when the implement is of the simple kind just referred to, that is, without shafts. When made of wood the cylinder is solid; hard wood should be used for the purpose, and either the ends should be well bound with iron to prevent the wood from splitting, or the whole of the cylinder covered with sheet iron. When metal is used the cylinder is hollow. The cylinder is sometimes made of wrought iron, but cast metal, owing to its cheapness, is generally preferred.

The weight of the roller should vary with the quality of the soil. A roller weighing about 12 cwt. is capable of crushing the clods on light land, while one weighing 16 cwt. and upwards is required on strong clay soil. For general purposes the length of the cylinder (that is, the width of the roller) is five feet and its diameter two feet.

By dividing the cylinder into two segments the implement is more easily turned at the headlands. It is sometimes divided into three segments, but two are quite enough in a one-horse roller.

The price of a metal roller, five feet wide and well mounted, is about £6. Drawn by an active horse it goes over six acres per day.

One of the commonest defects in the rollers met with in this country is that the diameter of the cylinder is only ten or twelve inches. A roller with a cylinder of this diameter is pulled with greater difficulty than another of equal weight with a cylinder two feet in diameter. For, in the first place, a small cylinder sinks more into hollows than a large one; and again, supposing the ground to be perfectly level, a roller with a large cylinder is more easily pulled than one (of the same weight) with a small cylinder, on the same principle that a cart or carriage with high wheels is more easily pulled than one with low wheels.

The mechanical principle here involved is that, in turning a wheel or roller, the power may be represented as acting at one end of a lever which is the radius of the wheel, and the longer this radius the less power is required to turn the wheel.

The frame of the roller presses on the axle of the cylinder, and the amount of friction thus caused is in direct proportion to the weight of the frame. As the horse has to overcome the friction, the lighter the frame is, the lighter the draught.

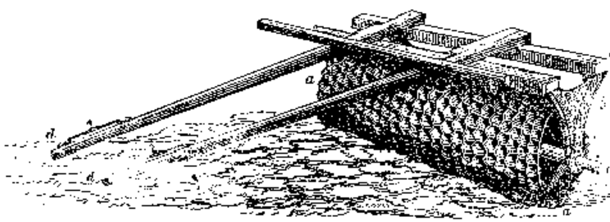
The weight of the roller is made up of the weight of the cylinder and frame; and as the friction caused by the latter is overcome at a disadvantage as compared with that of the former, it follows that a well-constructed roller has as much as possible of its total weight in the cylinder. It is therefore, a mistake to make the frame heavy and the cylinder light, as is often done in this country.

It is a common practice to fix on the frame a box into which stones or other material are put, when it is advisable to add to the weight of the implement. The same thing is sometimes done by fixing an old barrow or some other object on the frame. Every such increase of weight presses on the axle of the cylinder, causing an increase of friction there, which is overcome at a disadvantage; but when the farmer has only one roller it becomes necessary to vary its weight occasionally.

Theoretically speaking, the most perfect attempt at effecting this object is by making the cylinder waterproof, and introducing into it water as occasion requires it. Messrs. Amies and Barford of Peterborough make rollers on this principle.

The late Mr. Crosskill, of Beverley, Yorkshire, subdivided the cylinder into a number of discs, each about three inches thick, and all of course revolving on a common axis. By serrating them on the edges, and making the weight of the implement about 26 cwt., he produced a roller which so effectually pulverized lumps of soil, that it is called Crosskill's Clodcrusher. The width of the implement, which is illustrated in figure 12, is six

FIG. 12.



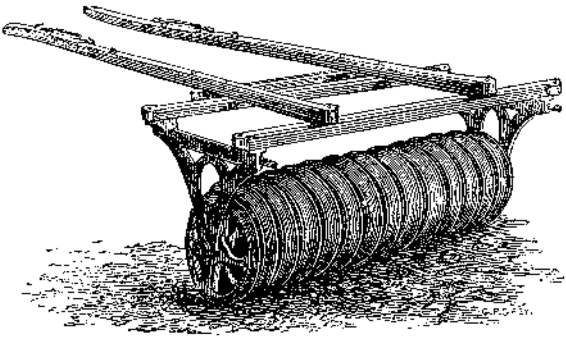
feet, and the discs are thirty inches in diameter: sometimes the alternate discs are of different diameters. The price of a good Crosskill is £18 10s., which places it beyond the reach of a small farmer; but it has special advantages, which renders its use almost indispensable on large farms. Thus, on clay soils, it was found difficult, if not impossible, to prepare the ground for root crops in due time until the introduction of this implement, by the aid of which heavy crops of roots are raised on land of this description.

Again, it gives firmness to light land, and checks the ravages of the wire worm. (See Corn Crops.)

Drawn by two horses it rolls eight acres per day.

A useful modification of this principle has been introduced into the Cambridge roller, represented in figure 13. In its recently improved form the discs are not made of uniform diameter, as formerly, but "each alternate one in the set is about two inches taller, and has the centre roll, not circular and close fitting, but triangular and wide. The result is that while the discs press uniformly on the surface on which they are rolled, the larger ones rise above their fellows with a jerking motion, which gives a most efficient self-cleaning power to the implement, and thus admits of its being used when other implements would be clogged."

Fig. 13.



The price of a Cambridge roller is from £10 to £15, according to the size.

SECTION II.

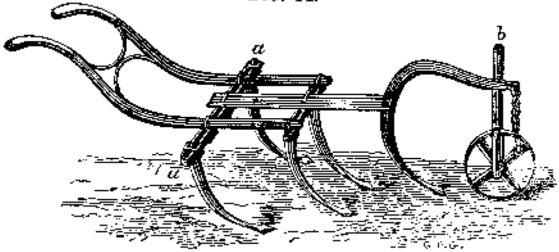
GRUBBER OR CULTIVATOR.

LESSON V.

In many soils the sod turned over by the plough is with difficulty broken down with the harrow. To overcome this difficulty, an implement with a number of strong and curved tines, called a "grubber" or cultivator was introduced.

Figure 14 represents a grubber introduced by Mr. Tennant of Ayrshire, and commonly known as Tennant's

Fig. 14.



Grubber. Five tines are shown in the figure; but as they are movable on the bars, the number can be increased to seven when necessary.

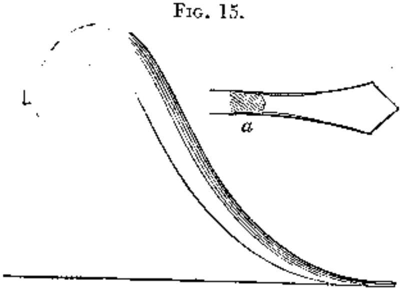
By using a short bar, *a a′*, and moving the tines on the bars closer together, the implement is converted into a drill grubber.

The curvature of each tine is one-fourth of a circle, the front one being set a little more vertically than the rest.

The depth to which the tines penetrate into the ground is regulated by lowering or raising the shank, *b*, to which the wheel is fixed.

The late Mr. Slight of Edinburgh, made the tines swan-neck at the top, as shown in figure 15, which is a

Fig. 15.



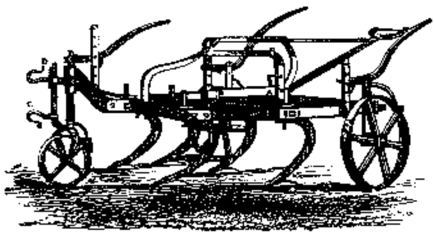
great improvement, as it prevents weeds from collecting round them, or, in other words, prevents the implements from choking: *a* gives a front view of the lower part of the tines.

An implement of this kind can be made up by any intelligent manufacturer, at a price varying from £4 to £5 and upwards, according to the strength required. Drawn by two horses this implement will grub three statute acres in a day.

Three and four-horse grubbers, containing a greater number of tines than the above, are used on large farms. An implement of this description is made by Coleman of Chelmsford, which goes over from four to five statute acres in a day. The depth to which the tines penetrate into the ground is regulated by the lever.

The points of the tines of Coleman's Cultivator, and some others, are so constructed as to admit of having broad shares or narrow points fitted on them. The broad shares are put on in autumn, when the grubber is used to scarify the land, and thus assist in loosening and collecting root-weeds. The use of the grubber for this purpose on land infested with couch grass is very easily understood, when it is remembered that this weed will be found within three or four inches of the surface in autumn. In spring cultivation narrow shares are used. We give illustrations of Clay's Cultivator, which is a very

Fig. 16.



efficient implement. One peculiarity of this implement is, that in lifting the tines out of work, say at the head and foot ridges, they turn backwards, as shown in figure 17, which requires less force than when they are lifted up through the unstirred soil, as in other grubbers. Figure 16 represents the implement at work.

FIG. 17.

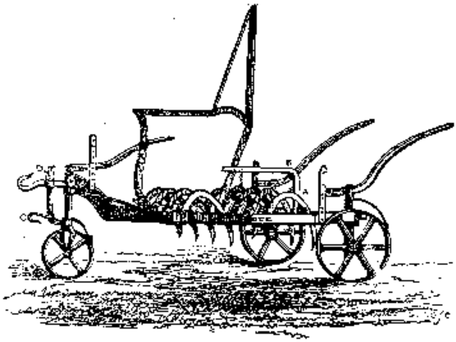
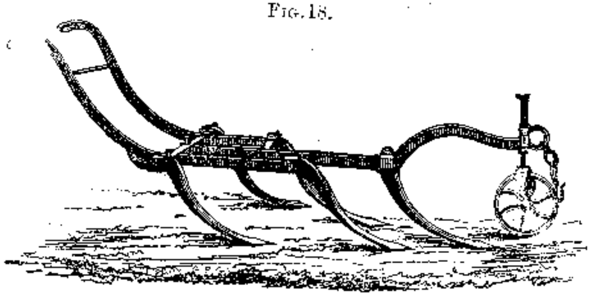


Figure 18 represents a drill grubber, which is used in the after cultivation of roots. It is run before the drill harrow, and, in common with that implement, goes over three statute acres in a day.

FIG. 18.



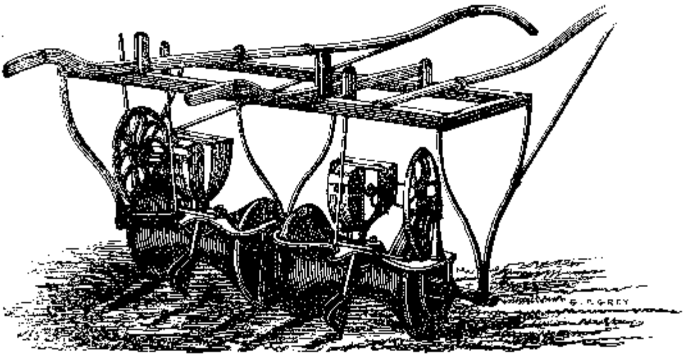
SECTION III.

MACHINES FOR SOWING SEED.

LESSON VI.

SMALL farmers sow the seeds of all farm crops by hand; while on extensive holdings seed is very generally sown by machinery.

FIG. 19.



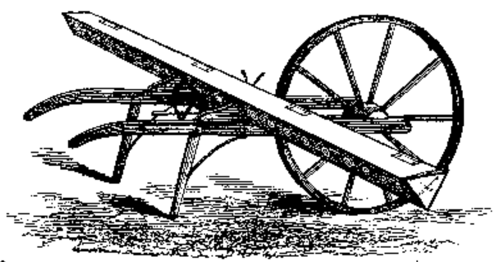
A great variety of machines have been devised for sowing turnips; some sowing one row, others two rows, or more. In the most common form of turnip-sowing machines the seed is put into a hopper, from which it passes into two cylinders, to which motion is communicated by the motion of the machine; these cylinders contain small circular openings through which the seed falls into tubes fixed behind the coulters. Owing to the varying quantity of seed in the hopper the fall or distribution of the seed is not quite uniform. And, again, if the motion of the machine be very rapid, the descent of the seed is prevented by the centrifugal force it acquires. The rollers are free on the axle, and thus accommodate themselves to drills of different width.

The machine represented in figure 19, is made by Jack of Maybole, Ayrshire, for £6 10s., is capable of sowing mangold and turnip seed, and is free from the objection first stated as to the unequal distribution of seed. It sows two rows at a time, and drawn by a pony, goes over six acres in a day.

Another class of seed-sowing machines consists of a cylinder or case, which does not revolve itself, but in the bottom of which are holes, through which the seed is forced by a revolving brush, or a series of revolving pinions, &c. Machines are made on this principle for sowing corn and grass seeds broadcast.

Figure 20 represents a grass seed sower, manufactured by Mr. Fry of Bristol. It is 12 feet long, and has 21 brushes. There is double gear for regulating the quantity of seed sown, and an arrangement for carrying the box diagonally on the frame when not in use. The price is £3 5s.; and 3s. for every additional foot.

FIG. 20.



The bean harrow, which consists of a pinion kept revolving within a case or barrow, is on this principle.

Machines for distributing artificial manures, and called manure distributers, are made on the same principle.

The sowing apparatus in Garrett's corn drilling machine, represented in figure 21, is on another principle; namely, motion is communicated by the driving wheels to an axle, on which is fixed a number of discs at right angles to the axle; these discs carry a number of little cups, which, as they revolve with the axle, dip into the corn, lift it, and throw it out into tubes, through which it passes behind the coulters.

The box in which the axle, discs, and cups revolve is called the "seed-barrel." The quantity of seed sown per acre varies with the size of the cog-wheels, which communicate motion from the driving wheel to the axle of the seed barrel. Different sets of these cog-wheels are sent out with each machine.

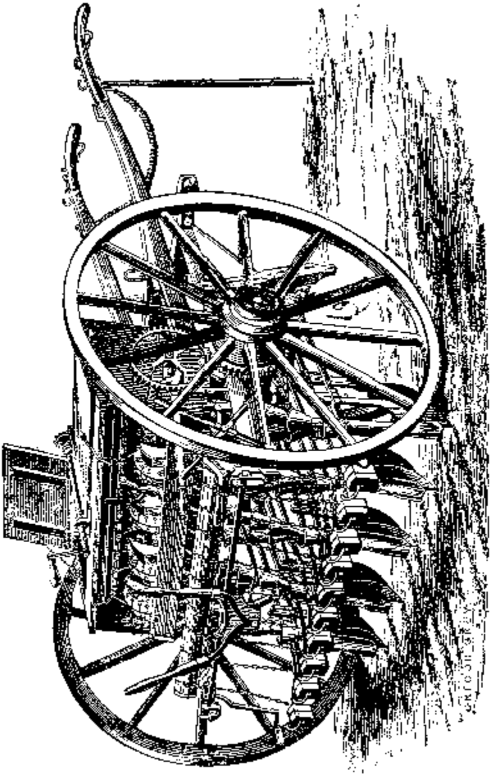
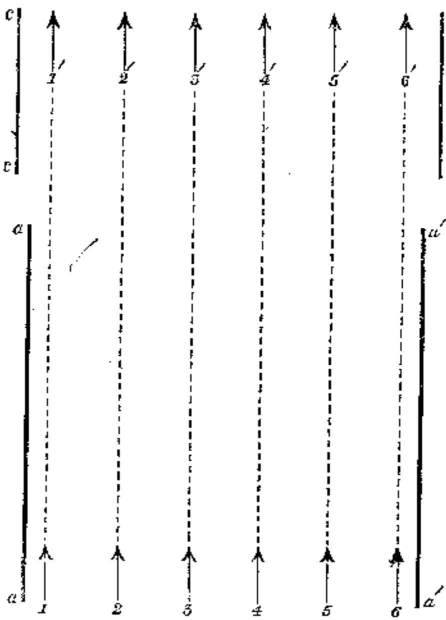


FIG. 21.

The distance between the rows is varied by shifting the coulters on the bar to which they are attached. In doing this, however, a difficulty arises when the width of the rows is not some submultiple of, or evenly divisible into, the width between the driving wheels. Let this distance be five feet, and let it be desired to sow the corn in rows ten inches wide. As ten inches are contained six times in five feet, we have six rows of corn; and as one of the wheels must always return in its last track, the coulters 1 and 6 must be five inches from the driving wheels, *a a* and *a′ a′*, figure 22; or we can have

FIG. 22.



five rows of corn sown by such a machine, the space between each pair being one foot wide, and the distance from the coulters, at either side to the driving wheel, being six inches; but it is evident, that if we want to sow corn in rows nine or eleven inches apart, with a machine five feet wide, we cannot have the distance from the outside coulters to the wheels half these widths, and consequently all the rows cannot be equally distant.

To obviate this difficulty, and to facilitate the turning of the machine, a "fore-carriage," as it is called, is introduced, adding about £3 10s. to the cost, and also increasing the draught. By constructing this fore-carriage, so that the wheels can be brought closer together, or moved farther apart, all the rows can be made any uniform distance apart.

Supposing the distance between the driving wheels to be five feet as before, and that the corn is to be sown in rows eleven inches apart, the fore-carriage wheels must be made to project three inches outside the driving wheels, so that the distance between the coulters 1′ and 6′ and the wheels *c c* and *c′ c′* of the fore-carriage would be five and a-half inches.

The price of Garrett's corn drill represented here is £16. It is capable of sowing six acres per day.

SECTION IV.

REAPING, MOWING, AND HAY-MAKING MACHINES.

LESSON VII.

The corn crops are now-a-days cut by reaping machines on a great many large farms; and a farmer whose holding is of moderate size can, in many districts, hire one of these machines.

On large farms reaping machines effect a saving; but their advantages do not end there. Thus, it often happens that a larger breadth of corn ripens at one time, on a farm or in a district, than can be cut in due time by hand by the labourers available. And, again, in broken or catching weather, it is of the utmost importance to be able to use a machine which cuts the crops quickly.

Emigration, too, has carried away so many of the farm labourers of this country, as to render the use of this machine more necessary now than formerly.

The want of a reaping machine has been long felt; and of the many efforts made to supply this want, the first successful one was made by the Rev. Mr. Bell. of Carmylie, Forfarshire, who, in 1829, received a prize for his machine from the Highland and Agricultural Society of Scotland. This machine cut down wheat like a shears. There were two rows of knives; one row, consisting of thirteen blades, was fixed, and the other, consisting of twelve blades, was made to oscillate to and fro. The machine was pushed by two horses walking behind it. The cut corn was received on an "endless web" of canvas, made to revolve from right to left and from left to right, according as the horse went up or down, so that the crop should fall to the right and left of the machine.

Little was heard of the reaping machine from 1829 to 1851, when Mr. M'Cormick, of the United States of America, showed one at the Great Exhibition held in London that year. It soon attracted attention, and was tried with great success. Since then it has been greatly improved by Mr. Hussey, another American gentleman, and several others.

For practical purposes, the reaping machines now in use may be divided into three classes: first, those made on M'Cormick's principle; second, those made on the principle of Hussey; and third, those which retain the main features of Bell's machine.

The cutting apparatus in the reaping machines now in use consists of a blade of steel carrying a number of knives; the blade is worked from side to side with great rapidity by means of a crank, eccentric or other gear, and in doing so passes through slits in what are called "finger pieces," which are fixed parts of the machine; the corn is cut between the surface of these and the edges of the knives on the oscillating blade.

In M'Cormick's machine the angle formed by the cutting edges of each knife is obtuse, as shown in fig. 23.

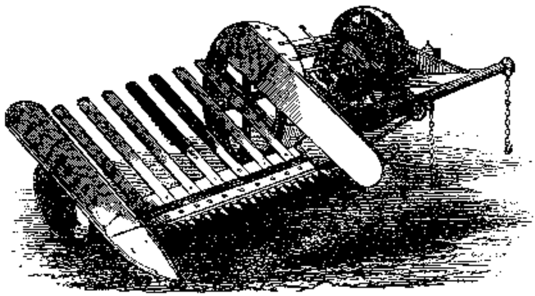
FIG. 23.

FIG. 24.

In all machines on Hussey's principle the angle is acute. See figure 24.

Figure 25 represents Woods' One-horse Reaper, price £18, which is capable of cutting six acres per day.

Fig. 25.



LESSON VIII.

Meadows are mown by the scythe or a machine worked by horse-power, called a mowing machine.

An experienced man will mow a statute acre in a day; and his wages may vary from 2*s*. 6*d*. to 5*s*. a day.

The cutting apparatus in mowing machines is the same in construction as that of reaping machines. Several machines are capable of both reaping and mowing. The cutting blade is moved with greater speed in mowing than in reaping.

Woods' Two-horse Mower, price £22, is capable of cutting an acre per hour, or ten acres in a day of ten hours. It takes a man and boy to guide the horses and direct the machine; and their joint wages would be about 3*s*. per day, or about 3½*d*. per acre; the horse labour would be about 5*s*. a day, or 6*d*. an acre; the cost for manual and horse labour would be 9½*d*. an acre. We are to add ten per cent. on the price of the machine for wear and tear; and dividing the amount (£2 4*s*.) by the number of acres mown (which is a varying quantity) we get the charge per acre under this head.

A machine called a *hay-tedder* is used as a substitute for manual labour in turning hay. It inverts the hay most satisfactorily, and breaks the lumps more fully than unskilled labourers. One horse is capable of working it, but when the crop is heavy it is usual to employ two horses to relieve one another at intervals. A good machine, worked by two horses,

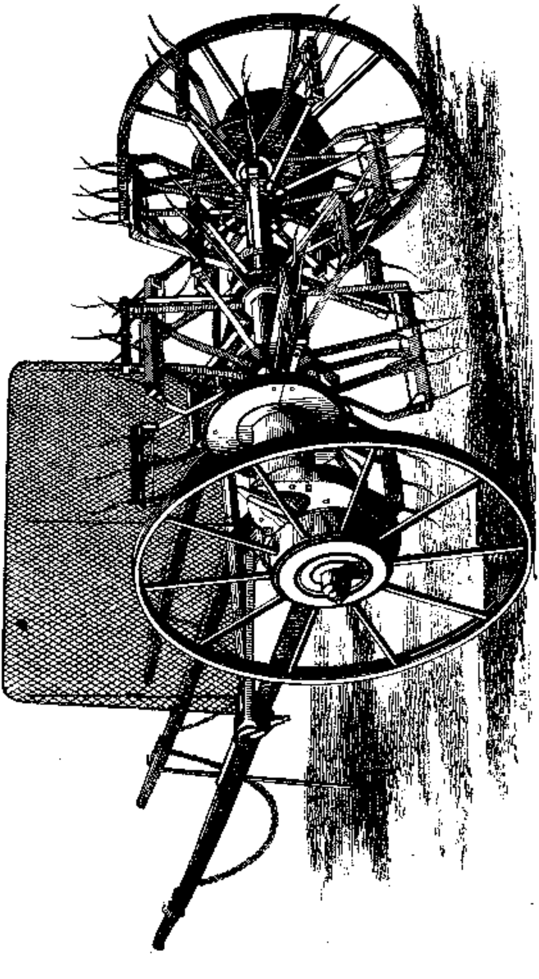


Fig. 26.

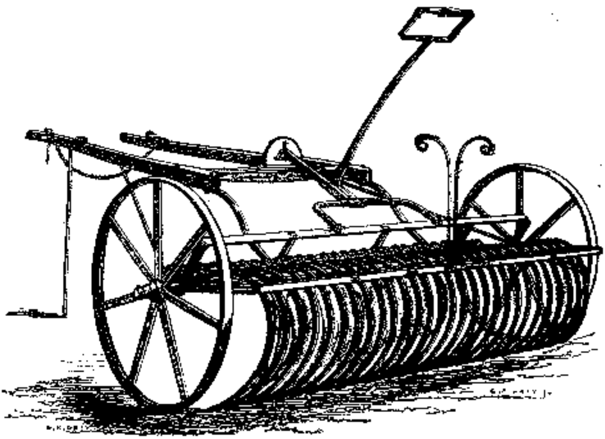
in this way, will go over twenty statute acres in a day; and, when the crop is not heavy, a single horse will ted fifteen acres, and do the work of at least fifteen men or women, and effect a saving of about 10*s.* a day; and besides the pecuniary gain, a machine of this kind has, in the present state of the labour market, a great advantage in the certainty with which the farmer can calculate on the work being satisfactorily done.

A good hay-tedder has what is called double action, that is, it gives the first or forward stroke, which lifts the hay clean off the ground, and throws it forward and upwards, after which, as the machine passes along it falls on the ground; and the backward or lighter stroke, by which the hay is gently turned from behind the machine.

Figure 26 represents a first-class hay-tedder, made by Messrs. Howard, of Bedford, price £15.

Hay rakes are worked either by hand or horse-power.

FIG. 27.



A horse rake goes over nearly the same area of ground, and supersedes almost as many hands as the hay-tedder. It is used to collect the grass into rows (called windrows) and to rake the spaces between these rows afterwards. It is difficult to get a rake which will accomplish the first of these objects in heavy meadows.

Figure 27 illustrates the horse rake as manufactured by Messrs. Howard of Bedford, which is their H H rake, price £8 10*s.*; it is 8½ feet wide, has 28 steel teeth, which are lifted or depressed by the lever shown in the illustration, and is capable of raking any meadow into rows, except heavy watered meadows, for which their H H H rake is specially made. The latter has 24 steel teeth, and is fitted with higher wheels than the other.

Both the hay-tedder and horse rake can be hired for 2*s.* 6*d.* a day, each, in several parts of the country.

There is another form of horse rake, known as the American rake, which is both cheap and efficient. It can be made of wood for about £1 10*s.*, and of tubular iron for £3.

SECTION V.

THRASHING AND WINNOWING MACHINES.

LESSON IX.

The modes adopted, from time to time, for separating the grain from the straw of our corn crops are exceedingly interesting, and intimately connected with the progress of agriculture. Probably the most primitive mode of effecting this object was by causing horses and oxen to trample on the corn—a system still in use in some eastern countries.

The flail is a very ancient implement. It was known to the Romans, and is still very generally used on the Continent, by the small farmers of Ireland, and by the Highland crofters.

An expert hand could thrash a barrel of wheat in a day; two men working together, facing each other, and striking alternately, do more than when working separately; and in the South of Ireland three men work together with great dexterity and economy.

The thrashing machine driven by horse, water, or steam power succeeded to, and has on all well-managed large tillage farms superseded, the flail. Thrashing machines are made of all sizes, from one-horse power upwards. They have even been made small enough for hand-power, but the flail appears preferable to a hand-power machine. Water, when available in sufficient quantity, and can be applied at the cost of erecting a dam and driving-wheel, is the cheapest motive power for driving machinery. Horse-power is very generally used for the purpose, and possesses one advantage which recommends it to the farmer, namely, that he can employ his horses and men at the work in wet weather. The strain on the horses is, however, so great and unequal as to go far to counterbalance this advantage, and, in consequence, almost all large farmers of advanced knowledge thrash by steam when they cannot command an adequate volume of water-power.

We are informed that a Mr. Meikle of Houston Mill, near Haddington, in Scotland, invented the thrashing machine. A model of this invention was completed in 1785; it was patented in 1788; and in 1798 the machine was so far appreciated that a sum of £1,500 was subscribed for Mr. Meikle and his family.

Miekle's machine consisted of a revolving cylinder or *drum*, on which was fixed a number of bars or *beaters* rising a few inches above its surface: a *concave*, within which the drum revolved; and a feeding board and rollers fixed in the breast of the drum. The grain was afterwards separated from the straw by hand. To this contrivance was afterwards added shakers and a winnowing machine.

The drum of a good modern Scotch machine is about $2\frac{1}{2}$ feet in diameter, is from $2\frac{1}{2}$ to $3\frac{1}{2}$ feet long, has four or more beaters, which rise about three inches above its surface, and makes about 400 revolutions per minute. The grain falls from the shakers into the winnowing machine.

The thrashing machine now approved of in England (and called by way of distinction the English machine) differs from the above in several points. The drum is longer, but smaller in diameter; the corn is put in (not at the breast, but) at the top of the machine; there are no feeding rollers; the speed of the drum is

FIG. 28.

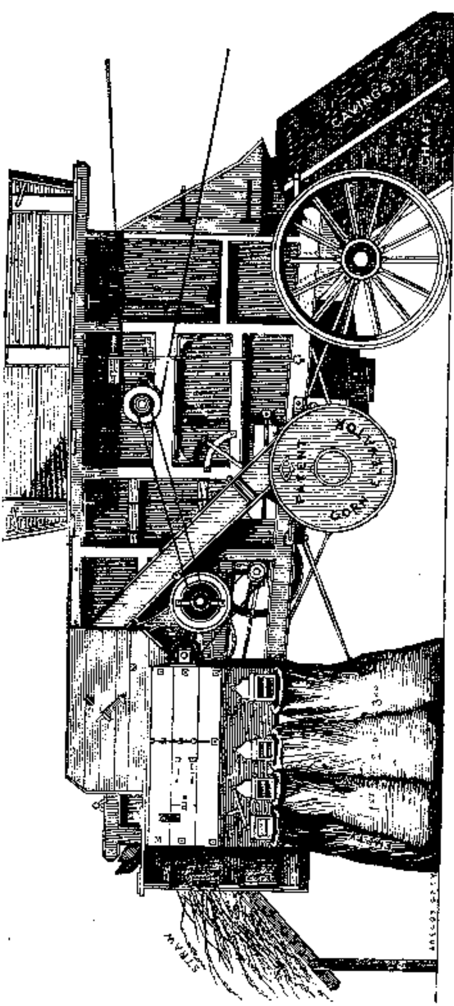


Figure 28 illustrates a first-class combined thrashing and winnowing machine, manufactured by Messrs. Clayton, Shuttleworth, and Co., of Lincolnshire. The dressed corn comes from the winnowing machine into sacks, marked 1st, 2nd, and 3rd.

fully 1,000 revolutions per minute; and the number of beaters is greater in the English than in the Scotch machine. In the English machine, too, the grain is separated from the straw by friction between the drum and concave. An English machine, owing to the greater speed of the drum, must evidently break the straw more than a Scotch machine. In the latter the shaker or shakers (for sometimes there are two and sometimes only one) consist of a revolving cylinder carrying a number of spikes. The shakers of the English machine consist of a number of louvres or boxes without bottoms, placed at a small angle with a horizontal line, and made to move up and down alternately, and thus really shake the straw. A good popular idea may be formed of the action of these shakers, by placing two ladders side by side, and moving them up and down alternately, so that the one shall be going up while the other is going down. The motion or "throw" being forward, the straw is moved onwards at the same time that it is shaken.

In large thrashing machines of modern construction the corn is winnowed fit for market; they are in consequence called "combined machines." In all good machines of this description the following separations are made:—1°, the straw goes out at the end of the shakers; 2°, there are the "cavings" or short straw; 3°, the chaff; 4°, "cobs" or unshelled kernels; 5°, good grain; 6°, tail corn; 7°, seeds of weeds.

It may be interesting to note here the scale of points by which the merits of combined thrashing machines were tested at the Chester meeting of the Royal Agricultural Society of England:—

For clean thrashing, ...	100 marks.
For clean shaking, ...	70 ,,
For well-dressed corn, ...	70 ,,
For having cavings free from corn, . .	70 ,,
For having chaff, ,, .	50 ,,
For having chaff free from cavings, .	20 ,,
For the corn being uninjured, . .	50 ,,
For straw being unbroken, ...	20 ,,
For having chaff free from seeds of weeds,	20 ,,
	470 marks.

The thrashing machine is either fixed or portable. The former is preferable when the farm is compact. On the other hand, when the farm is large and parts of it very remote from the farm steading; or, again, when a farmer rents several farms, the portable machine, which is on wheels and admits of being carried from farm to farm, is better than a fixed machine.

The majority of the small farmers of Ireland do not use a thrashing machine of any kind, the price being beyond their means; but there is no reason why a number of them should not combine and buy a machine of moderate size. Messrs. Ransome and Sims, of Ipswich, make a portable two-horse machine for forty guineas, which is capable of thrashing from 90 to 100 stones of wheat per hour.

Portable thrashing machines are worked by horse or steam power, the former being used for small and the latter invariably for large machines.

LESSON X.

After corn is thrashed it becomes necessary to clean it for market; and this is done either by hand or by a winnowing machine, which is also called a fanner.

Winnowing corn by hand is tedious, and often wasteful. It is generally practised by the small farmers of this country who do the work themselves, but it is rarely or never adopted now-a-days by any farmer who has to pay for labour. Some farmers keep two winnowing machines; one for rough work, the other for finishing the corn.

The part of the machine at the top where the corn is put into it is called the hopper; and by a slide in the front of this, the quantity of grain admitted to the fanners is regulated. In Hornsby's machines a spiked roller is kept in motion in the hopper to prevent it from being choked by straws.

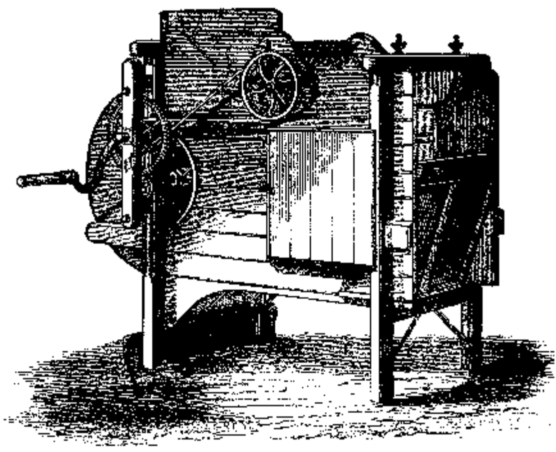
In a very excellent fanner, made by Messrs. Fry, of Bristol, two spikes of metal, formed like the prongs of a hay fork, are made to oscillate from one side of the hopper to the other for the same purpose.

A winnowing machine contains riddles and sieves, on the construction, adjustment, and motion of which the efficiency of the machine greatly depends.

The meshes of riddles for separating the small kinds of grain from heavy articles of any kind may be made of the following dimensions:—*

	Wooden Riddles.		Riddles made of Iron Wire.
——	Meshes.	Width of wood.	No. of Meshes in a square inch, including wire.
For Wheat, .	$\frac{1}{4}$ of an inch sq.	$\frac{3}{16}$ of an inch,	25
,, Barley, .	$\frac{5}{16}$,,	$\frac{1}{4}$,,	16
,, Oats, .	$\frac{2}{5}$,,	$\frac{1}{4}$,,	12
,, Beans, .	$\frac{5}{16}$,,	$\frac{3}{16}$,,	16†

Fig. 29.



* *Vide* Book of the Farm, vol. 1, p. 414.
† Impurities and shrivelled grains pass through.

In the passage of the grain over the riddles and sieves in a winnowing machine, the chaff is blown out of it by the draft generated by the *fan*, the construction of which materially affects the efficiency of the machine.

Figure 29 represents a large winnowing machine, manufactured by Messrs. Garrett, of Saxmundham, Suffolk, which is capable of cleaning from 40 to 60 bushels of corn per hour. The price of this machine is £13.

The awns of barley adhere so firmly to the grain, that a machine called a barley hummeller has been made for the purpose of separating them. A simple form of this machine consists of a small roller of metal, with blunt edges, which can be had for about £1, and which is made to pass over the grain on a barn floor.

SECTION VI.

CARTS.

LESSON XI.

The vehicles employed for conveying manure from the farmyard to the fields, as well as for conveying farm produce from the fields to the farmyard, and from the latter to market, are called carts and waggons. Carts have only two wheels, and are of all sizes, from the small donkey cart to the large cart drawn by the heavy draught horse. Waggons have four wheels, and are not so much used in Ireland or Scotland as in England.

Carts possess many advantages over waggons, such as their lightness and cheapness, and the despatch with which work is done.

The principal parts of a cart are the shafts, body, and wheels. The shafts are usually made of ash, which is elastic and durable. The sides and bottom of the body are generally made of deal or common fir, and the contents of the body should be at least one cubic yard;

and very convenient dimensions in a body of this size would be five feet in length, four feet wide, and sixteen inches deep. The sides should slope outwards a little.

It is found that the nearer the wheels are to one another the less draught is expended in drawing the cart.

A high wheel is more easily rolled than a low one; and, other things being equal, a cart with high wheels is more easily pulled than one with low wheels. The height of cart wheels is principally limited by two considerations. First, they must not be made so high as to cause inconvenience and unnecessary labour in loading the cart. It has been estimated that a rise of one foot in the height of a cart may add one-fifth to the labour of filling it. Secondly, if made too high the traces would incline downwards, and part of the draught would be uselessly expended.

A convenient height for cart wheels is four feet and a half.

Each wheel consists of a nave, spokes, which are made of oak, and felloes, which are made of elm.

The spokes are driven into the nave in such a way as to give the wheel what is called a "dishing," the object of which is to enable the wheel to resist the shocks to which it is subjected on passing over ruts and stones. When from any cause one side of a cart is higher than the other (such as when one wheel falls into a rut) extra weight is placed on the lower wheel, and by having it dished with its convex side inwards, it bears the shock better; the effect of this increase of strain on a dished wheel is, to drive the spokes "home" into the nave, and thus strengthen the wheel. Dished wheels are required more on bad than good roads. If roads were perfectly level it would not be necessary to introduce dishing into wheels; and owing to modern improvements in road making, the degree of dishing in wheels is less now than it used to be.

The wheels are connected by the *axle-tree*, on which the body of the cart rests. The *axle-arm* is that part of the axle-tree which passes through the nave; and in dished wheels the axle-arm should taper in mathematical proportion to, or a little less than, the dishing of the wheel.

The axle-arm is also made to deflect downwards, so that the wheels would incline outwards to correspond to the inclination of the sides of the cart, and thus admit of an increase in the capacity of the latter without increasing the width of the axle, or the distance between the wheels.

The felloes are bound by a hoop of iron, the width of which should not be less than two inches. Wheels with narrow rims cut up roads more quickly than those with broad rims.

In order to facilitate the emptying or tilting of a farm cart, the shaft is usually divided into two parts. Sometimes the division takes place at the axle, but it is better to unite the parts in front of the axle by passing a spindle through them, so that when the horse moves after the cart is emptied, he brings, or assists to bring the body of the cart into its former position.

A farm cart should be made as light as is consistent with strength and durability. It is not advisable to make it much less than eight cwt., or more than ten cwt.

The price of a farm cart varies from £8 to £15, according to the quality of the material and the style in which it is made.

SECTION VII.

MACHINES FOR PREPARING FOOD FOR LIVE STOCK.

LESSON XII.

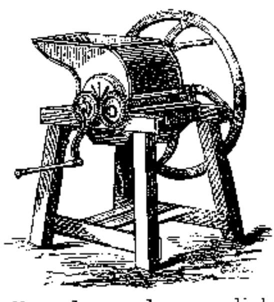
Food is prepared for live stock by a great variety of machines and apparatus. Thus, root crops are cut into slices or pulped into shreds; hay and straw are cut up into short lengths; and several farmers use apparatus for steaming or boiling some or all the food of stock.

Root Slicers.—Cattle fed on whole roots are liable to be choked by swallowing the last piece eaten, which is more or less roundish and lodges in the throat. By cutting the roots into thin slices, from three-quarters of an inch to an inch in thickness, this is avoided. There is also a manifest advantage in cutting roots for old cattle or such as have bad teeth. The late Mr. Pusey, one of the highest authorities in agriculture, estimated that by slicing roots for sheep a saving of one-third may be effected; but if we assume the saving to be one-sixth, the advantage would be very considerable. Roots scooped out by the sheep themselves, are rolled about in the clay, trampled upon, and wasted.

Sheep eat a greater weight of cut than uncut roots, which induces some farmers to think that the slicing of those crops entails a loss; but they forget that the sheep fatten much quicker on cut than on uncut roots. For slicing roots for cattle on small farms, a simple machine could be made up for about £1, which would answer very well.

Bentall's *pulper* (figure 30) consists of a barrel in which are fixed a number of steel teeth, and as the barrel revolves, the teeth bite the roots and cut them up into pulp or small shreds. The teeth are arranged in the direction of a spiral round and round the barrel. As the machine works, a screw of corresponding pitch is made to revolve; the teeth pass between the threads of the screw, by which they are prevented from choking.

FIG. 30.



The pulp thus produced is usually allowed to undergo a slight fermentation, either by itself, or mixed with something else. This mode of preparing food suits very well for pigs.

For cattle the pulped roots are mixed with cut straw or hay, and the whole allowed to undergo a slight degree of fermentation.

Straw and hay cutters (now commonly called *chaff-cutters*) are used for cutting hay and straw for feeding, and sometimes for cutting straw for litter.

For feeding purposes the chaff-cutter is said to be useful, not so much by aiding mastication, as by enabling the farmer to thoroughly mix hay or straw of unequal quality, and thus consume the bad with the good.

Straw is not as commonly cut for litter as for feeding. In many cases, however, the chaff-cutter could be advantageously used for the former purpose. The author of this work was enabled to use it with great effect on the *School* farm attached to the Albert Institution. On that little farm, which contains only five and a-half statute acres, four and sometimes five cows have been maintained. He found that on good floors he was enabled to keep the cattle clean, comfortable, and healthy, by the use of a quarter of a stone of chaffed straw as litter for each, in the twenty-four hours.

The chaff-cutter consists of an open box into which is put the material to be cut; spiked or fluted rollers for moving it forward, and knives for cutting it.

In some machines the knives move in a vertical plane, giving what is called an "intermittent cut," which Mr. Morton considers the best form for hand machines, as the velocity and momentum accumulated during the intervals adds force to the action.

Sometimes, again, the knives are arranged round a cylinder; and this form of knife has the advantage that all points of the cutting edge are equally distant from the centre of motion, and consequently equally effective.

The greater number of machines now in use have the knives fixed in a vertical disc, the edges of the knives themselves being straight, concave, or convex. The concave form of blade is most in use; and the curvature is regulated so that all parts of the blade shall make the same angle with upper surface of the material to be cut. In most machines on this principle the cut is said to be "continuous," to distinguish it from the intermittent or chopping action already referred to. The straw (or hay, as the case may be) being continuously pushed forward while the knife is cutting through, it is evident the cutting edge should not be at right angles to the direction of the motion of the straw, but should incline from before backwards, at an angle varying with the motion of the straw.

A machine called an oat-bruiser is commonly used for crushing oats for horses. It is found that many horses chew their oats very imperfectly, and consequently abstract from it only a part of the nutriment it contains, a circumstance occasionally rendered evident by the appearance of the oats voided in the excrements. Bruised oats prove exceedingly economical in the feeding of such horses; and it is still more useful in the feeding of old horses with bad teeth.

Farmers who use oilcake or rapecake for feeding live stock, require for breaking it a machine called an oilcake breaker.

The advantages of cooking food for live stock will be considered in the lessons on live stock. Here it is only necessary to notice the kinds of apparatus in use.

Some of them, like Smith and Welstod's, consist of a simple pan fitted into a case, in the bottom of which fire is placed.

When a large quantity of food is cooked, it is found more economical to subject it to the action of steam than to boil it.

Large farmers having a steam engine worked not less than two or three times a week, could cook a sufficient quantity of food for their stock, by passing through it steam from the boiler.

A simple and efficient steaming apparatus consists of a vertical boiler with a fire in the bottom of it; the heat soon generates steam, which is conveyed by a pipe to a vat of suitable dimensions, in which the food to be steamed is placed. A small iron pan, with a close fitting lid for steaming meal, bruised oats, or similar food, is also very useful.

PART III.

CROPS.

SECTION I.

THE ROTATION OF CROPS.

LESSON I.

If we sow clover too often on the same land it either refuses to grow altogether, or the crop becomes patchy. When turnips are repeated too often on the same land the bulbs become diseased. Flax should not be repeated on the same soil until a period varying from eight to twelve years has elapsed.

The farmer has found, from practical experience, that the failure or loss of his crops in this way is prevented by what is called the rotation of crops: that is, growing the crops of the farm in regular rotation or succession. The order of succession varies with the soil, market, and other circumstances.

Scientific men have offered several theories of the advantage of alternating crops, only two of which we will notice. De Candolle, a celebrated botanist, finding a deposit of the nature of a bitter extract in the water in which wheat grew, and that after wheat refused to grow in this water, beans grew luxuriantly in it, suggested that plants excreted from their roots matters which were injurious to themselves but useful or not injurious to other plants. This *excretory* theory, as it has been called, accorded so well with practical experience that it was universally accepted by farmers and gardeners. In many clay land districts beans and wheat had been alternated for years. Even as far back as the time of the Roman Empire, it was a pretty common practice to alternate *far* (a kind of wheat) and beans. The gardener found that a fruit tree would not succeed as well after one of the same as after one of a different species. In renewing vines, strawberries, &c., it is found beneficial to plant an intermediate crop. De Candolle's theory explained all this in a way which everybody believed for the time.

This exeretory theory continued to be popularly received until the publication of Baron Liebig's first work on Agricultural Chemistry in 1840. No sooner did that great man turn his attention to the analyses of soils and crops than he saw there existed a most intimate connexion between them. It was found that ten or eleven mineral substances were indispensable to the growth and full development of farm crops, and that these minerals existed in very different proportions in the different families of those crops. Thus, while a crop of wheat abtracts from the land 137 lbs. of silica and 34 lbs. of potash per acre, a crop of beans carries off 15 lbs. silica and 134 lbs. potash. It was reasonable, therefore, to suppose that if wheat were grown consecutively on the same ground, without an adequate return of silica in manure, the supply of this substance in the soil would become so far reduced as to render it incapable of producing a remunerative crop of wheat; and, if instead of wheat, beans were continuously grown for a number of years, the quantity of potash in the soil would soon become too limited for the wants of the bean crop. It was then suggested that the advantages of alternating these two crops arose from the difference in their chemical composition; and that crops should be alternated in accordance with the analyses of their ashes. This constitutes the celebrated *mineral* theory of the rotation of crops. To comprehend the full force of this theory, it is necessary to bear in mind that plants derive all their mineral constituents from the soil, and that the progress of vegetation is greatly dependent on the quantity of these constituents in the soil, and the state or *quality* in which they exist in it. For illustrating this, we will take root and corn crops. By the thorough exposure of the soil to the air and its influences during the cultivation of a root crop, a large quantity of silica becomes liberated, which is not required by that crop, and remains in the soil for the nourishment of the grain crop, which requires soluble silica in large quantity.

Plants differ very much in their habits of growth; and this affords an additional reason for alternating them. Thus, the corn crops possess a small system of foliage; root crops, on the contrary, have large leaves which take in from the air carbonic acid, watery vapour, &c., which help to build up the combustible part of their substance. In the same way the grasses, which have a large system of leaves, take in a large quantity of those materials from the air; and, as is well known, by their death and decay the quantity of vegetable (combustible) matter in the soil increases. It is a common practice to allow poor land to remain in grass for a few years with the view of enriching it in vegetable matter.

Another reason for alternating crops is afforded in the fact that they send their roots to different depths in the soil and feed on different parts of it. Root crops—especially parsnips and carrots—send their roots to a great depth into the soil. Grain crops send some of their roots down to a considerable depth, but throw out a great many lateral roots. The natural grasses are essentially surface-rooted plants. Red clover sends its strong tap-root to a great depth. It is manifest that the exhaustion of the soil must be deferred by growing these crops in succession. Even wheat and barley differ so widely in this repect that there is an advantage in alternating them. The wheat plant sends its roots deep into the ground, while barley rather sends them laterally in the loose surface mould prepared for it. When, therefore, the farmer finds that his land is well able to bear two grain crops in succession, and that their growth is likely to pay, this difference in the habits of growth of wheat and barley suggests the propriety of growing them in succession. We have known an excellent crop of barley raised after wheat, when a second crop of wheat could not be ventured upon. "My present course of cropping," says an eminent farmer before the London Farmers' Club in 1859, "is—1st, turnips or mangolds; 2nd, wheat; 3rd, barley; 4th, clover or grass; 5th, wheat; and I grow more barley and of better quality after wheat than immediately after turnips or mangolds."

LESSON II.

One of the greatest practical advantages of the rotation of crops is that it enables us to keep the land clean. Green crops, owing to the tillage they receive, are called *cleansing* crops. On the other hand if we grow three or four crops of corn in succession the land is sure to be overrun with weeds.

The simplest rotation in use is a two-years course of—1st, beans; 2nd, wheat. This course has been occasionally practised on strong clay land, which is the best land for these two crops. As both crops are raised for their seed, the rotation is very severe on land, and could not be attempted except on clay land rich in the food of plants.

A three-years course of cropping has been followed in some instances, the order of succession being—

1st Year.—Green crops manured—such as turnips, mangold wurzel, &c.
2nd Year.—Grain crops laid down with grass and clover seeds.
3rd Year.—Grass, for house-feeding cattle and hay.

This course is practised successfully by small farmers who employ spade-labour. Two-thirds of the farm may be put under crops for feeding cattle, which recommends it to small holders who adopt the system of soiling or house-feeding cattle. The preparation of grass land for roots increases the labour very much; and, besides, in this course the same crop comes round too often on the land. We have seen this system once adopted as a means of enriching a thin poor clay and preparing it for another course of cropping.

The rotation of crops most extensively practised in these countries is the Norfolk four course, which is—

1st Year.—Green crops manured.
2nd Year.—A grain crop, with grass and clover seeds.
3rd Year.—Grass.
4th Year.—Grain alone.

One-half the land is under grass and roots, and one-half under grain. A fourth of the land is manured every year. It was by means of this rotation, and by feeding sheep on the turnips where they grew that extensive tracts of poor light soils in Norfolkshire (from which this rotation takes its name) have been converted into most productive farms. The "golden foot" of the sheep consolidated the land and their droppings enriched it. Sheep-folding is not as general in Ireland as in England. Owing to the drier and warmer climate of Norfolk and other English counties in which this rotation is followed, barley is more generally grown in the second year of the rotation after roots than in Ireland. For the same reason the English farmer sows more red clover than the Irish farmer for the third year's crop. In all the warmer counties of England, too, wheat follows clover in the fourth year in the four course rotation not only because the climate is suited for wheat, but also because it is found in practice that wheat does exceedingly well after red clover. In Ireland, on the other hand, oats usually follows grass in the fourth year of the course.

The Norfolk four-course forms the basis of a great many other courses of cropping. It is on the whole well suited for a large number of the small farmers of Ireland. Two grain crops coming within four years are severe on poor land, of which so much is in the hands of small farmers, unless the roots are well manured. The small farmer who housefeeds his cattle and attends to the collection and preservation of manure is always able to apply a good dressing of dung to one-fourth of his land every year. This rotation is very simple, and simplicity is one of the most essential features of any rotation which is proposed for the instruction of the Irish farmers who are most in need of agricultural instruction.

It has been said that clover will not bear to be repeated on the same land every fourth year. Turnips, too, when grown on the same land every four years, become subject to a disease called *anbury*; and even the corn crops become more precarious when repeated on the land too frequently. Practical experience teaches that this crop-sickness is mitigated by efficient tillage and by the application of lime. It is also greatly mitigated, if not prevented, by keeping the same crop off the land as far as possible. Now, we can easily accomplish this in any rotation by alternating the several kinds of roots, grasses, &c., among themselves. Thus, supposing we have, this year, turnips in one part of a field, and mangold in another part, this time four years, when the same field is under roots again, the mangold should be put where the turnips are this year, and *vice versâ*. In this way turnips are not grown on the land oftener than once in eight years. In the same way, by alternating clover and rye-grass, the former comes round on the same land only once in eight years; and so on of other crops. This principle may be carried out still further. Thus the green crop field may be divided into three parts, and by shifting the turnips from one part to another they would recur to same land only once in twelve years; and in the same way, by dividing the grass-field into three sections, clover would not come round on the same soil oftener than once in twelve years. The farmer who tills well and manures fairly does not suffer from clover-sickness or turnip-sickness when these crops are not repeated oftener than once in eight years; but if from poverty of soil or any other cause, the crops show signs of degeneracy, the rotation may be extended in the way pointed out.

By allowing the grass to lie unbroken a second year, the Norfolk four-course is converted into the Northumberland five-course, in which the order of succession is—

1st Year.—Green crops manured.
2nd Year.—Grain, with grass seeds.
3rd Year.—Grass.
4th Year.—Grass.
5th Year.—Grain alone.

This rotation has been extensively followed in the county from which it takes its name, and in the more humid parts of England. The first year's grass is usually mown, and the second pastured. The second year's grass is never as heavy as that of the first; but the cost of the former per acre is less, as the seeds, which are expensive, fall on one year's grass in the four-course rotation. Now the relative profitableness of the first and second year's grass depends principally on the soil and climate. In a humid climate like that of the north of England, the second year's grass does very well on medium soils for pasturage. The climate of Ireland is humid, and, accordingly, this rotation has been pretty extensively followed on our medium soils. It is not suited to small farmers who house-feed their stock, as the second year's grass is not as profitable for soiling as the first; and if they require pasture for the cattle, the best plan, on the majority of the small holdings, is to keep a part of the farm in permanent pasture for the purpose, and to put the rest of the land under a rotation which would allow the land to remain in grass only one year.

By allowing the land to remain three years in grass, we get the following six course:—

1st Year.—Root crops, manured.
2nd Year.—Grain, laid down with grass seeds; the grain crop in this case being almost invariably oats.
3rd Year.—Grass, say for soiling or hay.
4th Year.—Second year's grass, for pasture.
5th Year.—The third year's grass.
6th Year.—Oats.

In this rotation one-half the land is in grass, one-sixth in roots, and one-third in grain. It would answer very well on lighter land than that for which the five course is adapted, and more especially for hill-side farms, on which the rearing of young stock is the principal object; that is, land which is too poor to bear two grain crops in five years. The roots of the grasses enrich the poor land and prepare it for a crop of corn. On hill-side farms a rotation of this kind, which lessens the area under tillage and gives a large proportion of grass for the rearing of sheep and horned cattle, answers very well. The carting of manure and crops in hilly districts is very expensive; and, besides, the climate of those districts is better adapted for grass than any other crop.

LESSON III.

The following six-course rotation has been extensively followed in East Lothian, whence it takes the name of the East Lothian Six-Course:—

1st Year.—Root crops manured, generally turnips.
2nd Year.—Grain, say barley, laid down with grass seeds.
3rd Year.—Grass.
4th Year.—Oats.
5th Year.—Potatoes and beans, manured.
6th Year.—Wheat.

For the first four years the order of succession in this rotation is the same as in the four-course. The oat stubble is then tilled for potatoes and beans, which prepare the land well for wheat. One-half the land is under corn, and each corn crop comes in the place best adapted for it. We have the most valuable farm-crops in this rotation. One-third of the farm is manured every year, namely, one-sixth for roots, and one-sixth for potatoes and beans. The recurrence of the same crop on the land only once in six years prevents crop-sickness. This is essentially a tillage rotation. It is practised in some of the best cultivated districts of Scotland. Probably the average rent of land in those districts is higher than in any other part of the United Kingdom. We have as good soil and climate in parts of Ireland as the climate of some districts in which this course of cropping is followed out.

When we find the five-course rotation successfully practised in the humid climate of the north of England, and this six-course in Scotland, there is no good reason why Irish farmers should not be encouraged to adopt either or both of these and other systems of tillage. The notion is very generally entertained that Ireland is unfit for tillage. The advocates of this theory say nature made Ireland a grazing country. It is true that nature gave the Irish farmer a climate which is, on the whole, peculiarly well adapted for the production of grass; but this peculiarity of climate is just as well fitted for the production of the grass crop of *tillage* as for the grasses of permanent pasture. As regards climate, Ireland can never compete with the east and south-east of England in the production of wheat; but that is no reason for abandoning tillage in Ireland. If it were, then, on the same ground, England should discontinue tillage, because she cannot compete with the foreigner in the production of that crop. Nature enables the Irish farmer to compete successfully with the English farmer in the production of root-crops which form the backbone of the rotation of crops. The climate of Ireland is well suited for the oat crop. It may, therefore, be stated that nature puts no obstacle in the way of a profitable system of tillage in this country.

There are many other rotations in use, but those which we have described are the most common. The adoption of any of them would effect a vast improvement in the circumstances of the small farmers of Ireland, very few of whom adopt any fixed system of cropping. The prevailing system on those small farms is to raise a crop of potatoes on the lea, and grow one crop of grain after another as long as the land will bear it, and then to "rest" the land by letting it run to grass for some years, after which the same round of cropping is gone over again. This may be characterized as an exhausting and ruinous system. It goes on the principle of starving the crop and exhausting the land, and ends by exhausting the scanty capital of the small farmer.

Flax can be introduced into any of the foregoing rotations. The precise place it should occupy in any rotation depends on several circumstances. When the object is to obtain a large crop of seed or a heavy return of coarse fibre, it is grown after a manured root crop. On the other hand, when fibre of good quality is required, it should not follow a manured root crop, but should come after the grain that succeeds the manured root crop, or the grain that succeeds grass. It may follow a manured root crop or potatoes on poor soils. Flax also follows grass occasionally, but it is not the best place for it, as a difficulty is experienced in converting grass land into a proper seed bed for flax. When attempted at all, the grass should be dug or ploughed very early. The land should not be too rich, nor yet too poor for the production of flax fibre of good quality. Flax should not, as already described, be grown at short intervals on the same land. The Royal Flax Society of Ulster does not consider it advisable to grow flax more frequently than once in ten years on land of average quality. Flax may be raised once in ten years, in a five-course rotation, as follows :—

1st Year.—Roots manured.
2nd Year.—Grain, with grass seeds.
3rd Year.—Grass.
4th Year.—Grain.
5th Year.—Part of the field, say one-half, is put under flax; the other part is cropped with something else

In the same way the period may be extended in any other rotation.

Grass seeds are sometimes laid down with the flax plant. It is not the best crop for the purpose; still excellent crops of grass are obtained in this way. When flax follows a manured root crop in the four-course rotation, we could have the following order of succession :—

1st Year.—Roots manured.
2nd Year.—One-half the field under grain laid down with grass seeds; the other half flax, laid down with grass seeds.
3rd Year.—Grass.
4th Year.—Grain.

In this rotation flax occurs once in eight years; and by putting flax in one-third of the field only, it would not occur oftener than once in twelve years.

SECTION II.

ROOT CROPS.

LESSON IV.

Crops with large fleshy roots are called root crops. The root crops best suited to the climate of Ireland are turnips, mangold wurzel, carrots, and parsnips. These are also sometimes called green crops, but it is better to restrict that name to crops like cabbage and rape, the leaves of which are used in the green state.

Root crops form the groundwork of all modern rotations of cropping. They require good tillage, which enables us to keep the land clean, and prepare it for other crops. When used on the farm a large quantity of valuable manure is produced, which enriches and improves the soil. Since the introduction of green crops, a greater number of cattle and sheep are maintained on a given area of ground than before; and as the roots are used in winter and spring, the farmer who uses those crops can keep a better description of stock than the farmer who relies on grass and fodder.

The proper place for root crops in the rotation is after grain, and the preparation of the ground for the former should commence as soon as the grain is removed. It is impossible to raise heavy and profitable crops of roots without good tillage. The two great objects of cultivation are, as already explained, first, to make the soil loose to as great a depth as possible, so as to present the greatest bulk of soil to the roots of crops, and secondly, to convert as much as possible of the substance of the soil itself into plant-food. We can effect these two objects most effectually by giving the land intended for root crops good tillage as early as possible in autumn. By this means we expose the soil to the full action of the winter's frost, which pulverizes and prepares it for the action of air and rain water, which are capable of liberating from it plant food. If the land contains *couch* or other weeds which creep through the soil, autumn is the best time to get rid of them. Experience tells us that a given amount of labour expended on eradicating those weeds in autumn is fully equal to three times the same amount of labour expended the following spring and summer. By exposing the soil early, too, to the influence of the winter's frost, many of the seeds of weeds, as well as eggs of insects, are destroyed.

The kind of cultivation which land should get in autumn, in preparation for root crops, depends on circumstances, such as the nature and state of the soil, the size of the farm, and the resources of the farmer. If the stubble is clean it should be ploughed deeply, and turned over into rough furrow-slices, commonly called sods in this country. Where spade labour is employed, the land should be dug to the full depth of the spade, and left in a rough state, with the sods inverted. If the land is infested with couch or similar weeds, they should be forked out; and where horse labour is employed, the ground should be grubbed so as to loosen the weeds, and afterwards harrowed, to assist in collecting them. When the weeds are removed the ground should be ploughed or dug as already described. The depth to which it is proper to stir the soil at this season of the year depends on its nature and condition, the kind of implements used, &c. There is little danger of its being too deeply tilled; on the contrary, the tillage is almost invariably too shallow. One of the improvements most urgently required in the tillage of land is increasing the depth of autumn cultivation for roots. In practice the average depth is about five or six inches; it should at once be increased to ten or twelve. The increased depth of tillage here suggested would give 50 per cent. more active soil for plants to grow in, and, in a few years, increase the produce in a corresponding degree. By deep tillage a less quantity of manure produces a given weight of crop. Ground once deeply tilled requires less labour in its cultivation ever after. The Marquess of Tweeddale has found that six horses after deep tillage are equivalent to eight horses before it. Land tilled deeply and well retains its moisture in the heat of summer, when shallow soils are parched. Deep tillage brings in the harvest early, and this is a strong reason for practising it in a country like Ireland, the humidity of which retards the ripening of crops, and makes it more difficult to harvest them.

The spade is the best implement that can be used for deeply tilling land in autumn in preparation for roots. The cost of digging an acre is, however, so much greater than that of ploughing, that the spade is not much used except by small farmers, who do not keep horses. It costs *3d.* per square perch (statute), or £2 per acre for digging stubble and only 15*s.* an acre for ploughing it, but the yield of crops is much greater after digging than ploughing. In one case we have six tons of mangolds more after the spade than the plough, and the land was left in a better condition for the succeeding crops when the spade was used. Why, then it may be asked, is spade labour not more generally used? The answer is, that the supply of manual labour is so limited and uncertain that the work could not be performed within the proper time. A good autumn ploughing does, however, prepare land for growing a profitable crop of roots; and the essential conditions of such a ploughing are, that it be done early and as deeply as the strength of the horses will permit. When the farmer has three horses they should be yoked to the implement "abreast," and it is not uncommon to see four or more horses yoked together, ploughing stubble land in preparation for roots. In this case the beam and body of the plough requires to be made extra strong, and the mould board should be thicker and a few inches higher than usual.

Sometimes farmers run an implement called a subsoil-plough, drawn by two or more horses, according to the nature of the land, in the furrow made by the common plough. This operation, which requires at least four horses, is called subsoiling, and consists in smashing up the subsoil without mixing it with the surface soil. When, on the other hand, a plough drawn by three or more horses penetrates below the surface soil, and some of the subsoil is brought up to, and mixed with, the surface soil, the operation is called trench-ploughing.

When the subsoil contains nothing injurious to plants, trench-ploughing is preferable to subsoiling, because fresh material is added to the soil, and the matter so added must contain some of the ingredients which, in the course of time, have been washed down from the surface soil into the subsoil. Land should be drained twelve months at least before subsoiling it. If cold clay subsoils are stirred before drainage, they become more unmanageable and unprofitable than before.

LESSON V.

The land intended for roots, after being ploughed or dug in autumn, is left in that state till spring, and the treatment it receives in the latter season varies with the nature of the soil, the kind of implements used, and other circumstances. The most common practice is to cross-plough the land in spring, and to follow this up by harrowing, rolling, and weed picking, until the land is reduced to a sufficiently fine and clean state for the seed. Sometimes the land is ploughed twice in spring before commencing to pulverize it with the harrow and roller; but as a rule, one cross-ploughing (or ploughing across the direction in which the land was ploughed in autumn) is enough.

No rule can be laid down as to the number of harrowings and rollings necessary to reduce the soil to a sufficiently fine seed-bed; but it may be stated as a rule, which admits of no exception, that it is impossible to grow profitable crops of roots unless the soil is reduced to a fine state for the seed. When green crops are sown in rough or cloddy ground the bulbs become forked and deteriorated in value. In roughly prepared soil too, a large proportion of small seeds, such as the seed of turnips, &c., do not vegetate at all, particularly in dry seasons, or in other words, the crop partially fails. A little extra labour is therefore well expended in pulverizing the ground for the seed of green crops. The farmer is also amply repaid for labour judiciously expended on cleaning the land before the seed is sown. A given quantity of labour expended at this time in removing couch and troublesome root-weeds may, as already stated, be as efficacious as three times the same labour applied afterwards.

When the soil is infested with annual weeds, it is sometimes harrowed at the opening of spring and before cross-ploughing, so that the seeds would grow, and a crop of the weeds be destroyed in ploughing and harrowing the ground afterwards.

The grubber is now very generally used in the spring cultivation of land for roots; thus, instead of cross-ploughing the land in spring it is grubbed. In some cases cross-ploughing is better, as it more effectually helps to break the sods turned over in autumn. On the other hand the grubber has several advantages over the plough. In the first place a pair of horses could grub three statute acres in a day, where they could not plough more than an acre. In cross-ploughing we bury the fine mould produced by the winter's frost; whereas the grubber leaves it on or near the surface, and within reach of the roots of the young plants where it is so useful to them. And, again, the grubber helps to loosen the weeds, and thus facilitates the cleaning of the ground.

Root crops are grown in rows or drills, the distance between the rows, or, what is called the width of the drills, depending on the nature of the ground, the kind of crops, &c. The rows should be closer in poor than rich land; for the better the soil, the larger will each plant grow, and of course the more space it requires. When on good land, highly manured roots are allowed too much space they become soft and spongy, and less valuable, and a given weight of them possesses less nutriment than an equal weight of smaller roots. This is especially true of the softer kinds of turnips. On good land, well farmed, it is supposed that the best crop (that is the crop which gives the greatest quantity of nutriment from a given area of land) is obtained by making the drills about thirty inches asunder, and the plants to stand from twelve to fifteen inches apart.

On poor land the drills should be made wide enough to enable us to use the implements required in the after cultivation of the crops without injuring the plants. The rows or drills, are made either on the flat surface, or the soil is formed into raised drills. As raised drills present a greater surface for evaporation, and as a deficiency of moisture is one of the difficulties in growing roots in parts of the south and east of England, where the soil is light and the climate dry, flat drills are preferred. In Ireland, in the north and west of England, and in Scotland, root crops are almost universally grown in raised drills. The drills are formed with a common plough, or a double mould-board plough, which, as the name denotes, has two mould boards.

LESSON VI.

Root crops are always manured; and the kind and quantity of manure used, and the modes of applying it, vary with the soil, climate, and system of farming pursued. The best manure for roots is good farmyard manure, and of this we generally apply from twenty-five to thirty-five tons per statute acre. It is sometimes applied in autumn immediately before ploughing the land. Autumn manuring has many advocates. It distributes the labour of carting between autumn and spring, and it is said that as the manure has time to decompose in the ground before spring, its constituents are distributed through the soil, and available for the plants as soon as they begin to grow. The practice is a good one on good strong land which has the power of absorbing and retaining the constituents of the manure as they are liberated by decomposition; but it is not equally, if at all safe, on light land through which the heavy rains would probably wash some or all of those constituents. The farmer seldom or never has enough of farmyard manure for all his green crop land in autumn. The more universal practice, therefore, is to apply the manure in spring.

All our root crops require well rotted manure. It is impossible to grow carrots or parsnips unless the manure is well decomposed; and the better decomposed the manure we apply for mangold wurtzel or turnips, the greater our chance of obtaining a large crop of well-shaped bulbs.

As soon as the drills are formed the manure is carted on the land, and evenly spread in the bottom of the drills. The manure is then covered by splitting the drills, after which the seed is sown.

Good crops of roots are often raised by the use of artificial manure, such as guano and superphosphate of lime. When there is no farmyard manure, the artificial manure is used alone, at the rate of from three to four cwt. of Peruvian guano or six cwt. of superphosphate per statute acre. When there is some but not enough farmyard manure, it is better to use artificial manure in conjunction with it, than to apply them separately. In this case the farmyard manure is applied as before, and after it is half covered in by splitting every alternate drill, the artificial manure, broken as finely as possible, is spread on the farmyard manure, and both are then covered by splitting the remaining drills.

When artificial manure is used alone, it may be applied in the same way, or at the back of the earth turned over as the drills are being formed, taking care that it shall be near to, but not come into actual contact with, the seed.

The proper time for sowing any farm crop varies with circumstances, such as the nature of the soil and climate. In the north and west of Ireland crops cannot be sown so early as in the warmer districts of the south and east. Sandy, calcareous, and other soils of a similar description, not only admit of being tilled earlier than those of a cold or clayey character, but vegetation commences earlier in the former than the latter.

The following dates may be taken as the best time for sowing root crops in good loamy soils, in the eastern and midland counties of Ireland. Mangold wurtzel from 20th April to 10th May; Swedish turnips, as soon after the mangolds as practicable, or say from 10th to 20th of May; yellow turnips from 1st to 20th of June; white turnips from 1st to end of July.

The parsnip is the hardiest of our root crops. It is even so hardy that it has occasionally been sown in autumn. The usual practice is, however, to sow it in the month of March, or as early in spring as the land will admit of being properly prepared for the reception of the seed.

The carrot usually receives the same treatment as the parsnip, and is in some districts sown about the same time; but as it is more liable to be injured by frost, and more disposed to run to seed, it is not unusual to defer the sowing of it for about a fortnight after the parsnips.

The quantity of seed sown per acre will vary, not only with the soil and climate, but with the quality of the seed. It is more prudent to sow too much than too little; indeed the seeds of our root crops suffer so materially from bad weather, and the mode of saving them, and are besides so frequently adulterated that we feel justified in recommending the following quantities per acre, viz.:—

Mangold wurtzel,	6 lbs.
Swede turnips,	5 „
Yellow and white turnips,	6 „
Carrots and parsnips, from	6 to 8 lbs.

LESSON VII.

The seed of green crops is usually sown by hand on small farms, and by machinery on large ones. Turnip seed is sown in a continuous stream on the top of the drill, in the following manner:—The drills are rolled with a light roller; a boy follows, and with a pointed stick or corner of a hoe makes a rut, the depth of which is generally about an inch; a second boy deposits the seed with his fingers in the rut thus made, and a third covers the seed with a rake or the back of a shovel, taking care that the finest mould is put about the seed. The drills are then rolled, or their tops are beaten down with the back of a spade or shovel, so as to keep the moisture, which is so necessary for germination, about the seed.

When turnip seed is sown by a machine a quantity of earth falls in from the brows of the ruts made by the coulter, which, in the opinion of many farmers, is a sufficient covering for the seed; and for the same reason the drills are not in such a case always rolled after the seed is sown. In moist soils and humid climates this answers very well, but in dry soils and warm seasons it becomes necessary to cover and roll the seed carefully, so as to retain about it sufficient moisture.

Mangold seed is sometimes sown like that of turnips, in a continuous stream on the top of the drill; but the safer and more usual way is to sow it at intervals of from ten inches on poor land to twelve or fifteen inches on good land. In this case holes are made with the corner of a hoe; a number of seeds (or capsules, which contain the seed) is sown in each hole, and covered in with the finest mould; and finally the drills are rolled or beaten down as before.

Carrot and parsnip seed may be sown in the same way as turnips or mangold; as the former seeds take a long time to germinate it is usual to keep them in a warm place, and in a moistened state, for at least a week before sowing. These seeds adhere to one another so closely that it becomes necessary to mix them with sand or fine sawdust, in order to facilitate the sowing.

The tillage given to green crops from the time of sowing the seed until they are lifted, is by farmers called their "after cultivation." This consists in thinning the plants when they become so large as to interfere with each other's growth, and in tilling the spaces between the rows or drills, so as to loosen the soil and keep down weeds.

Turnips are thinned when the "rough leaf" (that is, the second leaf which the plant throws up) is about three inches long, and mangolds when about the same size. Mangolds, owing to the uncertainty of the growth of the young plants, are generally thinned twice, the first being made when the leaves of the plants are three or four inches long, two or three plants being left in each clump, the best of which is retained at the second thinning. Many good farmers also thin carrots and parsnips twice.

The kind of tillage given to green crops, in their after-cultivation, varies with the nature of the soil, and the sort of implements used.

When horse labour is employed the ground is worked by a drill grubber and drill harrow, and in addition to the work of these implements the surface of the ground is loosened and weeds destroyed by hand-hoes. No rule can be laid down as to the number of drill-grubbings, drill-harrowings, and hand-hoeings which the land requires, so much depends on its quality and preparatory cultivation.

The two great objects to be kept in view are to keep the soil loose, so as to enable the plants to grow freely in it, and to keep down weeds, which exclude air from the soil and abstract from it materials which would otherwise go to nourish the crop.

On small farms, on which horses are not employed, the after-cultivation of root crops consists in digging or forking the spaces between the drills, and hand-hoeing as before to loosen the surface of the drills and keep down weeds.

The fork is preferable to the spade for this purpose, and if the land be properly prepared in *autumn* and spring, a couple of forkings and two or three hand-hoeings will be quite enough.

It may be stated as a rule, that in the after-cultivation of roots, ground in a wet state should neither be grubbed, forked, hoed, or otherwise tilled. Any blanks that occur in the drills from failure of seed, insect injuries, or other causes, should be filled up by transplanting the best of the superfluous plants taken out in thinning. Mangold wurtzel and Swedish turnips give a very fair yield when transplanted. Cabbage plants, which grow with greater certainty, may be used with more safety for this purpose, and are often planted when and where transplantings of Swedish turnips fail.

As soon as the young turnip plants appear above ground they are often attacked by a beetle (*altica nemorum*) commonly but erroneously called "the fly." The turnips in a whole field or farm and even county have been often destroyed by this pest. It does more harm in the dry climate of England than in the humid climate of this island. Rolling offers some resistance to the ravages of this insect; but the best means of saving a crop is to have the soil reduced to a fine state before sowing the seed, to use liquid manure, or some Peruvian guano, or superphosphate of lime for forcing on the plants rapidly, and to sow plenty of seed.

If the crop be attacked afterwards, it is a good plan to dust the plants with quicklime, or a mixture of lime and soot.*

LESSON VIII.

The proportion of the ground intended for roots to be put under carrot, parsnips, mangold wurtzel, and the several kinds of turnips, respectively, depends on the nature of the soil, the proximity of the farm to a large town or city, system of feeding stock pursued, &c. Parsnips should be grown in this country only for human use, as they do not yield so large a quantity of nourishment for live-stock as other roots. Red carrots, like parsnips, should be raised only where, as in the neighbourhood of large towns and cities, they can be sold at a high price in the market. White Belgian carrots are raised for feeding horses in the proportion of from half a rood to a rood, for every horse kept. They agree well with the constitution of the horse, and when given in moderate quantity in winter and spring help to keep

* The following mixture has been recommended by Mr. Fisher Hobbs.—For one statute acre mix and dust over the plants :—

½ bushel white gas lime.
¼ bushel fresh lime from the kiln.
3 lbs. sulphur.
5 lbs. soot.

his coat and condition healthy; but carrots are not nourishing enough to become the sole or principal food of a hard wrought horse.

Mangold wurtzel and the different sorts of turnips are raised principally for feeding cattle and sheep. An occasional meal of mangolds or turnips is given to horses, and they are also given to pigs with other food; but the great bulk of the turnips and mangolds raised in these countries is consumed by cattle and sheep.

Comparing the same weights of turnips and mangolds, it appears to us that their relative merits vary according as we want to produce milk or beef and mutton. According to experiments a given quantity of mangold wurtzel produces more milk than the same weight of Swedish turnips; and the butter from the former has a better flavour than that from the latter.

On the other hand, for fattening stock, we think a ton of Swedes is rather more valuable than a ton of mangolds; but much depends on the soil and climate. Mangolds require a warmer climate and a deeper and richer soil than turnips. In the south of England farmers can grow thirty tons of mangolds as easily as twenty tons of turnips per acre; whereas in Scotland the average yield of turnips is greater than of mangolds. In the county of Dublin mangolds give from five to ten tons of roots per statute acre more than Swedish turnips. In the north and north-west of Ireland, on the other hand, owing to the climate, Swedish turnips are more certain than mangolds.

The three kinds of turnips grown, are Swedish, yellow and white. Of those the Swedish is the hardiest, most nutritious, and gives the greatest amount of nutriment per acre. Yellow turnips are next in value, and common or white turnips the least valuable of all.

For fattening purposes a ton of Swedish is equal to about a ton and a half of yellow, and about two tons of white turnips; for the production of milk the difference is not so great. The dates of sowing the three kinds of turnips are in the order of their feeding value; but white turnips, though sown last, arrive at maturity first, and the yellow are ripe before the Swedish turnips.

White being inferior to yellow, and yellow to Swedish turnips, it may be asked why the two first are grown at all. The answer to this question is that each of the three kinds of turnips has its own peculiar merits. Thus the white turnip while less nutritious and more perishable than the others, grows so rapidly that it admits of being always sown after a stolen crop of vetches, and becomes fit for use before Swedish or even yellow turnips. Again, if from unfavourable weather the ground cannot be prepared in time for Swedes, the farmer can fall back upon the yellow, and is thus enabled to obtain from his land a quantity of valuable roots even in adverse seasons. Vetches sown early in autumn as a stolen crop between grain and roots are also off the land in time to be followed by yellow turnips. The sheep farmer, too, finds it necessary to grow some of the softer kind of turnips, as they agree with the sheep better than Swedes at particular times, such as the lambing season, when the use of Swedes is apt to bring on inflammation of the bowels. Neither white nor yellow is, however, an adequate substitute for Swedish turnips as a main crop, more particularly for fattening purposes.

As root crops are easily injured by frost they should be lifted and stored as soon after the bulbs have come to maturity as possible. Mangold wurtzel is most easily affected, and should therefore be stored first; and the long red variety, which grows so much out of the ground, is more susceptible of injury than the globe variety. Carrots and parsnips are stored after the mangolds, and Swedish turnips last of all. Swedish turnips bear frost better than any other root crop; indeed a slight frost does them no harm, but a severe frost ruptures the cells and induces decay in this as in all other roots. Aberdeen or yellow turnips bear frost better than common or white turnips. On some farms the quantity of white turnips raised is so small that they are all consumed before frost sets in. Some large farmers, particularly sheep farmers, do not store turnips at all, and allege that the cost of storing makes it unprofitable. It often happens that when turnips are not protected in some way or other one-half the crop rots, and the half that remains is greatly deteriorated. When the intention is to consume turnips by sheep where they grow, a common and simple way of protecting them is to run the plough between the rows, for the purpose of raising earth on the bulbs. This is by no means an effectual mode of protecting roots against frost, and should be resorted to only where they are to be consumed within a short time. Another and better plan is to lift the roots off every third, fourth, or fifth row, and to hollow the drill into V shape, by giving one turn of a double-harrowed board plough, or two turns of a common plough, to throw the roots of three, or four, or five drills, as the case may be, into the hollow so made, and to cover the roots by going round them with a common plough, and using the spade or shovel for covering any root which may escape the plough.

Neither of the foregoing modes of protecting roots is as safe as storing them in regular pits or heaps. The site of the pit should be dry and free from vegetable matter, and if elevated a little above the adjoining gound so much the better, because the roots rot in the bottom of a pit in which water lodges; and once decay commences in one part of a heap of vegetable or animal matter of any kind, it soon spreads, in accordance with the well known laws of decomposition.

By surrounding the pit with a small open channel, having a sufficient fall to carry off the wet, the roots in the bottom are kept dry and sound.

The pit or heap is usually made Λ shape. Its width should not exceed four feet, nor its perpendicular height five feet, for roots heat and rot soon in large heaps.

Sometimes roots are stored against a stone wall. In either case the heap requires to be covered with thatch to the depth of from six to twelve inches, according to the kind of crop and severity of the climate. Mangolds, carrots, and parsnips require more thatch than Swedish turnips. As the straw used in thatching roots will be fit only for bedding stock afterwards, the worse should be selected for the purpose.

When sand or dry peat mould can be conveniently had, it is desirable to mix a little of either with carrots or parsnips, in the heap. These materials absorb moisture from the roots, and thus help to preserve them longer. A little extra labour expended in this way in preserving such valuable roots as carrots and parsnips amply repays the farmer.

SECTION III.

GREEN CROPS.

LESSON IX.

The cabbage (*Brassica oleracea*) is grown as a field crop for cattle feeding, but not to the extent which it should be. This plant is exceedingly hardy, and differs from almost all other crops in this, that it admits of being sown at all seasons of the year. It takes its place in the rotation along with the root crops, or is grown as a stolen crop. According to chemical analysis, it is more nutritious than turnips or mangolds; and on deep loamy soil gives a greater acreable produce than any other green crop. The cabbage does not, however, keep as long as turnips or mangolds; in no case, therefore, can it altogether supersede these crops. Near large towns and cities it is a very profitable crop, and is therefore extensively grown by market gardeners.

This crop can be raised by sowing it in the same way as turnips, mangolds, and other root crops; but as the young plants grow very slowly, the more usual and correct practice is to sow the seed in the first instance in a well prepared bed, called a seedling bed, and to put out the plants afterwards, or "transplant" them, as it is called, in rows or drills. In this case the ground is tilled, manured, and drilled in the same way as for turnips and mangolds. The width of the drills varies with the kind of cabbage, and, as in the case of other crops, with the quality of the ground. On rich land, Flat Dutch and Drumhead cabbages, the two principal kinds grown for cattle feeding, require the drills to be from two and a half to three feet wide, and the distances between the plants along the drills should not be less than two feet. Savoy, Nonpareil, York, and other small-headed varieties grown as field crops for cattle feeding, require drills of the same width as turnips and mangolds; and the distance from plant to plant along the drill should be about eighteen inches.

If cabbage seed be sown in a well prepared seedling bed in August, and the plants transplanted in April, the crop will come to maturity in the ensuing autumn. If the seed of Nonpareil and similar varieties be sown in the end of summer, and transplanted in the end of autumn, the crop will be ready for use in the end of spring, when cattle feeding is generally scarce. By sowing the seed in the end of spring, and transplanting in the end of summer—for instance, after early potatoes—the crop will be ready for use about Christmas.

Three ounces of seed will sow a square perch of a seedling bed, and give an adequate supply of plants for an acre of ground.

The produce of flat Dutch or Drumhead cabbage on good rich land is often forty tons per statute acre, and sometimes more.

Rape belongs to the same genus or tribe of plants as cabbage and turnips, and is grown in this country almost exclusively for its succulent leaves and branches and stem, which are used in a green state for feeding cattle and sheep. In some parts of England, such as the fens of Lincolnshire, and in several parts of continental Europe, rape is raised for its seed, from which colza oil, and the well-known feeding substance, rape-cake, is obtained.

There are several species of rape, and of these only two are grown in these islands, namely, summer rape (*Brassica campestris oleifera*), and winter rape (*Brassica rapus*). Summer rape (named also wild navew and colza), is so called from its being supposed to be better adapted for use in summer or autumn than spring. It is also said to be better for the production of oil than winter rape. In the young state the two varieties are easily distinguished by their leaves, those of the summer rape being smoother or freer from hairs than the leaves of the winter rape. As they advance in growth the leaves of both kinds resemble one another. These two species of rape are like the cabbage, turnip, and other root crops, biennial; that is, they perfect their seed in the second year. When raised for seed, therefore, rape remains in the ground a second year, but when raised for feeding cattle or sheep, rape sown in spring is used in autumn, and when sown in autumn it is used the following spring and summer.

Rape is raised direct from seed, or transplanted like cabbages, and is, like the latter, very hardy, and admits of being sown at almost all seasons of the year. Under favourable circumstances, too, it gives two or more cuttings in the year, but it is not safe to depend on more than one cutting.

Rape may be sown for feeding purposes as a principal crop or a stolen crop. As a principal crop it is inferior to turnips, mangolds, and cabbages; but as a stolen crop, it is most invaluable in several situations. It is excellent feeding for sheep at two periods of the year, namely, at the tupping and yeaning seasons, or when the grass begins to fail in autumn, and before the fresh grass is available in spring.

Rape is useful for cattle feeding, too, at these seasons; that is, in autumn, before roots are fit for use, and in spring, when roots run short and the grass is not yet ready.

It is grown as a stolen or "catch" crop between corn and roots in any of the ordinary rotations. The ground is ploughed and harrowed, the weeds collected (if there be any), and the seed sown broadcast, or in rows, either on the flat or in raised drills. The drills are sometimes made as wide as for root crops; but this is quite unnecessary unless when the crop is raised for seed. When sown as a catch crop the drills should not be more than eighteen inches asunder, and at this distance five or six pounds of seed will be enough for a statute acre. When sown broadcast, ten pounds of seed are required. Sometimes the crop is transplanted, the same as cabbage; and not unfrequently the plants are dropped in every second or third furrow as the land is being ploughed, and covered in by the sod which follows. This is a ready way of planting rape, and answers extremely well in autumn, when other work is pressing. The plants grow in drills, which admit of horse and hand-hoeing.

The produce of an acre of rape raised in this way, with the aid of a moderate quantity of farmyard manure, superphosphate, or Peruvian guano (when necessary), varies from eight tons on light to twenty tons and upwards on good land.* It gives a good return on a great variety of soils. It is found to yield upwards of ten tons of leaves on the poor soil of the farm attached to the Royal Agricultural College which is situated on the Cotswold hills. It is a very profitable crop on reclaimed bog or fen land. In the fens of England it is, according to the testimony of Mr. Clarke, sometimes so productive as to carry twenty sheep per acre for twenty weeks. It would be found a profitable crop on bog land in Ireland, too, not only for feeding stock but also for seed. In the improvement of tenacious clayland it is also a useful crop, yielding, not only a fair return, but loosening the soil by its strong growing roots.

SECTION IV.

THE POTATO.

LESSON X.

The potato *(solanum tuberosum)* has long occupied a prominent place in Irish agriculture. The tuber or edible part of the plant is an expansion of the underground part of the stem, and not of the root, as is commonly supposed. It is not, therefore, correct to call it

* In one season the yield of a stolen crop of rape grown on the Albert Model Farm was at the rate of 25 tons per statute acre.

a root crop; and as no part of the plant is used in a green state, it is equally inaccurate to call it a green crop.

The potato is the most valuable esculent we possess, and ranks second only to the grain crops for human sustenance. There is not, perhaps, any other crop raised in this country so agreeable to the palate, so easily digested by the stomach, or so conducive to the health of man, which gives an equal quantity of nutriment from a given area of land. The tuber, however, contains so much water, and the flesh-forming constituents bear so small a ratio to the heat-givers and fat-formers, that it should not form the sole diet of any people.

The potato can be grown on almost all soils; but those of a light and friable texture, in which the tubers can grow freely, are naturally best suited to the crop. Dry land of this description yields potatoes of the best quality for table use; but rich loamy land gives the greatest produce. The potato is usually the first crop raised on bog and other land undergoing reclamation; it often yields a good return when no other crop would thrive, and the tillage and manure it receives prepare the ground for some other crop.

The potato may occupy any place in the rotation. It is frequently grown in the same field as roots; and very commonly follows grass.

On dry land the best way of growing potatoes is in raised drills. When potatoes and roots are grown in the same place in the rotation, the preparatory tillage is alike for both, except that the same degree of pulverization is not required in the surface soil for potatoes, as for the small delicate seeds of roots.

The ground being reduced to a sufficiently fine state by cross-ploughing or grubbing, harrowing, and rolling when necessary, is made into drills, from twenty-seven to thirty inches wide, according to the variety and richness of the soil, manure is applied, the seed is placed over the manure, at distances varying from ten to twelve inches, or more; and both manure and seed are then covered by splitting the drills. The after-cultivation on large farms consists in breaking the surface of the drills with a "saddle-harrow" or fork, when the young plants have grown half way towards it; drill grubbing and harrowing, and hoeing, to loosen the soil and keep down weeds, and in putting earth or mould up against the plants. The object of moulding the plant is to increase the extent of the under-ground part of the stem, on which alone tubers grow. Potatoes should be moulded at least twice; namely, when the plants are four inches or so above the surface, and again when about half their full size. Potatoes are sometimes planted in every third furrow as the land is being ploughed; the sods being nine inches wide, the plants grow in rows or drills, twenty-seven inches apart. The after-cultivation consists in harrowing the ground when the young plants are half way to the surface, to enable them to rise without injury; drill grubbing and harrowing, and hoeing and moulding, as before. This mode of growing potatoes is wholly unsuited to cold clay or bog, or wet land of any kind, and is admissible only on hilly land, where the expense of the raised drill would be excessive, or in parching localities, where raised drills would present too great a surface for evaporation.

The small farmers of Ireland commonly plant potatoes in beds, sometimes called lazy-beds. The ground is ploughed in narrow ridges or beds of about six sods each, and as the sods are usually nine or ten inches wide, the beds are about four and a half or five feet wide, and the furrow eighteen or twenty inches. Sometimes the manure is spread on the surface before ploughing, but the more common practice is to apply it on the ploughed surface after it is levelled by the harrow, or, as in the case of lea, a hand implement like an adze, specially made for the purpose. The seed is dropped on the manure in regular rows across the ridges, the rows being from sixteen to twenty inches apart, and the seed being nine or ten inches asunder in the rows, and half this distance from the brows of the ridges. The earth in the furrows is then loosened by the plough or grubber when horses are employed, and by hand on small farms, and is shovelled on the ridges to cover the seed. When the plants appear three or four inches above the surface they are moulded, that is, more earth is shovelled from the furrows over the ridges. In moulding potatoes the shovel must be used with care, so as not to injure the plants. The further cultivation of lazy beds consists in forking, across the ridges, the spaces between the rows, hoeing and weeding as often as necessary; and in giving the plants a second moulding when half grown, by forming the surface into raised drills, at right angles to the direction of the ridges.

This mode of growing potatoes in drills across the ridges, has many advantages over the common practice of planting them irregularly over the surface. The one possesses many of the advantages of the ordinary mode of drilling already described; with the other it is impossible either to till the spaces between the plants or keep down weeds.

On wet or unimproved land the lazy bed is the best system of growing potatoes; the furrows carry off the superfluous water and keep the soil dry about the roots and tubers. By the lazy bed system, too, some of the subsoil is brought up to and mixed with the surface soil, and thus the ground is partially trenched.

LESSON XI.

The potato is propagated from its tubers, while all other farm crops are raised from seed. The potato, can be, and is occasionally, raised from seed; but the tubers do not usually grow bigger than good sized marbles the first year. If the tubers obtained from seed, called "seedlings," be planted the year after, they produce tubers of a larger size, and if these be again planted, full sized tubers can be obtained in the third year.

Another peculiarity of potatoes raised from seed is that they are liable to "sport" or change; that is, we may obtain from the same seed tubers differing in shape, colour, and quality. It is in this way that new and improved potatoes are usually obtained, and the necessity for producing new varieties is rendered most manifest by the circumstance that varieties begin to show symptoms of degeneracy after they have been fifteen or sixteen years in use.

Each eye of a potato tuber contains a germ capable of producing a plant. It is, therefore, usual to cut seed potatoes into "sets;" and in order to avoid misses, each set should contain two eyes. The whole tubers are sometimes planted, but this is not only unnecessary, but the stalks are so numerous that the tubers never grow to the full size. Planting whole seed is admissible only when the tubers are small, and desirable only when the ground is particularly rich, and the farmer wishes to grow tubers of moderate size.

It is worthy of remark here that the germs at the top or "rose" end of a potato have quicker powers of growth, and produce plants which arrive at maturity sooner, than those at the lower or "root" end. Thus, if the sets from the rose ends of a quantity of potatoes be separated from the sets at the lower end, and the two lots be planted side by side, the one will arrive at maturity a fortnight earlier than the other. By taking advantage of this interesting fact, we can make any variety of potatoes late or early, and thus to some extent suit it to a given soil and climate.

The seed should be changed occasionally. Reclaimed bog or moory land gives the best seed potatoes. It is well to bear in mind in reference to all crops that a change of seed does not necessarily require or render it desirable to change the variety.

About 100 stones of potatoes of average size cut into sets will plant a statute acre.

Potatoes may be classed into early, late, and intermediate. Potatoes required for use in June, require to be planted before Christmas, and to be well covered to protect them from frost; those required for use in July and August should be planted not later than February, and the late varieties should be planted in March or the beginning of April. Before the famine, the main crop of potatoes was not sown in Ireland till May; but it is found now that a crop sown so late is liable to suffer more from the "blight" than if sown in February or March.

There is a greater number of varieties of the potato than of any other farm crop; and of these the farmer should select the kinds best suited to his soil, climate, and market. Potatoes grown for seed are lifted before they are fully matured; but if lifted too soon they shrivel up and are not so valuable afterwards. The bulk of the potato crop requires to be stored and is not lifted until the tubers are fully matured, which is known by the withered appearance of the stems.

SECTION V.

LEGUMINOUS CROPS.

LESSON XII.

Beans and pease are the principal leguminous crops grown in these countries. They are raised both in the garden and farm. In the garden the seeds are gathered by hand; hence the words legumes and leguminous (from the Latin *lego*, to gather), as applied to those crops.

Beans and pease are raised principally for their seed, which is contained in pods; the straw or stalks (called also haulm) is used for feeding cattle and for litter.

The *bean* (*faba vulgaris*) is, like wheat, best adapted to strong clay land. It is extensively grown on the strong clays or carses of Scotland, as well as in the clay-land districts of England. In Ireland we had last year about 14,000 acres of beans, nearly one-half of which may be said to be grown in Leinster, and the other half in Ulster; Connaught contributed only 30 acres, and Munster 1,000. The acreable yield of beans is about the same as of wheat.

The seeds of beans contain about twice as much flesh-giving material as the seeds of wheat; but the latter contains far more heat-giving material. Beans being so rich in the substance of muscle, are used in feeding the hard-wrought dray-horses of cities and large towns; but they are too heating to be given alone.

The bean is cultivated in several ways, according to its place in the rotation and other circumstances. In the East Lothian six-course rotation it occupies the same place as the potato, and the ground is tilled and manured in the same way for both crops. Sometimes the bean is, like the potato, introduced into the same place in the rotation as roots. In this case, too, the ground is tilled, drilled, and manured in the same way as for potatoes. Sometimes, again, the bean follows grass, and on good strong land it is grown after wheat.

The most perfect way of tilling this crop is the East Lothian plan of growing it in raised drills, about twenty-seven inches wide, the same as potatoes. After the manure is spread in the bottom of the drill the seeds are deposited over it by hand or by a bean harrow, at the rate of two and a-half bushels per statute acre;* seed and manure are then covered in by splitting the drills. The after cultivation consists in drill-grubbing and harrowing, putting earth up against the plants with the plough, and hoeing and weeding.

Beans are also sown with the drilling machine on the flat surface in rows from fifteen to eighteen inches asunder. When the crop is raised without farmyard manure, and the ground rich and clean, this is a very good way of growing it; but the East Lothian plan has the advantage of enabling the farmer to till, clean, and manure the land the same as for a root crop.

In the north of Ireland and elsewhere beans are often sown broadcast. The ground being ploughed, and harrowed when necessary, the seed is scattered by hand, at the rate of four bushels or more per statute acre, and covered in the same way as corn. Very heavy crops have been obtained in this way on the clay lands of Antrim.

* The seeds of the different varieties of beans vary very much in size; and as more seed is contained in a bushel of small than of large grain, the quantity of seed varies with the variety.

An expeditious way of sowing beans is to drop the seed either by hand, or an apparatus attached to the plough, in every second or third furrow as the land is being ploughed. The plants grow in rows, the space between which can be grubbed and hoed, etc., as before.

The spring varieties of beans are sown from the 1st February to the middle of March. The variety known as Russian or winter bean is sown in October.

The bean crop should be cut with the common reaping-hook or sickle when the upper part of the stalk as well as the leaves and pods acquire a brown leathery appearance, when the seed separates easily from the pod, and the scar (*hilum*) left on detaching the seed becomes black. In Ireland the crop is not cut in time, and the result is, that a good deal of the seed is shed in harvesting it, and the straw is rendered almost useless for feeding purposes. Scottish farmers generally cut the crop at the proper time, and report highly of the feeding quality of the straw.

The crop being reaped at the proper stage, and the weather fine, it is allowed to remain a day or so in the swath, after which it is bound with oat straw into sheaves and stooked; and when sufficiently seasoned in the stooks it is carried to the haggard and stacked.

The bean is in this climate subject to many casualties, which render it a precarious crop. It suffers severely from the attacks of insects, one of its most destructive enemies being a species of aphis (*aphis fabæ*), commonly called "black dolphin fly" or "collier," which in certain states of the weather is propagated with great rapidity, and soon destroys the plants, by eating off the upper soft leaves, when the pods are beginning to swell. The only remedy we know is nipping off by hand the tops of the plants as soon as the insects are detected on them.

The *pea*, like the bean, belongs to the tribe of leguminous plants. It is divided into two classes, namely, common garden pea (*pisum sativum*), the seed of which is white, and field, or gray pea (*pisum sativum arvensis*), the seed of which is of a grayish colour. In Ireland the pea is not extensively grown as a field crop, as it is found very precarious. The range of soils suited to its growth is very limited. It thrives best on light calcareous soils, such as those on the chalk formation in England, and can scarcely be raised with profit on any other. Unless the soil be peculiarly favourable to their growth, pease encourage weeds, and should not, therefore, be grown before or after a crop with a like tendency.

Pease may be sown broadcast or in drills. The drill system is preferable, as it enables us to hoe the ground and keep down weeds. The width of the drills varies from six to twelve inches according to the condition of the ground, and the average quantity of seed is about three bushels per statute acre. The seed should not be deposited more than three or four inches beneath the surface. If the farmer cannot procure a drilling machine, the ground, when duly prepared, may be ribbed, the seed scattered broadcast, and covered in with the harrow; the crop will then grow in rows. On clean land, the seed is sometimes sown broadcast, like corn.

The best time for sowing pease in this climate is the beginning of March, but the crop may be sown any time from the end of February to the end of March.

When, from any cause, the pea appears thin or unpromising, the ground should be ploughed up, and some other crop put into it.

Sometimes a mixture of two-thirds beans and one-third pease is sown. The beans support the pease; and, it is said, beans rarely suffer much injury from the black dolphin when peas are mixed with them. The seeds of beans being much larger than those of pease, the two can be easily separated by a riddle.

Pease are cut with the hook or sickle at the same stage of growth as beans. Freshly-cut pease being very apt to heat are not usually tied into sheaves for about eight days after reaping. When bound, the sheaves, if dry, are removed to the haggard and stacked; if not, they are made into stooks until they can be stacked with safety.

A good average crop of pease yields thirty barrels of seed per statute acre.

SECTION VI.

GRAIN CROPS.

LESSON XIII.

Two great families of crops are raised for their seed, namely, grain or corn crops, in which the seeds grow in ears, and leguminous crops, whose seeds grow in pods, or legumins. Wheat, oats, barley, rye are the grain crops grown in the British islands. Maize, or Indian corn, and rice, so extensively grown in warmer climates, belong to this class.

The grain crops (also called cereal crops and cereal grasses) form the staple articles of human food in these countries. In 1846 Parliament carried the measure well known as Free Trade, which, by removing duty previously imposed on imported corn, and thus enabling the farmers of foreign countries, whose climate is well suited for wheat, to compete with British farmers in their own markets, has materially lessened the cultivation of corn crops in these countries. The falling off in the cultivation of grain in Ireland is shown in the following table:—

	1847. Acres.	1864. Acres.
Wheat,	743,871	276,483
Oats,	2,200,870	1,814,886
Barley, Bere, and Rye,	345,070	181,594

It will be seen that the falling off in wheat is relatively greater than in any other cereal, and this is owing principally to the circumstance that our climate is not as well suited for wheat as for oats, barley, or rye. A warm and dry climate is required to bring wheat to perfection. The best samples of this grain imported into Ireland for seed are grown in Kent, Sussex, and other counties in the south-east of England, the climate of which is both warm and dry. Very little wheat is grown in the west of Ireland, owing to the humidity of its climate; for example, in Sligo there were only 224 acres under this crop in 1864, while the area under oats was 40,021 acres.

The profitableness of wheat depends greatly on its price; and when this reaches 1*s.* 6*d.* a stone, wheat can, on suitable soils, and by skilful tillage, be raised profitably in all districts in Ireland except those on the north-western, western, and south-western seaboards, which have a very humid climate.

The oat crop thrives well in Ireland. It not only bears, but requires more moisture than wheat. There is no part of Ireland in which a farmer who tills skilfully could not afford to sell oats at 10*d.* a stone, below which we believe its average prices is not likely to fall.

Barley bears more wet than wheat, but not so much as oats. Barley has of late years well paid the farmer who introduced it into its proper place in the rotation, and treated it in a skilful manner.

Wheat requires strong land to give the necessary support to the plants. The heaviest crops of it are raised on loamy clay. Of all the grain crops wheat answers best for what is called high farming, which consists in keeping the land in high condition by liberal applications of manure.

Barley thrives best in moderately loose soils in good condition. Thus sandy loams give excellent crops of barley. Oats grows well on a greater variety of soils than wheat or barley; it is the first kind of corn grown on reclaimed moor or bog land; it is raised in clays, sands, and all other soils, and it can be introduced in all parts of the rotation, such as after roots, after grass, etc. The proper place for barley is after roots, as it requires the surface soil to be loose and rich. Sometimes it is grown after grass, but the produce is never equal to that obtained after roots. Barley does not strike its roots to the same depth into the soil as wheat, and, on this account, it sometimes follows wheat on good rich land. As the two crops feed on different parts of the soil the wheat does not injure the ground for the barley. This is, however, a dangerous practice except on very good land. Clover is almost invariably followed by wheat in England. Wheat rarely follows grass in Ireland, its usual place being after potatoes and roots. The best crops of wheat raised in Ireland have followed potatoes, the cultivation and manure for which are beneficial to the wheat. Potatoes can be taken out of the ground in time to enable the farmer to sow his wheat in the beginning of winter, which is the best time for putting in the seed of this crop. Roots have not this advantage.

LESSON XIV.

WHEAT is commonly divided into winter or autumn, and spring, according to the season in which it is sown. Autumn wheat is sown in autumn and winter, the proper time depending on the soil, climate, etc. Spring wheat is sown in February and March, and a variety called April wheat, is sown in the month of April. Experience tells us that autumn pays better than spring wheat.

The oat crop is usually sown in March, and barley in April. A common saying among farmers is, that all the oats should be sown before Patrick's Day (17th March). Some varieties of oats, such as the "Dun," or "Russian Dun," admits of being sown in October. There is a strong feeling growing among our best modern farmers in favour of sowing barley earlier than formerly, and some of the heaviest crops of barley we have seen were sown in February. On land made dry and warm by good management (including drainage when necessary), the beginning of March appears to be the best time for sowing this crop.

The thinner we sow any grain crop the earlier it should be sown. When the seeds are scattered thinly each plant finds more food in the soil, grows larger, and takes a longer time to come to maturity than otherwise. This brings us at once to consider the merits of the several ways in which the corn crops are sown. Theoretically speaking, perfection in sowing corn requires the following conditions: —First, that the seed be evenly distributed over the ground; secondly, that the space occupied by each plant be just enough and no more; and thirdly, that all the seed be covered to a uniform depth. In practice it is impossible to combine these conditions.

Corn is sown in four different ways. The first and most common, as it is the most expeditious system, is to scatter the seed broadcast. A good seed sower will go over twenty acres in a day, and an indifferent man will sow ten or twelve acres. On clean land corn sown broadcast does extremely well in this climate. The usual quantity of wheat sown broadcast on good land varies from ten stone per statute acre in autumn or winter to twelve or more in spring; of oats the quantity varies from ten to sixteen stone, according to the climate, soil of the farm, and season; and the quantity of barley sown is about the same. The poorer the soil and severer the climate, the greater the quantity of seed required.

Corn is sown in drills or rows by machinery. The width of the drills varies from eight inches on poor to twelve or more on good land; and the quantity of seed per statute acre varies from five to eight stones, the average being from six to seven. The principal advantages of drilling corn are, first, the saving of seed, which is at least four stones per statute acre; and secondly, the spaces between the rows can be hoed, which not only admits air into the soil and about the roots of the corn, but also keeps down weeds. The cost of a good corn-drilling machine is beyond the means of any one of the class of small farmers in this country; but several of them could club together and buy a machine, which they could use in common.

The third mode of sowing grain is by *ribbing*, which consists in throwing the soil into small drills or ribs by a plough or a ribbing machine, sowing the corn broadcast over the ribbed surface, and covering it with the harrow. The crop grows in rows or drills. Wheat is very frequently ribbed, and it is doubtful if a better mode could be adopted on good land, but oats or barley are rarely sown in this way. In ribbing, the quantity of seed sown is about the same as broadcasting.

Corn is sometimes dibbled, a process which consists in depositing the seed in holes made at regular intervals by an instrument called a dibble. Lines are laid out at about the same width as the rows of drilled corn, and along these lines holes are made a few inches asunder; two or three seeds are deposited in each hole, and the whole covered in. Two or three stones of wheat will supply seeds enough for dibbling an acre of land. The spaces between the rows, too, can be well tilled. Dibbling corn, however, consumes too much time and labour. In the present state of the labour market a farmer could not find hands enough to dibble any considerable breadth of wheat. Dibbling is admissible only on small plots, such as those used for experimental purposes. When dibbling is adopted for this or any other purpose, the crop should be sown as early in autumn as possible, for, as already stated, thin seeding produces a late harvest. There are some good varieties of wheat seed now before the public, raised by dibbling, and which require to be sown a fortnight or so earlier than seed raised in the common way.

LESSON XV.

Much valuable corn is wasted in Ireland by excessive thick seeding. It is not too much to say that if the land of the country was well farmed, a saving of at *least* two and a half stones of seed could be effected on each of the two millions and a quarter acres under grain; and this represents about 32,000 tons of grain, worth more than a quarter of a million sterling. This saving cannot be effected until improved farming becomes general. More seed is required under bad than good farming. Some of the seed is killed by frost on undrained or wet land; and when the soil is not properly prepared, a great deal is buried so deep that it never grows at all.

On the other hand, extremely thin seeding, which makes the harvest late, is unsuited to our climate.

The preparation of the ground for any of the corn crops varies with its place in the rotation, the nature of the soil, &c. When the corn follows roots the ground is ploughed, and the furrow slices broken down by the harrow to produce a proper seed bed. The grubber is sometimes used before the harrow. A proper seed bed being obtained, the seed is sown and covered by the harrow. The number of harrowings required for covering the seed varies with the state of the ground; in most cases two double turns or "strokes" of a good harrow suffice.

When corn follows beans the ground is prepared by ploughing, grubbing, and harrowing, as just described. The preparation of grass land for corn consists, in the first place, in ploughing the land as soon as circumstances will admit. The oldest grass is first ploughed, say in January, and the grass of alternate husbanding as soon after as possible. If the grass be old and the land well ploughed, the seed may be sown on the ploughed surface and covered by the harrow. The seed falls into the hollows of the ploughed surface, and comes up afterwards in rows. Generally speaking it is necessary to harrow the ploughed surface of one or two years' grass before sowing the seed, for the sods break on being turned over, and if seed be sown on the ploughed surface in this state, a good deal of it would fall through the crevices and never vegetate. To prevent waste of seed in this way the surface is, in the first instance, harrowed; the seed is then sown and harrowed in, and when the harrow does not sufficiently cover the seed, a little earth is scattered over it from the furrows.

Corn sown in autumn is not rolled till spring. If rolled after sowing, the roots of the young plants are liable to be thrown out by frost, that is, the roots would lose their hold on the soil as it crumbles down after frost. Corn sown in spring is usually rolled after the seed is covered by the harrow.

Wheat requires a good firm soil. When, therefore, wheat is raised on light land it is a very common practice with large farmers to consolidate the ground by a heavy roller (Crosskill's is the best), or an implement specially made for the purpose called a land-presser.

Young corn plants are frequently injured by "wire worms," which are the larvæ of click beetles, and to a less extent by other insect pests.

The ravages of these insects are checked by rolling with the Crosskill, or a heavy roller of some kind. By applying caustic lime to the land their eggs are destroyed. Corn grown after grass suffers most from those pests. Good tillage, applications of lime, and heavy rolling are useful preventive measures. By ploughing the grass, too, early and *deeply*, the eggs of the insects are destroyed.

The grain selected for seed should be perfectly sound, and of good average size; the colour should be uniform through the entire mass of grain, and particular care should be taken to see that it has not heated. Seed-corn should be winnowed with great care, so as to remove the seeds of weeds as well as shrivelled and imperfect grains of corn.

It is found from experience that any variety of grain begins to deteriorate after it has been grown for a number of years in the same land. An occasional change of seed should, therefore, be made, and the necessity for this change is greatest on the worst farmed land. Good sound land produces the best seed corn; and it should always be selected from a better soil and climate than those of the farm to which it is brought. Seed corn raised in the best districts of Great Britain is sold in this country under the name of *imported* seed and gives the greatest return. As the price of this class of seed is very high, the small farmers of the country do not use much of it. Our advice to them is to buy as much of the best imported seed every year as would give seed corn enough for all their land the year after. It is found that the first crop from imported corn is nearly as good for seed as the imported grain itself.

LESSON XVI.

CORN is, in this country, cut in one or other of three ways, namely, with the reaping hook or sickle, scythe, or reaping machine. The corn is left in the best state for binding after the hook or sickle. The scythe is, however, a more expeditious and less expensive instrument for cutting corn than either hook or sickle. One man will mow an acre of corn in the day; four men are required to reap an acre of wheat, five an acre of barley, and six an acre of oats. The cost of binding is much greater after the scythe than after the sickle; but on the score of cost the balance is greatly in favour of the scythe.

The sheaves of corn are looser and more permeable to air after the scythe or reaping machine than after the hook or sickle; the crop is, therefore, fit for stacking sooner in the one case than the other.

The hook is preferable to the scythe when the corn is lodged or when from any cause it cannot be cut in time.

A skilful man can mow corn very well with a common scythe; but it is better to have a shorter blade for corn than for grass. The mower should cut against the standing corn, and a few pieces of strong wire should be fixed in the sned to catch the crop as it falls on the scythe, and assist in getting it into a swath.

After the corn is reaped or mowed it is bound into sheaves, and these are made into stooks. When the corn is cut before it is fully ripe and the weather fine, it is usual to allow it to remain to dry and ripen for a day or half a day in the swath, but in broken or uncertain weather it should be bound and stooked at once. Corn dries quicker and becomes fit for stacking sooner in small than large sheaves. In this climate the sheaves should not exceed ten to twelve inches in diameter; and there should not be more than twelve sheaves in a stook. A good crop gives thirty-six stooks of this size per statute acre.

When, on being grasped in the hand, the straw feels dry and crisp in the stooks, the crop should be carried to the haggard and stacked. It is a common but most objectionable practice to make the corn into small stacks in the field. It involves more labour, and causes loss of grain often to the value of ten shillings an acre and upwards.

The size of the stacks should vary with the facilities for thrashing and other circumstances. Thus, when a thrashing machine is used, it is sometimes found convenient to put as much corn into a stack as would keep the machine going for one day.

A common mistake made in building stacks in this country is giving too high a pitch to the head, under the impression that a long head is necessary to throw off the rain. It is quite enough to have the perpendicular height of the head equal to half the diameter at the base. This gives a slope of 45°, and throws off the rain very well, and as it gives less surface than a higher pitch, less straw is wasted for thatch.

With a view of preventing corn from rotting and keeping vermin out of it, the stacks should be built on "stands," raised a couple of feet above the ground. The pillars of these stands may be made of metal, stone, or wood. Metal is the dearest and wood the most perishable. The frame which rests on the pillars consists of a number of bars of metal or wood, the latter being the cheaper and more suited to the circumstances of small farmers. When the pillars are made of metal they are cast in the shape of a mushroom, so that when vermin climb the uprights they are prevented from entering the stacks by the caps. When the pillars are made of wood or stone each should invariably be capped with a piece of sheet iron or zinc. No loose straws or branches should be permitted to protrude from the bottom of the stacks as vermin jump at and catch them, and thus enter the corn.

When the farmer has no stands, and is compelled to build the stacks on the ground, he should begin to build them by placing a dozen sheaves in the centre, in an upright position or nearly so; these should be surrounded by others less upright, and these again by others still less so, and so on until the outer row is laid. All the sheaves would thus have a tendency upwards, which would help to keep the stack dry.

The harvesting of corn requires skill and care. It must be cut at the proper time and saved in a proper way. It may be affirmed that the crop yields the greatest quantity of grain by allowing it to come to full maturity, or to become what is commonly called *dead ripe*. It is found, however, that a great quantity of wheat and oats is shelled or shed, particulary in windy weather, when either is allowed to advance so far before it is cut; and, accordingly, good farmers always cut these crops three or four days before they are dead ripe. Barley, on the contrary, which is not liable to shed its seed like oats or wheat, is not cut until the crop is fully ripe, which is known by the ear turning over and the straw becoming yellow. Barley is not good for malting if the crop be cut before the seed is fully matured. Wheat should be cut when the seed, on being pressed between the fingers, has acquired the consistence of dough. The seed ripens in the stook afterwards; and it is believed that the quality of the flour is better when the crop is cut at this stage than when it is allowed to become dead ripe. The same may be said of oats. The early varieties of this crop are much more liable to shell than the late ones.

The quantity of wheat and oats annually lost in Ireland by not cutting these crops in time is fully equal to the seed sown; and this for the two millions of acres under these two crops in 1864, fully amounts to one million sterling!

This is a national disgrace which can only be removed by diffusing agricultural knowledge among the farmers of the country.

In the ripening of corn and other crops a good deal of the saccharine matter of the plants is changed into woody fibre, and as the latter substance is not nutritive, the value of straw for feeding purposes is considerably less when the corn crops are allowed to become dead ripe than when they are cut at an earlier stage. Not only, therefore, is there a loss of grain by allowing wheat and oats to become fully ripe before cutting them, but the feeding value of the straw is greatly lessened.

SECTION VII.

FORAGE AND HERBAGE CROPS.

LESSON XVII.

It is usual to divide forage and herbage plants into two great classes, viz., artificial and natural grasses. According to this arrangement, vetches, clovers, and trefoils are included in the class of artificial grasses, and the true grasses alone are embraced under the head of natural grasses. This classification is very unsatisfactory, inasmuch as the term grass cannot be properly applied to a crop like vetches. At present we do not propose to enter upon a new classification, and proceed to give an account of the principal crops used for forage and herbage in this country.

The TARE OR VETCH (*vicia sativa*), is a very useful forage plant, and is usually divided into two varieties, summer and winter. This subdivision is useless, because if the winter be substituted for the summer variety for a few seasons, it acquires the properties of the latter, and *vice versâ*.

Vetches sown in autumn become fit for feeding early in the following summer. It is a very common practice to sow it after corn, and if properly cultivated, it is removed in time to be followed by turnips. In this case it is called a "stolen" crop, that is, a crop taken off the land between two principal crops.

As soon as the corn is removed the stubble is ploughed, the seed sown broadcast, and covered in with the harrow. In some cases it becomes necessary to give a turn of the harrow before sowing the seed, and to shovel the earth from the furrows to give the necessary covering to the seed. A moderate application of farmyard manure, Peruvian guano, or superphosphate of lime, considerably promotes the growth of the crop, and well repays the farmer for the outlay. The quantity of manure applied should vary with the condition of the land. Ten tons of farmyard manure, or from a hundred and a half to two cwt. of Peruvian guano will be found a suitable application on land of average quality. The farmyard manure is applied before ploughing the land, and the artificial manure is spread on the ploughed surface in the same way as the seed. Large farmers who use drilling machines, sow the seed in drills, and even the manure is sometimes drilled in.

The summer vetch is sown in spring and summer, and by sowing it at different periods, the farmer is enabled to keep up a succession of feeding. Thus it is sown in succession from January till May, the interval between the first and second sowing being about a fortnight; the interval gradually extends as the season advances.

The advantages of the vetch crop, and the relative merits of the autumn and summer kinds, vary with the system of farming pursued, and other circumstances. In our own practice we have been enabled to keep up a succession of house feeding for cattle without summer vetches, but have found a moderate area of autumn or winter vetches very useful, as they usually come in between the first and second cutting of rye-grass or clover.

On some soils the summer vetch is very useful to sheep farmers and others. When sown alone the quantity of vetch seed used per statute acre is about three bushels. With the view of giving support to the vetch, and preventing it from lodging and rotting, it is usual to mix the seed of rye or winter oats along with winter vetch, and common oats along with the summer vetch, at the rate of about two bushels of vetches to one bushel, or a little less of corn.

We use oats in preference to rye for mixing with the winter vetch, as we find that the rye runs to seed, and is thereby deteriorated for feeding value before the vetches are fit to cut.

The acreable yield of vetches varies with the nature of the soil, and with the treatment the crop receives. Twenty tons have been sometimes obtained, but this is double the average of the country. One obstacle to the extension of the cultivation of vetches is the cost of the seed; but there is no reason why the farmer should not save his own seed.

LUCERNE (*Medicago sativa*) is a plant with a perennial root, which continues to grow and give fodder for several years. Its cultivation is confined to deep sandy soils, on which it yields a large quantity of valuable feeding. It is a favourite crop in the Channel Islands, and is also grown on deep brashy soils in the southern districts of England. It is little known as a field crop in Ireland, but we believe there are several light limestone soils on which it would yield a larger amount of cattle feeding than clover or rye-grass. Lucerne continues in the ground for eight or more years, giving several cuttings annually, and should therefore follow a manured crop.

The usual time of sowing it is the middle of April, and the seed may be sown broadcast or in drills; the latter is preferable, as the spaces between the drills can be hoed from time to time. The drills should be fifteen inches apart, and with this width of drill about twelve pounds of seed per statute acre are sufficient. When sown broadcast twenty pounds or more are required.

When the ground is properly prepared lucerne gives one cutting in the year in which it is sown, but this cutting is rarely a heavy one, and in no case should a second cutting be attempted within that year. In the second year two or more cuttings are obtained, according to the condition of the ground, but the crop does not reach its maximum until the third year, after which, if manured every autumn, a profitable return is obtained for about five years.

SANFOIN (*Onobrychis sativa*) is another forage plant of limited cultivation, and which, like lucerne, continues in the ground for several years. It is deep-rooted, and has the peculiar merit of striking its roots into, and thriving on dry rocky ground, which resists the growth of almost any other forage crop. On the light limestone soils of the Cotswold hills, and the chalk soils of Berkshire and Hampshire, sanfoin formed, until the extended cultivation of turnips, one of the main crops of the sheep farmer, and even still it is an important crop in those districts. It has been cultivated so extensively in some places that the land has become tired or "sick" of it, and in consequence other crops have been substituted in its place. Again, in the districts above referred to, it is not unusual, when the land becomes sick of red clover, to grow sanfoin in its stead.

Sanfoin may be sown by itself, like lucerne, but it is frequently sown with a grain crop, in the same way as grasses and clovers. When sown by itself in drills, two or three bushels of seed are required per statute acre. It may be put into the ground a little earlier than lucerne. The general opinion is that sanfoin, like lucerne, does not attain its full productive power until the third year of its growth, and that it need not be broken up before eight or ten years. This crop is mown but once annually, and then depastured.

The produce in hay usually exceeds one ton, but rarely amounts to two tons, per statute acre.

LESSON XVIII.

CLOVERS.—Several distinct plants differing widely in their habits, are included in this class; the most usually cultivated being red clover, white clover, and yellow clover.

Of these *red clover* is the most productive. It may be divided into two classes, the common or biennial red clover (called by botanists *Trifolium pratense bienna*), and the perennial or more permanent red clover (the *Trifolium* medium *perenne*), sometimes called "cow-grass." These two species are not easily distinguished, and even in the seed shops one is often sold for the other. Both have a woody fibrous root, which penetrates to a considerable depth into the ground, and which, by drawing nourishment from the under soil, enables the plant to resist drought, a property that enhances the value of clover in a dry climate, such as prevails in the southern districts of England. The root of the biennial species is thicker at its upper end, and its leaves are generally smoother or less hairy than those of the perennial clover. The latter, as the name indicates, is the more permanent of the two, but it is not, strictly speaking, perennial, as it dies out in a few years.

Both varieties of red clover are very valuable for forage purposes, giving on land in good condition, two, three, and sometimes four cuttings of green food in the year. When sown without other grass seeds, red clover is allowed to stand only one year in the ground, and when as in the five-course rotation the grass remains unbroken for two years, it becomes necessary to use one or other of the mixtures to be hereafter given.

Experience teaches that when red clover is repeated at short intervals (such as once in every four years in the ordinary four-course rotation), the land becomes what is called "clover-sick."

In Lesson II., we have shown that this is prevented by lengthening the period of the recurrence of the crop on the land, as well as by deep tillage and good manuring. It is worthy of remark, that when land becomes sick of the common or biennial red clover, a good crop of the perennial species, or cow-grass, may be obtained; but the latter, when repeated two or three times at short intervals, also causes clover sickness.

When red clover is sown alone, twelve to fourteen pounds of seed per statute acre are required.

White Clover, called also Dutch clover (*Trifolium repens* of botanists), is a perennial plant with fibrous root and creeping stem. It grows naturally on a great variety of soils, and is particularly abundant on the soils of the limestone formation of this country.

In soils deficient in lime, this plant springs up naturally after an application of that manure.

The white clover is a sweet and wholesome herbage plant, is much relished by sheep, and enters into all mixtures of grasses for permanent pasture; but it is not so valuable for forage purposes, or for one or two years' grass.

Yellow Clover, called also Common Trefoil (*Medicago lupulina*), has been pretty extensively grown both for hay and pasture. For forage purposes it is far inferior to the red clover, and its principal merit consists in its suitableness to dry inferior soils, on which red clover could not be profitably grown. On the chalk and similar soils of England, it is commonly mixed with other seeds, for one or two years' grass in the four and five-course rotations, and its chief recommendation for such a purpose, is that it grows with great certainty, and fills up the blanks that would otherwise occur.

ALSIKE CLOVER (*Trifolium hybridum*) is a plant recently introduced from Sweden. As it grows on land sick of red clover, its introduction has caused considerable interest, but, compared with the latter, the produce is so small that it is not likely to come into general use.

CRIMSON CLOVER (*Trifolium incarnatum*), called also Italian and scarlet clover, is a plant long known in the garden as a border annual, and which, in the various efforts made to provide substitutes for red clover, has received some attention. Like the Alsike Clover it is not likely to come into general use. It is sometimes sown in autumn after corn, in parts of England where the harvest is early. The preparation of the ground is not expensive, and the crop is ready in spring, when it proves useful to sheep farmers.

LESSON XIX.

WE now have to treat of the natural or true grasses which, as permanent pasture and meadow, occupy about one-half the land of Ireland. There is no class of plants so little understood, or so imperfectly cultivated in these countries. A high authority has declared that the grass lands of England are a disgrace to British agriculturists; and it may be safely stated, that the grass land of Ireland does not give one-half the produce of which it is capable. The unproductive state of our grass land arises from several causes, the principal of which are, 1st, ignorance (on the part of farmers) of the proper grasses to grow in given situations; 2nd, want of care and skill in laying down the land with grasses; and 3rd, want of care and attention in weeding, and, when necessary, manuring the grasses.

Botanists tell us that 116 species of true grasses grow naturally in the British islands, and of these 82 species grow in Ireland. In this treatise we shall describe only 19 species.

1. PERENNIAL RYE-GRASS (*Lolium Perenne*), Fig. 31, is a fibrous rooted plant, which is more extensively grown on land under rotation or alternate husbandry, than any other British grass; and though not a true permanent grass, it is mixed with the more permanent grasses in laying down land to pasture, as it yields a good crop while it lasts, and many of the more permanent grasses do not fully develop themselves for a year or two.

FIG. 31.

This grass grows freely on a great variety of soils, giving, when fairly treated, and on being cut before flowering, two or three cuttings in the year. It is a good meadow grass.

There are several varieties of perennial rye-grass in use, some being more permanent than others. No variety of the grass is really perennial; hence the name is not strictly correct. The less durable kind is sometimes formed into a sub-class, called annual perennial rye-grass, a name which is in itself a contradiction. Under favourable circumstances the annual varieties last a couple of years; but they are by no means as productive or suitable for general use as the perennial sorts.

The more permanent kinds of perennial rye-grass give a good return for two years; but after that they begin to die out, and to be replaced by other grasses.

Fig. 32.

This grass is not usually sown alone; but for the reasons already stated, it should form part of all mixtures for hay or permanent pasture.

2. Italian Rye-grass (*Lolium Italicum*), Fig. 32, is a most valuable grass, which was brought from Italy in 1833 by Messrs. Lawson, the eminent seedsmen of Edinburgh. This grass is often mistaken forperennial rye-grass, which it resembles in many respects, and of which, some botanists say, it is merely a variety. Italian rye-grass grows more in tufts than perennial. Owing to this peculiarity, when Italian rye-grass is mown, the ground, even when the crop is heavy, appears not to be half covered with plants. Awns or hairs usually project from the seed of Italian rye-grass, a character absent in the seed of perennial rye-grass.

Italian rye-grass is capable of producing more forage than any other natural grass we possess. It comes in earlier in spring and continues to grow later in autumn than perennial. Under favourable circumstances it will, if mown before flowering, produce four heavy cuttings in the year, amounting, when the land is rich, to forty tons of green grass (equal to upwards of eight tons of hay) per statute acre; but this is probably double the average yield which can reasonably be expected. A plant that grows so rapidly, and gives so heavy a hay crop, requires the land to be rich and well tilled; indeed its produce varies with the treatment, as regards manure, tillage, &c., which the land receives. Italian rye-grass aptly illustrates a property which distinguishes the grasses from corn and other cultivated plants, namely, that there is scarcely any limit to the extent to which the grasses may be forced, whereas, if land be manured beyond a certain point for corn the crop lodges, and suffers from over luxuriance. Italian rye-grass is the only natural grass sown by itself; and when sown in this way it takes the same place in any ordinary rotation as clover. It is never safe to rely upon it for more than two years; and when three or four heavy cuttings are obtained in the first year it begins to decline the second year. Sometimes a quantity of seed is shed by the first year's crop, which grows up and increases the second year's return. The propriety of allowing the land to stand a second year, depends on a great many circumstances, such as the quality of the soil, the climate, &c. This grass grows more luxuriantly in the mild, moist climates of Ireland and Scotland, and in the north and west of England, than in the drier climate of the south and south-east of England.

Italian rye-grass is, like other grasses, usually sown along with corn in spring, and this is likely to continue the most general way of raising it. It grows freely with the corn crop, and the first year's growth is cut with the latter, and adds to the value of the straw. When the ground is very rich the grass grows so rapidly as to interfere with that free circulation of air among the plants of corn, which is so necessary for their healthy growth. Sometimes, again, on such land the corn lodges, and destroys the grass. To avoid these injuries to the corn on the one hand, and to the grass on the other, it is recommended to sow the grass in autumn rather than in spring. In this case, the stubble is ploughed or grubbed, and carefully cleaned as soon as the corn is removed in autumn, the soil is reduced to a fine state, the seed sown, and covered in with the harrow. When the harvest is early enough to admit of the grass being sown not later than September this is a good practice in rich land; but when frost sets in before the plant has had time to become sufficiently strong in the braid it should not be attempted.

The author of this treatise has introduced Italian rye-grass after potatoes into the following four-course rotation, which he has practised with great success on the smallest of the three farms attached to the Albert Institution. First year, roots; second year, potatoes; the potatoes are removed and the grass sown not later than the end of September for the third year's crop; fourth, oats. The two years' tillage and manuring prepare the land peculiarly well for Italian rye-grass, and it is not too much to say that the heaviest and most profitable crops of Italian rye-grass raised in Ireland have been thus obtained.

LESSON XX.

3. Cocksfoot (*Dactylis glomerata*), Fig. 33, is a productive grass, so called from the resemblance of its flower stalks to a cock's foot. It grows in all soils except those which are saturated with water or too light in texture, is met with in all good meadow land, and is readily known by its coarse leaves, which are numerous, strong, of a deep green colour, and grow with a great rapidity. Cocksfoot is generally regarded as a coarse grass, but in reality it is productive and nutritious, and its apparent coarseness arises from its strong and tufty habits of growth. When depastured for five or six years it is said to die out, and gives way to the finer and smaller grasses. It should enter into all mixtures for meadow land. It thrives particularly well in shaded places, and when mixed with the weaker sorts in such situations it

becomes a support to them, and prevents their foliage from being rotted on the ground.

FIG. 33.

4. TIMOTHY, or MEADOW CATSTAIL (*Phleum pratense*), Fig. 34, is another very valuable grass, introduced into these countries from America in 1702 by a Mr. Timothy

Hanson, after whom it is called. It is said to be cultivated in parts of the Northern States of America and Canada to the exclusion of all other grasses, but in

Fig. 34.

Fig. 35.

these countries it is never sown alone. Timothy is best adapted for deep moist soils, and is said to excel all other grasses on strong tenacious clays. It also grows well on reclaimed moory ground. It should, therefore, form part of all mixtures of grass seeds for laying down such lands for alternate husbandry or pasture. The aftergrowth of Timothy is very light, which has brought it into disfavour for meadow.

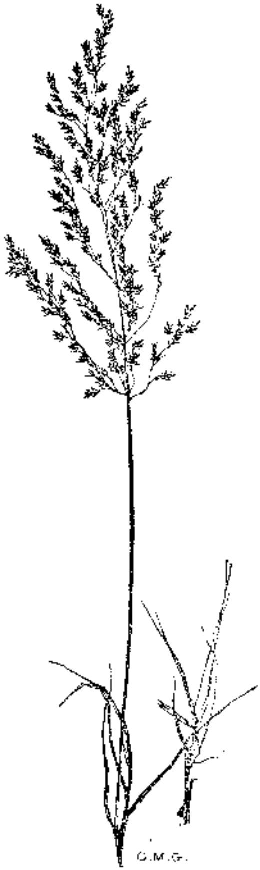
5. MEADOW FOXTAIL (*Alopecurus pratensis*), Fig. 35, is the earliest of the valuable grasses, and forms a large proportion of the herbage in our best pastures. It throws out from the crown of its root long, broad, and succulent leaves, which are renewed with great rapidity when eaten down by cattle and sheep, a circumstance which greatly enhances its value for permanent pasture. It answers very well for irrigation. As it does not acquire its full size for three years, and throws up a comparatively bare stem, it is not suited for alternate husbandry.

FIG. 36.

6. ROUGH-STALKED MEADOW GRASS (*Poa trivialis*), Fig. 36, is very generally met with in good meadows and pastures. It grows most luxuriantly in rich moist soils, and does very well in the shade of trees and in irrigated land, but gets burned up in the heat of summer on light dry ground. It throws out shoots from the root at the base of the culms, which trail on the ground, and send down small roots at their joints in

moist weather. These shoots begin to grow pretty early in spring, but wither if exposed to the effects of much sunshine in summer; they, however, shoot out again towards the end of the season, when the weather becomes more moist, and continue green during the greater part of winter. This habit of growth fits it admirably for growing in mixture with the more upright kinds of grasses, such as Italian rye-grass, meadow fescue, &c.

Fig. 37.



7. Smooth-stalked Meadow Grass (*Poa pratensis*), Fig. 37, is not so valuable as the last-named grass, which it resembles in some respects, but from which it is distinguished by several well-marked characters. As the names of both indicate, the stem of the one is rougher than that of the other. The root of the rough-stalked meadow grass is fibrous or but slightly creeping, whereas the smooth-stalked species has a creeping root. The smooth-stalked meadow grass, too, is the smaller plant, and has the more open panicle of the two. As a rule, grasses with creeping roots thrive better in light land than grasses with fibrous roots, and smooth-stalked meadow grass is no exception to the rule. This grass cannot be recommended for cultivation, except perhaps to enter in small quantity into mixtures for lands which are too light for more valuable grasses.

8. MEADOW FESCUE (*Festuca pratensis*), Fig. 38, grows abundantly on rich pasture, especially where the soil is somewhat moist, but it is not well suited for light dry land. The stalks are strong and coarse; but they are greedily eaten by horses and cattle.

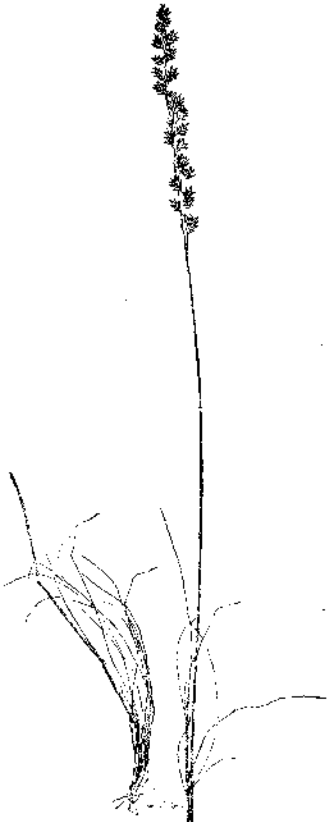
FIG. 38.

LESSON XXI.

9. HARD FESCUE (*Festuca duriuscula*), Fig. 39, is perhaps more abundant in British pastures than any other grass. It thrives in a great variety of soils, but it is

FIG. 39.

FIG. 40.



best suited for dry light land, and forms a very large proportion of our sheep walks. It resists the drought of our summer, retains its verdure during winter in a remarkable degree, and is more productive than its dwarfish habits of growth would indicate. It is a good grass to sow with others in lawns, when it is desired to produce both a pleasing effect and a good return.

Fig. 41.

10. Sheep's Fescue (*Festuca Ovina*), Fig. 40, forms a large proportion of the herbage of sheep pastures, especially those in elevated situations. It is a small grass, sometimes only a few inches in height, and is therefore unfit for meadow land; but it is early and hardy, grows in tufts, and has very fine leaves which have a nice effect in lawns and pleasure grounds. It is not so productive as either meadow fescue or hard fescue, but the quality of the mutton fed on it is said to be superior to that obtained from any other grass.

11. Crested Dogstail (*Cynosurus Cristatus*), Fig. 41,

is a grass on the merits of which there is a great diversity of opinion. Like meadow foxtail it throws up a number of root-leaves of which sheep are very fond. Unless pasture which contains much of this grass is kept closely stocked, it throws up hard wiry stems which neither sheep nor cattle eat, and which sometimes irritate the

Fig. 42.

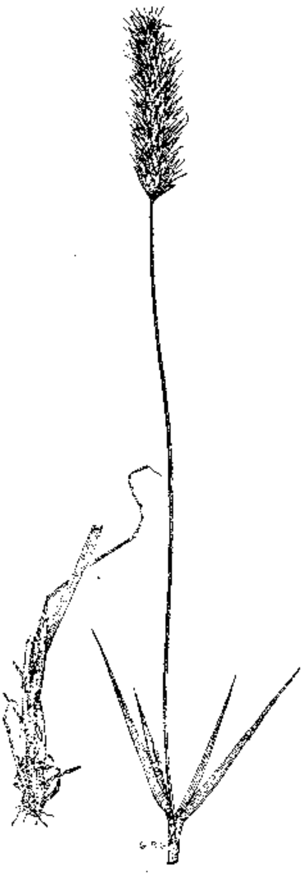
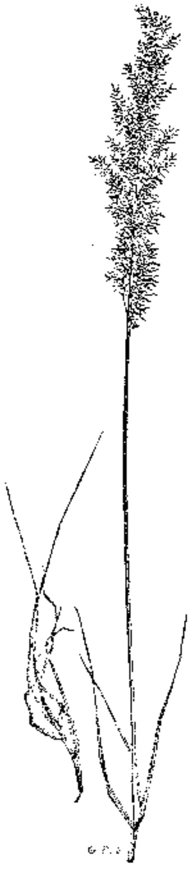


Fig. 43.



eyes of sheep. This grass should, therefore, be used sparingly in laying down land to grass.

Dogstail has deep roots, which enable it to resist drought.

Fig. 44.

Fig. 45.

12. Sweet Scented Vernal Grass (*Anthoxanthum odoratum*), Fig. 42, is not a productive grass; but it begins to grow early in spring and continues growing up to a late period in autumn. It should be introduced only to a limited extent into any mixture of grass seeds. It is supposed to give out the agreeable odour so characteristic of newly-made hay.

13. Fiorin Grass (*Agrostis Stolonifera*), Fig. 43, has a creeping root, each stolon or joint of which is capable of sending independent roots into the ground and producing an independent plant. This grass is quite unsuited to sandy soils or light lands of any kind except those which contain a good deal of peaty matter; but it gives a weighty crop on salt marshes and reclaimed bog where other grasses would not thrive. It is also a useful grass on irrigated land, especially those of a moory or peaty character.

Fiorin grass is propagated either from seed, or by chopping up the plant, and planting the stolons in rows.

The foregoing list includes the most valuable grasses; but there are a few others which merit a brief notice.

14. Floating Sweet Grass or Water Grass (*Poa fluitans*), Fig. 44, grows naturally in pools, the sides of ditches, and wet land, and is found very useful in irrigated meadows.

15. Wood-meadow Grass (*Poa nemoralis*), Fig. 45, grows freely among trees and gives a good crop of grass in woods where the finer grasses would fail.

16. Upright Lime Grass or Sand Grass (*Elymus arenarius*), Fig. 46, is found useful in binding loose sands, for which purpose "its creeping matted roots peculiarly fit it." It has been used in Holland and elsewhere for checking the encroachment of the sea.

17. Sea-reed or Mat Grass (*Ammophila arundinacea*), Fig. 47, is used either by itself or in conjunction with the last grass for binding blowing sand. It has been found so useful for this purpose that Acts of Parliament have been passed prohibiting its destruction under severe penalties. This grass has been sometimes used in the manufacture of coarse mats; hence the name mat grass.

FIG. 46.

FIG. 47.

We have next to notice two grasses of comparatively little value, but which are very abundant in many of the meadows of Ireland.

18. Of these soft meadow grass, called also "*York-*

shire Fog" and "*White hay*" (*Holcus lanatus*), Fig. 48, is the more prevalent. It is covered with soft downy hairs; and it is found that all grasses of this kind possess little value. This grass is little better than a weed, and yet we have seen meadows one-half of which were composed of it. Many farmers are very

Fig. 48.

Fig. 49.

fond of buying what they call white hayseed, but which, being the sweepings of haylofts, and composed principally of the seed of *Holcus lanatus* are dear at any price. There can be no greater mistake than the purchase of these white seeds, which are not only composed of the seeds of worthless grasses like this, but frequently convey to the land the seeds of most noxious weeds, whose eradication afterwards costs a great deal of labour.

19. CREEPING SOFT GRASS (*Holcus mollis*), Fig. 49, is another grass of the same class, often met with in meadow and pasture land, but not to the same extent as Yorkshire fog. Creeping soft grass is not only downy and innutritious like Yorkshire fog, but it has a creeping root which gives it the character of a troublesome weed.

LESSON XXII.

A RICH clean soil is required to produce good crops of the grasses; and as their seeds are small and delicate, they also require the seed-bed to be extremely well pulverized. We have seen that the place in the rotation usually assigned to grasses is after the grain that follows manured roots and potatoes.

Barley is the best corn crop with which to sow grasses, oats is next, and wheat the least suitable of the three. When the grass seeds are carefully sown they grow very well along with any grain crop; and the complaints constantly made that they do not thrive well with wheat, are owing partly to the circumstance that wheat is usually sown in the stiffest and strongest land, which is not the best for grasses, and to want of skill and care in sowing them. Wheat, too, being generally sown in autumn, the ground becomes hard for grass seeds in spring, which is the usual time for sowing them.

When grass seeds are sown with spring grain the mode of operation is as follows:—The grain being covered with the harrow to a sufficient depth, the ground is rolled, the grass seeds evenly distributed, and harrowed in with a bush harrow, or seed harrow (which is much lighter and has shorter tines than a common harrow), and the ground again rolled. It has been ascertained by careful experiments that grass seeds should not be covered to a greater depth than half an inch.

When grass seeds are sown with autumn wheat, the ground is lightly harrowed in the first fine weather in spring, the seeds sown lightly, harrowed, and rolled as before.

A dry calm day should be selected for sowing grass seeds.

Instead of being sown along with corn, the grasses are sometimes sown by themselves, autumn or spring time being selected for the purpose, according to circumstances. Mention has already been made of the practice of sowing Italian rye-grass by itself in autumn; this is a fast growing plant, and gives a full crop of forage the year after. Mixtures containing the finer grasses do not grow with equal vigour, and are not, therefore, equally well adapted for autumn sowing.

In a very favourable climate they may be sown after corn, by cultivating and cleaning the stubble, but in most cases the finer seeds would not attain sufficient strength by the time frost usually sets in. The best season for sowing grasses by themselves is, therefore, spring or early summer; and the practice of sowing grass without a corn crop adopted only when the object is to produce a good crop of permanent pasture in the shortest possible time. In this case the best plan is to sow the grasses after a manured root crop; and we have known farmers who, in order to bring the land into a rich state for pasture, grew two manured root crops in succession before laying down the land to grass. The grass seeds are sown by themselves with advantage, when a man takes up land in poor condition, and wishes to lay it down to permanent pasture at once, and when it would not produce a crop of grain without injury to the grasses. A corn crop is thus sacrificed; and it depends on the circumstance of the case whether this is likely to be compensated for by the increased productiveness of the grasses when sown alone.

Clover and grass seeds are commonly sown by hand;

but they are more evenly distributed over the ground by a seed barrow, specially made for the purpose. Sometimes the clover and grasses are mixed and sown together, and when a machine is used this answers very well, but when sown by hand it is usual to sow the clovers and lighter grass seeds separately.

In the Appendix will be found lists which, along with the observations already made, will, it is hoped, be useful to the young farmer in determining the kinds and quantities per acre of grass seeds to sow in any given place. If these lists be carefully followed, genuine seeds procured, and the land be clean, rich, and properly prepared, the herbage will be productive and profitable; and if any of these conditions be wanting, the produce and profit will be so much the less. There is not, perhaps, in Irish agriculture a more glaring defect, or one calling more for immediate improvement, than the mode of raising grasses. Sometimes the farmer does not sow any seeds at all, but allows the land to cover itself with whatever grasses it throws up naturally. Again, thousands of small farmers allow land to run to grass when it is reduced by corn crops and mismanagement to such a state of poverty that it will no longer yield even a middling crop of grain. The land is then allowed to rest itself in grass. This is a ruinous and miserable system. The herbage that grows under such circumstances is composed partly of indifferent and bad grasses, and partly of weeds, and leaves no margin for profit. It is true that this poor herbage is capable of increasing the quantity of vegetable matter in the soil, and as the combustible part of this is chiefly drawn from the atmosphere, the soil is thus enriched; but it would be enriched to a greater extent, and in a shorter time, if grasses of a good description were sown and properly treated. There is no family of farm crops that gives a better return for good tillage and judicious manuring than the grasses.

In conclusion, it may be stated as an axiom in practical farming, that land should never be laid down to pasture unless it is clean and in good heart.

LESSON XXIII.

HAYMAKING.—In order to obtain from a given area of meadow land the largest quantity of nutritive feeding, the first question which merits attention is, at what stage in their growth should the grasses be cut?

Now, we find that the grasses, while the blades are young, contain more water than at any subsequent period; that, as they grow in size and vigour, sugar, fat, and nitrogenized matters are produced; that, up to a certain stage, while they increase in bulk, the quality of a given weight of that bulk is improving. If permitted to grow beyond this stage, the quantity of woody fibre is rapidly increased at the expense of the sugar, and the quality deteriorates, so far as it depends on this constituent.

It may be regarded as true of all meadow lands, that the weight of the crop is actually lessened by being allowed to ripen its seed. There are, it is true, a few grasses which yield more when ripe than when in flower; but they never predominate in well laid-down land; and even should the acreable produce, when the grasses ripen, be a little greater than when in flower. yet it would not be economical to allow them to advance to that state, unless the excess so obtained exceeded the loss which is invariably sustained in the aftermath when the plants are allowed to mature their seed before being first cut—a loss which, on an average, amounts to half the bulk and value of the aftermath.

We may, then, safely assume that, so far as the quantity of the produce (including the aftergrass) is concerned, we obtain the maximum by mowing the grasses when in blossom.

The time-honoured practice of ages may in this particular instance be safely followed. In all periods of the historic age the haymaker has been advised to mow when the grasses are in flower. Pliny says, "the time of cutting is when the stalks begin to lose the flowers and to harden; it ought to be cut before it withers"—an advice to which, after the lapse of centuries, little can be added, and which shows how old is the idea that the maximum amount of nutriment is yielded by grasses when in full bloom.

As, however, all grasses do not flower at the same time, the following rules may be observed:—

1. Italian rye-grass should always be mown on the appearance of the flowers. This grass is such a fast grower that, if cut at this stage, a second cutting is obtained equal to the first, and, on good land, a third and fourth very little inferior.

2. Ordinary rye-grass may be allowed to produce the flowers.

3. Clover is best cut when the heads are in full blossom.

4. Mixed meadows should be mown when the bulk of the herbage is in full flower, or when the seeds of the earliest grasses are fully formed, such as sweet-scented vernal grass, meadow foxtail; and the late grasses, as crested dog's-tail, and meadow fescue, are just beginning to produce the floral organs. Timothy, Italian rye-grass, perennial rye-grass, and cock's-foot generally flower during the latter half of June, which, as these grasses constitute the great bulk of good meadow land, is the mowing season.

LESSON XXIV.

Mowing is frequently commenced early in the morning, and, provided the farmer is duly prepared to attend to it, the more quickly the operation is performed the better. We must not, however, mow more than can be properly saved. When both mowing and saving are performed by manual labour, the usual estimate is twenty rakers* to every five mowers. This was the estimate of Middleton in his well-known Essay, the best, perhaps, written on the subject, and it was endorsed by Arthur Young in his "Farmer's Calendar." The proportion is, however,

* This should be taken to include all operations connected with saving the crop.

a very fluctuating one, as every practical man knows. We would advise the farmer to have the number of rakers in excess. At the haymaking season there can be no difficulty in finding profitable employment for a few extra hands,—the hoeing of turnips and the keeping down of weeds are ready sources of occupying them, and when the necessity arises, a strong force can be brought to bear on the haymaking.

The ruling idea in the saving of hay should be to allow it to remain in the field as short a time as is absolutely necessary, and to rick it as soon as it can be done with safety. The time within which this can be accomplished varies with the succulence of the grass. In the case of rye-grass and mixed grasses from light or dry soils, the period may, by skilful management, be reduced to three days; in moist or low-land meadows, it takes a few days longer.

To render the practice as intelligible as possible, we will follow the management of the grass tedded on the first day. About 11 o'clock, A.M., on a fair day, in the eastern counties of Ireland, the moisture on grass mown before 9 o'clock, A.M., will be so far dissipated that it may be tedded. A tedding machine will, from 11, A.M., to 2, P.M., go over the ground cut down by a mowing machine from 5 to 9 o'clock, A.M.; and it will have gone over the same ground a second time, giving the backward and slighter stroke, by 5 o'clock, P.M. The subsequent management of the crop may differ somewhat, according to circumstances. It is usual to begin to collect into rows with the horse-rake the portion first tedded early in the afternoon—say, two hours after the tedding—taking six swathes or so to the row; and immediately after, the rows are made into fork or grass cocks, which should be all formed before dew begins to fall.

In uncertain weather, the lap-cock system may be adopted in preference to that described. In this case, two swaths are collected into one; the lapper takes up an armful of the hay, weighing half a stone or more, and dexterously wraps it together, using both hands and foot, and turns it over in a compact mass, "which looks like a bundle of green cloth turned upon its mouth, and *fends off much rain.*" An experienced hand will lap as fast as two men or women will collect the swaths with hand-rakes, and the three will make up a statute acre during the course of the evening. This system has long been practised by intelligent small farmers in the North of Ireland, where, notwithstanding the broken climate, good hay is frequently made. The system is safe and expeditious, and is, perhaps, the best which the small farmer could adopt. The horse-rake may be used, but not with the same decided success as when a larger number of swaths are gathered together. The lap-cocks present a very large surface for evaporation, and it is astonishing how soon the hay will dry up after rain in those little heaps. Rye-grass hay has been "carried" from lap-cocks into the rick on the day following that on which it was mown, and sweeter or better hay need not be desired.

The extensive farmer, who has often the produce of twenty or thirty acres tedded at the same time, may find it impossible to procure hands enough to make his hay into grass or lap-cocks. What, under such circumstances, is to be done? Simply to collect the hay into wind-rows, and leave in that state over night. In this loose condition it will collect more dew than in cocks, and if rain should fall during the night, it will readily pass through the hay, and wash out some of its soluble constituents. But there is no alternative. The system is not recommended for general adoption, but as the best that can be carried out practically on very large farms, and in the present state of the labour market.

We have thus detailed the principal operations of the first day. It is not meant that the hours of the day which have been mentioned can be adhered to in all cases. On the contrary, tedding can be begun much earlier in the forenoon in some places than in others; the dew, *e. g.*, rises an hour earlier and falls an hour later on the east than on the west and south-west coast of Ireland. And again, we are far from wishing to convey the idea that it would be injudicious to ted on the same day any portion of the hay mown after nine o'clock. No one adheres to any such arbitrary rule. Grass may be tedded in three or four hours after it is mown; and, accordingly, some of the grass cut after nine o'clock, A.M., on the first day, may be tedded on the same day, and, if time permits, it may be made into cocks in the evening.

LESSON XXV.

BEFORE proceeding any further, it is well to make two remarks:—1st. That the cleaner the spaces between the rows or cocks are raked, the earlier will the dew rise off the ground next day, and the sooner can the hay be spread out to dry. 2nd. Should wet overtake the farmer in haymaking—no matter whether it be in grass-cocks, lap-cocks, or rows, or in the swath—the safest plan is not to meddle with it;* for, each time that we turn or disturb it, a fresh surface is exposed to the solvent and deteriorating action of the rain. But if it should rain for several days, the portion on the ground would rot, so that it would be a less evil to turn the hay at some favourable moment than to allow it to remain undisturbed until the under side of the grass gets discoloured.

With these remarks we proceed to notice the operations of the second day. The mowing, of course, proceeds, and the grass mown this day must receive the same treatment as yesterday's. The grass-cocks made last evening must, if the day is favourable, be spread out on the cleared ground in a layer, the thickness of which depends on the quantity of moisture already evaporated, and this can be judged pretty well by the handling of the hay; it is rarely spread out over more than half the ground; the thinner it is spread and the more frequently it is turned, the sooner will it be fit for ricking. Should the day open with a doubtful aspect, instead of spreading out the cocks, they should

* For this suggestion we are far from wishing to claim originality; it is as old as the days of Columella, who assured the farmers of his day, that "if grass is wet, it is vain to meddle with it."

be simply aired by lifting and turning over, wholly or partially, the upper half; and if it should rain, they can be readily restored. If the day is fine, the cocks should be spread, as the hay requires, under ordinary circumstances, at least two days' thorough airing. In the afternoon of this day the grass which was cocked last evening, and of which we have been speaking, should be collected into larger rows, and made into larger cocks. The management of the lap-cocks made last evening is somewhat similar: the lap-cocks are spread out, turned, and made into fork-cocks in the evening. In drying weather, and when the crop consists principally of rye-grass, or is the produce of dry upland, the hay will dry sufficiently in lap-cocks; and under these circumstances it is unnecessary to disturb them.

When the wind-row system has to be adopted, the hay is also spread out, as in other cases, as soon as the dew is off the ground; it is turned during the day, and in the evening made into wind-rows of about double the size of those of the previous evening.

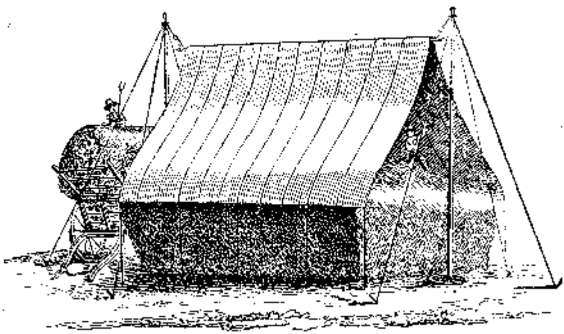
On the third day the same processes are to be gone over—the hay is spread in the forenoon, turned, and made up again if not ready to be transferred to the rick. Now, on ordinary meadows, no matter whether the fork-cock, lap-cock, or wind-row system be adopted, the crop has been safely "carried" home on the afternoon of the third day, provided no rain has fallen in the meantime. It is advisable, therefore, that the quantity saved each day be carried to the rick, and thus removed from the possibility of suffering injury from rain, &c. It will naturally occur to the practical reader that hay cannot be carted and ricked as economically in small as in large quantity; but this is a minor objection. If the farmer has a rick cover or a hay barn, he can spread the quantity "carried" each evening in a layer over the entire area of the rick. A man and a boy can receive the hay from the carter, and spread it as we recommend.

Without a rick cover, or some other protection against the wet, hay is less safe in a thin layer on a rick than in field-cocks. But we insist that every farmer, no matter whether he saves 5 tons or 100 tons of hay annually, should possess some such means of protecting the crop. Without it he cannot calculate with certainty on making first-class hay. We repeat, then, that on the afternoon of the third day the hay mown on the morning of the first may be carried to the rick, over which the rick-cloth should be placed; and, in order to prevent the deposition of dew on its inner side, the ridge pole should incline at a considerable angle.

As early next morning (if dry) as evaporation commences, the rick-cloth should be wound off, so as to expose the layer of hay to the further drying action of the sun; and on the approach of a shower, or towards dew-fall in the evening, the rick must again be roofed over.

Covers of the best canvas, 40 feet long by 30 feet broad, and fitted with pulley blocks, ropes, and spars, as shown in figure 50, can be made in this country for about £15. The cover is mounted by erecting a spar about 10 feet longer than the height of the rick, is fixed at each end of, and securely fastened by "guy" ropes; a ridge pole is made to rest on them, and on this is placed the cover which is raised to the required height by means of pulleys.

Fig. 50.



The hay as it is ready—whether on the third, fourth, or fifth day after it is cut—is "carried" and put on in a layer which has the advantage of next day's drying on the rick.

In the foregoing narrative we have assumed that no rain has fallen during the saving of the crop. Should rain fall, it will delay the carrying; but the farmer is not to blame for this, and can only regret what he cannot help. He is to bide his time; and, when the sun shines auspiciously once more, is to re-open his cocks, turn the hay, if there be time and a prospect of its being done with safety, and carry it home on the first favourable opportunity.

LESSON XXVI.

In nearly all works on agriculture the rules prescribed for making hay from clover and other "artificial grasses," are different from those for the natural grasses. It is said with truth, that the leaves of clover are more easily injured than those of ordinary meadow grasses; and that, in consequence, the former should be "gently" turned, and not tossed about by a tedding machine! Every man acquainted with haymaking on an extensive scale will agree with us, that, however sensible such remarks may appear, they cannot always be followed. The farmer should therefore turn over his clover carefully as soon as its upper surface gets a little dry, the large farmer using the tedder for the purpose. A few bits of dried leaves may get broken, but, compared with the injury done by rain and sun, in the slow practice usually adopted, the injury done in this way is very small. It must, however, be borne in mind, that while the average quantity of moisture contained in the most valuable natural grasses is about seventy per cent., the clover and trefoils on an average contain eighty per cent. of it. And accordingly we find it takes about a day or so longer to make clover hay than upland meadow hay.

Frequent mention has been made of the hay-rick, on the making of which we have to offer a few additional remarks. The hay is built on staddles or stands. The staddles are usually made of stones, loosely thrown together; but such a site becomes the resort of vermin, which taint and destroy a portion of the hay. The rick may be built on metal stands, which are now so commonly used for corn. Many intelligent agriculturists prefer, as being equally efficacious and cheaper, the erection of three narrow walls, about 2 ft. 6 in. high, and running parallel with each other the entire length of the rick; across which are laid spars of wood or branches of trees, the interstices of which are filled in with brushwood. The hay is then laid on; and if this be done carefully, there need be no apprehension of its undue fermentation. In any case, the following maxims may be borne in mind.—1. To break up the lumps of hay, and to spread it evenly. 2. To employ as few people as possible in tramping it; and to take great care that those so employed will walk equally over all parts of the rick, so as to prevent the unequal compression which would otherwise occur.

To check the fermentation of hay ricked in the ordinary way, various expedients are resorted to. The most common plan is to form chimneys by hauling up as the work proceeds, at intervals of 6 or 7 yards, well-stuffed bags. These openings should communicate with the external air by a vent running horizontally at about one-half the height of the crown of the rick. The vent may be formed of three long spars, united into a long crib by 18 in. pieces of wood nailed across them, the transverse section being in the form of a triangle, resting on its base. It must be confessed that the hay exposed to the air in these ventilators will suffer from contact with it; but with soft meadow hay, hurriedly saved so as to avoid rain, &c., in the field, some such plan is absolutely necessary. A suitable mode of ventilation, free from the objection raised against open flues, may be adopted. Cribs similar in shape, but different in construction to that described, may be laid across the rick at different heights, and at an inclination to permit the escape of any gases that may be generated, as well as of the heated air; and by having their transverse section a little greater at the higher than at the lower end, they could be withdrawn when the hay is out of danger. Each adjacent pair should incline to opposite sides, so that, by being simultaneously withdrawn, the rick may not be turned to one side.

Most cattle and horse feeders agree in thinking that a gentle fermentation sweetens hay, and also acts beneficially, by aiding the process of digestion. But highly-fermented or *mow-burnt* hay is said to produce an excessive secretion of urine in horses, which weakens them, and it has been often known to produce abortion in cattle. A high degree of fermentation in hay is generally succeeded by fungi (such as *Penicillium* and *Aspergill*); and there is every reason to believe that the spores of these are poisonous. It is found very useful to sprinkle salt over each layer of hay. It (1) sweetens the hay, and acts as a condiment in the animal system; (2) absorbs moisture, and thus checks fermentation; and (3) destroys insects, the eggs of insects, and the spores of fungi. A stone and a half of salt to every ton of hay will be found sufficient for ordinary purposes; a little more may be used with soft and inferior hay.

The practice of putting on the rick a few layers of straw has also been recommended. Oat straw is the best for the purpose. It serves two advantages: 1st, as the straw which is a year old contains much less water than fresh hay, it prevents an injurious degree of fermentation in the rick; 2nd, the hay sweetens the straw, and enables us to feed with it more largely than is usual. Straw has been successfully mixed with hay in the rick for a very long period; and no doubt it would be more general were it not that the year's supply of straw is nearly all used at haymaking time. A week or so after the rick is formed, and when it has settled, it should be carefully thatched.

LESSON XXVII.

An Inquiry into the Loss arising from the present defective Mode of managing the Hay Crop.—Of all the operations of practical agriculture, there is none, perhaps, more slothfully practised by the Irish farmer than that of hay-making. While many an industrious man labours hard to produce good crops of corn, and to lay down his land in a clean state, we find a recklessness in saving the hay crop which causes surprise and astonishment. The Scotch farmer, too, seems to have neglected this branch of husbandry to a degree which almost detracts from the national excellence of Scotch agriculture. The author of "The Book of the Farm" describes the national defects in Scotch husbandry in language which is equally applicable to Ireland. "The Scotch practice," says that experienced author, "allows the grass to lie on the ground, when cut, till it is bleached by the rain, scorched by the sun, rotted by the growth of the aftermath penetrating through the swaths; puts the weather-beaten swaths together as fast as possible into as large cocks as will keep the hay without heating; and permits these cocks to stand on the ground till the grass under them is destroyed."

The hay crop suffers deterioration chiefly from the following causes:—1st, rain; 2nd, loss of fragrance by fermentation, &c.; 3rd, loss of colouring matter; 4th, it is allowed to remain on the field until a portion of it is rotted away; and this again involves loss of aftermath.

1. Hay contains a considerable quantity of matter soluble in water, varying, according to experiments on our own hay, from 6 to $8\frac{1}{2}$ per cent., and all of which is liable to be washed away by excessive rain.

With the view of determining the solvent action of rain on hay, the author caused two specimens made from the same grass to be analyzed. Both were mown at the same time. One was saved without any rain; the other was saved in the open field in the ordinary way, and received, while drying, a fall of 0·303 inches of rain, as indicated by an accurate rain-gauge; the result was, that the constituents which may be regarded as nutritive were reduced from 50·09 to 49·12 per cent., or say 1 lb. in every 100 lbs.; and as every 100 lbs. of this hay contained only 50 lbs. on which its value as food depends, the money value of the hay suffered to the extent of 2 per cent. This gives a deterioration of about 1*s.* 6*d.* per ton, or 3*s.* per statute acre all over Ireland. When it is considered that we often have a fall of half an inch of rain in the day at the hay season (and in some places it is as much as one inch), there can be no difficulty in comprehending the powerful solvent action of rain; indeed there is reason to suppose that it will be in proportion to the amount of rain-fall, so long as any soluble matters remain in the hay. And it is necessary to state that the solvent action of rain is not confined to the portion merely soluble in cold water; for it was found by Thompson that while 387½ lbs. of grass contained 28 lbs. soluble in hot water, the resulting 100 lbs. of hay contained only 16 lbs., showing a loss of 12 lbs. in every 100 lbs. of hay. Coupling these considerations with the rain-fall in Ireland, we will not be considered to overstate the case when we assume that, during the process of haymaking, the Irish farmer permits the rain to run away with 5 per cent. of the valuable constituents of the crop.

2. The loss of the fragrance of hay deteriorates its value to an extent which has never been estimated, and which it is not easy to determine. The peculiar fragrance of hay is produced by a volatile organic compound (*Coumarin*), which is readily extracted by alcohol, and which does not directly contribute to animal nutrition, but which is, nevertheless, beneficial. It is, probably, the same compound which imparts any extra value they possess to those cattle foods which are puffed off at such exorbitant prices. In excess it produces an injurious effect upon the brain of all animals; but in moderate quantity it incites a healthy action in the glands that secrete the saliva, without a due quantity of which all the nutrient constituents of the food (hay included) cannot be digested and assimilated.

When hay ferments, the alcohol, in the presence of water (rain), dissolves the coumarin, and thus dissipates the fragrance of the hay, and deteriorates its value. And, though we cannot fix with any degree of accuracy the injury done to the hay, yet, in practice, we find a difference of 50 per cent. between well-saved and very badly saved hay from the same ground. This difference could *not* be produced by the action of any amount of rain in washing out the soluble nutritive constituents of the hay, nor to the loss of fatty matter, and must, in a great measure, be attributed to the medicinal action of the coumarin, precisely in the same way as the seeds of the Fœnu Greek (*Trigonella fœnum Græcæ*) act in the prepared cattle-foods now sold to the public.

3. The natural green colour of the grasses should, as far as practicable, be preserved in converting them into hay. The colouring matter is a vegetable fatty or waxy body, named *Chlorophyll* or *Phytochlor*, which, like coumarin, is separated by alcohol. When the grasses dry in the open air, this substance becomes oxidized, and the more oxygen it takes, the more the colour changes. The autumn tint is due to the oxidation of the chlorophyll.

It is evident, therefore, that the sooner hay is ricked the better; for the longer we expose it to the air, the more it becomes oxidized and diminished in value. If ricked too soon, however, the loss of coumarin by fermentation (without speaking at all of the loss of sugar, &c., from the same cause) would more than counterbalance the advantages of retaining the chlorophyll. Dr. Thompson's experiments most clearly show the loss that is sustained by the discoloration of hay. He found that 100 lbs. of rye-grass contained 2·01 lbs. of wax; 387½ lbs. of grass = 100 lbs. of hay should contain 7·73 lbs. of wax, while the 100 lbs. of hay actually contained only 2 per cent. of it; so that in the process of hay-making there was a loss of 5·78 lbs. of wax in every 100 lbs of hay, which amounts to upwards of 10 per cent. of its nutriment.*

* Young says: "A difference of an hour in a very hot, drying day is supposed to occasion a loss of 15 to 20 per cent. on the hay by its being carried beyond the point of perfection."—*Farmer's Calendar*, p. 352.

Some physiologists are of opinion that wax possesses no nutritive

4. That a considerable quantity of hay is lost annually, by being allowed to remain too long in cocks in the field, is a fact patent to anybody who has travelled much through the country. We have made agricultural tours through every part of Ireland; and from careful consideration of the subject, we have come to the conclusion that one-twentieth of the hay crop of the country is permitted to rot in field cocks. The portion on the ground, as well as that on the outside of the cocks, is, too often, only fit for manure. And the loss of aftermath, and of the subsequent year's crop (if hay or pasture), suffers to the extent of from 6*d*. to 1s. per acre.

If we unite all these foregoing sources, the loss annually sustained in this country is something serious to contemplate. On an average for all Ireland, it is not under 20 per cent., or a fifth of the actual value of the crop. We have about 1,500,000 acres under meadow in Ireland, the average produce of which is about 2 tons per acre. The total hay produced, therefore, is 3,000,000 tons; the value of which, in round numbers, amounts to about £10,000,000; and of this sum one-fifth, or £2,000,000, is lost by bad management.

SECTION VIII.

FLAX.

LESSON XXVIII.

The Flax crop (*Linum Usitatissimum*) gives the raw material for the manufacture of linen, which has long formed the staple industry of Ireland. Flax is profitably cultivated in a great variety of soils, but deep friable loams are best adapted to its growth. It is unsuited for wet lands, such as adhesive clays, or very light and dry land, such as light sands. While an excess of moisture is inimical to the crop, it delights

property. Mr. J. B. Lawes says, "It is certain that green plants contain abundance of wax, quite worthless as food."

in what are called cool soils. Very heavy crops of flax have been raised on reclaimed slob lands; and with the exceptions above referred to, flax can, by skilful management, be grown on all arable land.

The place which flax occupies in the rotation, having been already considered (*vide* Lesson iii.), the first point we have to consider in connexion with this crop is the tillage of the ground. It cannot be too often impressed on the attention of the farmer, that there is no farm crop which requires such careful cultivation as flax. When the ground is cultivated, and the crop managed with skill and care, flax is one of the most profitable crops raised in this country. On the other hand, when neither skill nor care is bestowed on its management, flax is the least profitable crop on the farm. Bad, or even negligent tillage, ought to be held as utterly incompatible with the profitable growth of flax.

In order to grow a good paying crop of flax, the surface soil must be reduced to a very fine state of tilth; secondly, it must at the same time be moderately firm, and thirdly, the surface must be as level as possible, so that the plants would grow to a uniform length, and ripen at the same time.

The first and second of these conditions, are best secured by giving the land, in autumn, a deep and efficient ploughing or digging, and in spring a shallow ploughing, grubbing, or forking, followed by a complete pulverization with the harrow and rake. The deep autumn tillage loosens a sufficient body of soil, and enables the air to act upon it. The shallow spring cultivation has several advantages. In the first place, it leaves in the surface layer of soil, the fine mould and plant food, produced by frost; secondly, we thus obtain the necessary pulverization of the surface; and thirdly, as the surface layer of soil is frequently rolled, and that beneath it is not at all stirred, we obtain the necessary degree of firmness in the seed bed. The firmness of soil here referred to, must not be confounded with hardness or want of pulverization: a well tilled and pulverized soil may be firm but not hard. The amount of tillage which the land should receive in preparation for flax, varies of course with the condition of the ground. Sometimes two ploughings, or a ploughing and grubbing are required in spring. The last ploughing is given some time before sowing, so that any seeds of weeds in the ground would have time to vegetate, and that the weeds themselves would be afterwards destroyed by the harrow.

The proper time for sowing flax, varies with the climate, &c., the second week in April being usually selected by good farmers in favourable seasons. Immediately before sowing, the ground is rolled; and on the even surface thus produced, the seed is most carefully and evenly sown, and covered to the depth of an inch, by giving two or three turns of a light seed harrow.

In order to distribute the seed more evenly, the harrow should go up and down the field first, then across it in lines parallel to one of the diagonals, and lastly, straight across the field, or up and down again. After the ground is sufficiently harrowed, it should be rolled with a heavy roller. The quantity of seed varies with the condition of the land, the season, and the quality of the seed itself. The richer the soil is the more seed should be sown, for if sparingly sown on rich land, the plants grow so strong, that the fibre becomes coarse and greatly reduced in value. On good flax land in suitable condition, two bushels of good seed per statute acre are enough.

Good imported seed gives a better crop than home-saved seed. The best imported seed is the produce of plants which have been allowed to arrive at full maturity before pulling them. It is considered, that for general purposes, the best seed comes from Riga; but for strong land many prefer Dutch seed. Flax is, like all other seeds, adulterated with various other seeds, including the seeds of weeds, of which it should be freed, by passing it through a fine sieve, containing twelve bars to the inch, which could be made to fit into a common winnowing machine.

One of the most common objections urged against the flax crop is, that it fills the ground with weeds. It is too true that in most cases land is left in a very dirty state after flax, but this arises chiefly from dirty seed, and not bestowing proper care on the preparatory tillage of the ground.

When the flax plants are about six inches long any weeds which threaten to interfere with their growth should be removed by young persons, who should be directed to move in the face of the wind, so that by their onward movement the plants thrown down may more readily regain their position. Strong weeds, the pulling of which would loosen the roots of the flax, should be cut with blunt knives below the surface.

The proper stage in the growth of flax, at which it should be pulled, has been the subject of much controversy. When, as in many parts of the Continent, the principal object of the flax grower is to obtain a large crop of seed, there can be no doubt whatever that the plant should be allowed to mature the seed; but it is well known that the quality of the fibre is thereby greatly deteriorated. On the other hand, when the principal object is to produce fibre of the best quality, the plants should be pulled before the seed is fully formed. The experience of the best flax farmers in the north of Ireland and in Belgium is, that in order to obtain fibre of the finest quality, the flax should be pulled when the seed is beginning to swell. When pulled thus early, however, there is such a great waste in scutching and hackling that the yield is small, and the management of the plant requires more than ordinary skill; but when that skill is applied, the greatest profit is thus obtained. In this case the seed is entirely sacrificed. Some people, again, pursue a medium course, and pull the crop when the seeds are beginning to change from a green to a brown colour, and the stems have become yellow to about two-thirds their height from the ground. In this way we obtain about five times the quantity of seed sown, or ten bushels per acre worth, for feeding purposes, about 6*s.* a bushel, and fibre of second-rate quality. This middle course is best suited to the *present* circumstances of Irish farmers, who want the skill to produce fibre of the very finest quality.

It often happens that from want of care in preparing the ground, &c., the flax plants grow of different lengths, and are not fit to pull at the same time, which causes great loss to the farmer. When the crop does not mature uniformly the fibre must of course be of mixed quality. And if the plants be of unequal length, or care be not taken to keep the plants even, like a brush, at the roots, there is great loss to the spinner, and more especially to the spinner of the finer yarns, and of course to the farmer. The loss may be explained in this way. If we divide the stem of a flax plant into three segments we shall find the quality of the fibre of the middle segment is finest, the segment next the root ranks next in quality, and the fibre in the uppermost segment is the least valuable of all. Accordingly the flax is in first-class mills cut into three parts, and each part spun separately from the others. Now, if long and short plants be cut up together, it is evident that part of the upper or least valuable part of the shorter one will be mixed with the middle or most valuable section of the larger one. It is better, therefore, to separate the different lengths in pulling the crop. "When there is much second growth the plants should be caught by the puller just underneath the bells, which will leave the short stalks behind. When any of the crop is lying and suffering from wet it should be pulled as soon as possible, and kept by itself."

The several handsful of pulled flax should be crossed on the ground to prevent the bolls from getting entangled.

LESSON XXIX.

In the subsequent management of the flax crop different systems are adopted. In the north of Ireland the common practice is to convey the flax to the watering pond the day it is pulled, the seed being sometimes previously removed by an instrument called a *ripple*, which usually consists of "a row of teeth eighteen inches long, made of half-inch iron, three-sixteenths of an inch asunder at the bottom, and half an inch at the top. The teeth should be fixed so that the angles would be next the ripplers; and each should begin to taper three inches from the top."

Many flax growers do not ripple the seed at all, and allege that its removal injures the fibre. The rippling process must lacerate the upper branches of the plants, but the fibre of these is not very valuable. The presence of the seed in the water by promoting putrefaction is probably of some use. The result of our own observation is, that when fibre of the finest quality is sought for the bolls should not be removed; and as in this case the flax is pulled long before the seed is fully formed the cost of rippling (which is at all times an expensive process), may equal and even exceed the value of the seed. On the other hand, when, as in this country, the flax is not pulled until the seed changes to a brown colour and the stems become yellow for two-thirds their height from the ground, the value of the seed for feeding purposes considerably exceeds the cost of rippling. The present wholesale sacrifice of seed in Ireland cannot, therefore, be justified, except on the ground often urged by small farmers, namely, want of lofts or rooms for drying it.

The fibre of flax adheres firmly to the *shove* or woody part. In order to effect their separation the flax is placed in water for several days. The quality of the fibre is greatly influenced by the quality of the water used, and the skill and care bestowed on the watering process. Soft or river water is better than hard or spring water. Water containing much iron is highly injurious to the fibre; and it has been observed that water in which trout cannot live should be avoided. Every flax grower should have good steeping pools, which should be carefully cleaned and dressed some time before they are required for use. The Flax Society of Ulster recommends that these pools should be from twelve to eighteen feet wide, and from three and a quarter to four feet in depth in the upper to four feet in the lower end.

When only spring or hard water is available it should be let into the pool some weeks or even months before it is required, so that the sun and air would soften it; but good soft or river water need not be let into the pool until a few days before steeping the flax.

The pool being ready, the flax is placed in it, root end undermost, and in such a sloping position that the band or tie of each row of sheaves shall lie on the roots of the last row. A layer of rushes or ferns is placed over the flax, and the whole covered with large flat stones, or sods cut from old lea. Additional weight is put on when fermentation has well set in, and removed again as soon as fermentation has subsided.

The time required to steep flax varies from a week to a fortnight, according to the nature of the water, the heat of the weather, and the quality of the flax itself. There is not perhaps in the entire management of the crop, a point requiring so much anxious care as the proper time of lifting it out of the pool. If not sufficiently watered there is great loss of fibre in scutching, and if over watered its quality is also greatly injured.

The Ulster Society recommends the following test:—"Try some stalks, of average thickness, by breaking the shove, or woody part, in two places, about six or eight inches apart, at the middle of the stalk; catch the broken bit of wood, and if it will pull freely out, downwards, for that length, without breaking or tearing the fibre, and with none of the fibre adhering to it, it is ready to take out. Make this trial every six hours, after fermentation subsides, for sometimes the change is rapid."

When sufficiently watered the flax is carefully lifted out of the pool by hand; the sheaves are placed for twelve hours, or more, close together in an upright or slanting position on grass, to allow the water to drain out of them; and they are afterwards evenly and thinly spread on short grass, on which they are allowed to remain for six or eight days in showery weather, and from ten to twelve in fine weather. In order that the rain and air may not discolour the flax, it is turned on the grass two or three times, either by hand or with a rod about eight feet long, and about an inch in diameter. It should be lifted when, on rubbing a few stalks from the top to the bottom, the wood breaks easily, and separates from the fibre, leaving it sound; or, when a large proportion of the stalks are perceived to form a bow and string, by the contracting and separating of the fibre from the woody stalk. But the most certain way is, to prove a small quantity with the hand-break, or in a flax mill.

When sufficiently grassed, the flax should be carefully lifted, set up to dry for a short time, then tied into sheaves, and for the reasons already assigned, the ends should be evenly put together. It is then made into small stacks, in which it is kept till required for scutching.

Immediately before scutching flax, it is dried, by opening and exposing it to the sun. The practice of kiln drying so common in this country is most pernicious, and ought to be abandoned at once.

The second mode of treatment is known as the *Courtrai* system, and consists in stooking the flax the day it is pulled, and afterwards making it into small ricks in the field, and allowing it to remain there until the seed is dry enough to admit of the crop being put into stacks or houses, in which it remains until it is found convenient to water it. In this case the handfuls of flax, as they are pulled, are placed in rows on the ground, the bolls and roots of every adjoining pair of handfuls being reversed. As soon as a few perches are pulled, boys or girls lift the handfuls and give them to a stooker, who builds them into a stook (⋀ shape), the handfuls being placed alternately on both sides of the stook, the roots being of course kept on the ground, and the bolls at the top. It is recommended to make the stooks from eight to ten feet long; and both ends are tied by strapping round them a few plants, from the fourth last handful on both sides.

An experienced man will stook the produce of a statute acre in a day, and require two boys or girls to fetch him the handfuls. In a week afterwards the flax is tied into sheaves about ten inches in diameter, and these are afterwards made into ricks of convenient length, about seven feet high, and equal in width to the length of the sheaves. With the view of raising the sheaves from the ground, it is usual to place two poles parallel on the site of each rick, about a foot asunder; the sheaves are laid across them, the tops and bottoms being placed alternately; when the height reaches about seven feet, a sort of roof is formed by placing other rows of sheaves in the direction of the length of the rick, and the whole is covered with straw, and carefully bound with ropes. Flax keeps in those ricks until it is convenient to store it in stacks or houses. This system possesses great advantages, when from any cause the flax grower in any one year is unable to procure an adequate supply of water at the flax pulling season. He should then stook his flax, collect water in properly constructed pools next spring, and steep the flax crop in summer when the weather is warm enough.

PART IV.

LIVE STOCK.

SECTION I.

ON THE BREEDING OF LIVE STOCK.

LESSON I.

The rearing and feeding of live stock form an important branch of farming in this country. The importation of grain from foreign countries is likely to keep down the price of bread; but there is no reason to suppose that the price of fleshmeat is likely to be unremunerative to farmers. Though we import bacon from America, and live cows and sheep from Spain and other European countries, yet the supply of meat does not appear to be keeping pace with the increasing demand created for it by the increasing wealth of the Empire. The small farmers of Ireland must adapt their system of management to this state of matters. Heretofore their chief dependence was on grain crops. For the future (at all events as long as prices continue as at present), they must produce more meat and dairy produce. In other words, to make the most of their holdings they must grow more root and forage crops, and keep a greater number of live stock, and of a better description, than they have hitherto done.

The profit derived from live stock, depends greatly on its quality. Animals of an inferior description which are badly housed, or which do not handle well, cost fully as much for attendance and house-room as those that possess the best shapes and quality, and they also eat more, and take a far longer time to fatten.

The quality of the live stock in Ireland has improved immensely of late years. The improvement is perceptible everywhere. Still, it is notorious that it has not become as general as it ought; and that there are thousands of small farms in the country, the live stock on which is unprofitable. There were in Ireland, in 1864, more than half a million of horses, about three and a quarter millions of cattle, a greater number of sheep, and upwards of a million of pigs. The gross value of the whole of these may be put down at about forty millions sterling. Some of the most intelligent farmers in the country think that by carrying out improved modes of breeding and management, this total could be increased twenty per cent. in five years. As the greatest improvement is to be effected on the small holdings, it follows that the greater portion of this increased wealth would accrue to the small farmers of the country. The first great means of effecting this object is to diffuse among the people correct notions on the subject of breeding.

The production of animals is governed by laws which science makes known to us, and which the enlightened breeder keeps continually before his mind. The first of these laws is embodied in the popular old saying, "Like begets like." The offspring partake of the appearance, disposition, peculiarities, and even diseases of parents; and the closest resemblance is often traced to ancestors several generations back.

Subordinate to this law, there is another important principle, namely, any race or breed of animals is susceptible of having some of its properties modified, and the new properties thus acquired are, like the permanent qualities of the race, capable of being transmitted from generation to generation. Thus food, climate, &c., change the covering and even the shape of animals. In the modern improvement of cattle, sheep, and pigs, the grand object has been "to establish the supremacy of the stomach, and dethrone the empire of the head; and at the same time diminish, as much as possible, the development of the nervous system, which would induce too much irritability, and destroy that indolence and quietness so essential for the fattening process." Short-horn cattle, Leicester sheep, and Yorkshire pigs, illustrate this very well. The head and bone have been made finer; the offal has been diminished, and the valuable parts increased; and the nervous system has been so subjected to the influence of the stomach, that the animals may be described as perfect machines for the manufacture of meat. Now, although all these characters have been impressed upon these breeds within three-quarters of a century, they are transmitted with almost unerring certainty.

When new properties are impressed upon animals in this way, a new breed or variety is established. As long as it is kept from mixing with any other breed, it is said to be *pure*, and possesses a *pedigree*. The breed of horses called "thorough-bred," has a long pedigree, which is recorded in a stud book. Several established breeds of cattle—short-horns, Herefords, and Devons—have their pedigree registered in herd books, which a farmer who breeds such cattle should study.

The power of an animal to transmit the qualities acquired in this way to its offspring, is in proportion to the age of the breed and purity of the blood, or what is sometimes called the length of its pedigree. Of all established breeds of animals, thorough-bred horses have the longest pedigree; and accordingly we find they have the greatest power of producing their own qualities in their offspring. Short-horned cattle and

Leicester sheep, from the purity of their blood, have, it is well known, extraordinary power of transmitting their own good qualities to their young.

The small farmers of Ireland commit a great mistake in neglecting these principles. They sometimes travel miles to reach an animal which has no pedigree, merely because he is a shilling or two cheaper than a pure bred one nearer home. They lose time and labour in going the extra journey; and they often lose as many pounds in the value of the offspring as they save shillings in such an effort of economy. The young of the cheap sire do not reach their full size or "maturity," as it is called, as soon as those from the pure breed. The difference in the maturity of the two animals may be a year. There is thus a year's feeding wasted. This may well be called the shilling wise and pound foolish system.

LESSON II.

On Crossing.—When we put a sire and dam of different but pure breeds together, the result is termed a "cross." When we put a pure-bred sire with a dam of no established breed, or *vice versâ*, we are also said to cross. Both systems of crossing are extensively adopted. In Ireland the latter mode generally prevails, owing to the limited number of pure-bred animals in the hands of farmers; and considering the high price of pure-bred stock, it is the better system for the small farmers of Ireland, whose capital is limited. To produce the greatest quantity of meat with the means at their disposal, they have only to use care in the selection of dams, and hire the best sires they can afford. By using pure blood always on the male side, and by "weeding," *i.e.*, rejecting from the breeding stock every female which has any marked defect, they would rapidly improve their stock and increase their capital. The better class of heifers and bullocks offered for sale in the fairs and markets of Ireland is the result of crossing short-horn bulls with the common cows of the country. The fine class of sheep which one meets with, under the name of Ballinasloe sheep, has been produced by crossing the native ewe with tups of the established breeds of long-woolled sheep in England, especially the Leicester. And the improved pigs which one sees here and there throughout Ireland owe their good points to the use of good boars of the established breeds of swine, more particularly the Berkshire and Yorkshire. We desire to see this system, which has enriched the few who have adopted it, practised by the public generally. If followed out with skill and judgment for some years, new breeds could be established, combining those qualities which the soil and climate of Ireland have stamped upon the native stock, with the good qualities of those pure breeds which the genius and enterprise of English and Scotch farmers have established in Great Britain. It is worthy of remark here, that if we except the Kerry cow, we have not in Ireland a pure breed of any class of domestic animals.

Breeding "in-and-in," called also *"close"* breeding, consists in using animals closely related in blood. Experience tells us that indiscriminate in-and-in breeding is followed by pernicious results. The constitution is weakened, proneness to disease is engendered, and many diseases inherited from ancestors several generations back, and which may never appear under other circumstances, make their appearance, and perhaps in a virulent form. Breeding in-and-in changes almost every feature of the animal. If carried too far, the skin becomes papery, and less capable of protecting the animal from cold; hence, close-bred animals are more subject to consumption and other affections. When skilfully practised, breeding in-and-in has, however, great advantages; the bone becomes smaller and finer, the body more symmetrical and less encumbered with offal or waste, and a tendency to early maturity is induced. Short-horn cattle are now fit for the butcher at from two to three years' old; formerly it used to take four and five years. Leicester sheep, weighing 25lbs. a quarter, are now sent to market in excellent condition at the age of fifteen or sixteen months; formerly it used to take three years and upwards to bring them to maturity. And some of our improved breeds of pigs are now sold as fully fat porkers at the age of nine months and under.

Now, it must not be forgotten that though crossing was the first step in the production of established breeds of live stock, yet when brought to a certain stage, breeding in-and-in was resorted to. One instance may be selected. The celebrated short-horn bull, *Comet*, and his dam, *Young Phœnix*, were out of the same bull, *Favourite*. In breeding Leicester sheep, near relationship prevailed oftener than in short-horns, and many pig breeders have practised it to a very great extent. But though in the original improvement of our best breeds of stock close breeding was successfully adopted, the necessity for it has to a great extent passed away. It is practised, however, at the present day by some of the most eminent breeders of short-horn cattle, Leicester sheep, and improved pigs in these countries; but such injurious results have followed from very close affinities, that the inexperienced cannot be too strongly cautioned from attempting it. Close breeding always did require, and always will require, great care in the selection of healthy and vigorous animals. When, however, the parents are vigorous and free from diseases, especially what are called *blood* diseases, the injurious effects of breeding in-and-in are less apparent.

SECTION II.

ON THE FOOD OF LIVE STOCK.

LESSON III.

We may breed our farm animals with the utmost skill and care, but our labour will avail little if we do not afterwards supply them with proper food. The appearance, condition, and profitableness, of live stock depend greatly on their food and mode of keeping. By careful observation of the laws of breeding, we can vary the shape and other qualities of our stock, to suit our very whims. If our cows are deficient in flesh on the hind quarter, or their ribs are not as well rounded as we think necessary, or if they are defective in other points, we can correct these defects by using bulls which have these points well developed. But the animals so produced cannot prove profitable unless they are supplied with adequate nourishment, and, when necessary, provided with adequate shelter. The improved breeds of cattle and sheep, of which mention was made in the foregoing chapter, would revert more or less to their original state if we should fail to supply them with proper feeding. In practice good farmers not only supply them with good grass in summer, but also give them hay, roots, grain, and oil-cake in winter. And while they owe their great merits to skilful breeding, it is well to bear in mind that their pre-eminence is also due in a great measure to the introduction of root crops. It has been observed, that while the Brothers Colling and Robert Bakewell were producing the cattle and sheep with which their names are honorably associated, Arthur Young and others were teaching the farmers how to grow root crops for their winter keep.

In Ireland good winter keep must go hand in hand with every improvement in breeding. Hay and artificial cakes of different sorts, together with grain, aid the farmer in carrying his stock through the winter; but every farmer who keeps cattle and sheep during winter should grow some roots. Farmers who depend largely upon dairy cows, could nearly double the yield from those cows by giving them roots during the winter season. The cows would then milk throughout the winter. At present, owing to want of proper winter keep, they run dry early in winter, and give milk only for a period of five or six months in summer.

There is also a great loss in store or young stock when they are not properly fed in winter. They lose flesh, and it takes a great deal of grass afterwards to restore their lost condition; and it too frequently happens that deficiency of food and want of shelter give such a check to young stock that they never thoroughly recover themselves afterwards.

The folly of neglecting to provide adequate food for stock will be best understood by explaining, in a simple way, the various purposes it serves in the animal economy. The constituents of food may be grouped into six divisions, as follows:—

1. Water.
2. Starch, sugar, &c.—compounds identical in composition and supposed to be equal for feeding.
3. Oil or fatty matter.
4. Flesh-forming material, such as gluten.
5. Woody or indigestible fibre.
6. Ash, or mineral matter (a large portion of which is composed of phosphate of lime, the well-known substance of bones).

The value of any feeding substance depends on the proportions in which these six groups of constituents exist in it. The food which the animal takes in through its mouth passes into the stomach (or stomachs, of which the cow and sheep have each four, and the horse and the pig only one each); after being subjected to various influences in this organ, the indigestible or innutritious part passes away through the intestines, and the assimilable or nutritious part is conveyed to the blood. It is evident from this that one condition of successful feeding is that as little as possible of the nutritive part of the food should go to the dung heap.

Overlooking water, the constituents we have first to consider are sugar, starch, and similar compounds. These, it has been found, are necessary to the production of animal heat. Animals could not exist without heat; and the heat they require is principally kept up by the consumption of starch, sugar, &c., which are, therefore, very properly called heat-givers. It is remarkable that the temperature of the body of an animal is about the same in all climates, provided it is properly fed. The blood of man, *e.g.*, is as warm in the Arctic as in the torrid regions of the earth. In the former, or colder climate, he must eat more carbonaceous food, or more starch, sugar, and other compounds capable of supplying carbon, to keep up animal heat.

The same holds good with regard to live stock. If we leave them exposed to cold, they must eat more food (which is thus wasted), to keep up the required temperature in the body. All good farmers know this, and provide adequate shelter for their stock. They know also that besides the greater quantity of food which badly sheltered stock require, animals cannot thrive properly unless they are protected from inclement weather.

The wretched condition of a vast number of domestic animals in this country is thus easily accounted for. Not only are they ill-bred, and their food inadequate, but they are left exposed during winter in the open fields or "bawns." Horned cattle require shelter in winter. Many good farmers keep them in day and night, giving them roots, with hay and straw. In no case should they be left out at night during winter. Sheep farmers should provide shelter-sheds and plantations to protect their flocks during severe weather. Nor is it necessary that much expense shall be incurred in providing ample shelter either for cattle or sheep; a few rough poles, and boards, will suffice to construct sheds which will serve the purpose quite as well as if put up on the most expensive plan.

LESSON IV.

All our cultivated crops, and almost all feeding substances, contain fatty matter, which, like starch and sugar, is digested in the stomach, and passes into the blood. It has the same composition as the fat of animals, and the inference is that the fatty matter of the food goes to form the fat of the animal body. We know that the animal system is capable of making fat out of starch and sugar, &c., which are not fatty compounds. If we feed an animal on food destitute of fat, but containing an abundance of starchy materials, the animal does not necessarily lose condition, and even the quantity of fat in its carcase may increase. Starchy matter contains every element required to form fat; and in practice the greater portion of the fat of animals is derived from the starchy matter of the food. In the case of pigs it has been found that the fatty matter of their food amounts to less than one-fourth the quantity stored up in the increased fat of the animals. There is this difference, however, between the fatty and starchy matter of food as producers of animal fat. The composition of the fatty matter of the food is analogous to or identical with that of animals; while in starch, sugar, or gum, the elements are differently combined. An animal can, therefore, produce its own fat from the fatty matter of its food more readily than from compounds not fatty in their nature, like starch, sugar, and gum. A pound of fatty matter is supposed to be equal to two and a half pounds of starchy matter for feeding purposes. The more fatty matter, therefore, any kind of food contains, the better it is adapted for the fattening of stock. Linseed (flax seed) contains 34 per cent., or about one-third of its weight of oil; and is, when properly used, one of the most rapid fat producers we have. The oil is, however, so valuable for other purposes, that the seed is pressed in powerful mills, the oil extracted, and a solid residue or *cake* is obtained, which still contains about 12 per cent. of oil, and is sold under the name of oil cake or linseed cake. Oil cake from linseed, when free from adulteration, is one of the best substances which the farmer can use for fattening cattle and sheep. Enormous quantities of it are now sold at £11 a ton. It is given to cattle at the rate of from 1 lb. or 2 lbs. per day, when put up to fatten; and 4 lbs. and upwards, as the fattening process advances. It should always be broken fine; and as it is adulterated to a great extent, the farmer should make it a rule to deal with men of acknowledged respectability. Rape seed, which contains a great deal of valuable oil, is also pressed in the same way; the oil, called colza oil, so extensively used in lighting lamps, is sold to the oil merchants, and the cake (rape cake), which contains about 11 per cent. of oil, is sold to the farmers, at from £6 to £7 10s. per ton. Compared with oil cake, rape cake appears very cheap. It does not, however, agree with cattle or sheep as well as linseed cake, owing to a small quantity of some peculiar compound which it contains. Before using rape cake it is recommended to subject it to the action of boiling water, which dissipates this compound. We are of opinion that rape cake pays best when given to store stock; for notwithstanding the higher price of linseed cake, we fully believe it pays better than rape cake for fattening cattle or sheep.

A cake, called cotton cake, is obtained from the seed of the cotton plant. When made from the whole seed, it contains 6 per cent. of oil, and upwards; but in this state it contains so much husk or indigestible matter, that animals have died from inflammation of the intestines, caused by the lodgment therein of this hard woody matter. When the cake is deprived of this husk, and becomes what is known in the market as "decorticated" cotton cake, it forms a wholesome food, especially for store stock.

The fatty matter of food is capable of undergoing the combustion which supports animal heat; and a given weight of it would in this way give out more heat than the same weight of starchy matter. The latter is, however, so much cheaper than the former, and appears to be provided by nature for supplying animal heat, that it is best to use it for the purpose.

LESSON V.

The flesh-forming constituents of food next demand attention. These supply the muscles of the body, and form the principal source whence the motive force of animals is derived. Animals could not live without those constituents, no matter how liberally we supply them with starchy and fatty matters. The muscles and all the tissues of an animal are continually undergoing decay or waste; even in a state of perfect health and repose this process goes on. If we wish the animal to keep up its health and condition, the matter removed in this way must be supplied to it in the food. It has been estimated that a man's body is renewed in about half-a-dozen years. In flesh and bone, therefore, we are not to-day what we were yesterday. The degree of waste which the body of any animal suffers varies with a great many circumstances. Disease or irritation increases it very much. A sheep suffering from foot-rot does not produce as much mutton from a given quantity of food as when free from this affection. A cow of a restless disposition does not thrive as well as one of quiet temper.

Exercise, whether mental or physical, accelerates the waste of the body. The harder a horse is worked, the more food he requires. It follows that in fattening cattle the quieter we keep them the greater the quantity of meat we are likely to get from a given quantity of food, because the loss of the latter is expended in supplying the waste of the body.

Woody fibre enters very largely into the composition of our farm crops. It has the same composition as starch, sugar, and gum: but as it is indigestible (or nearly so), its chief use is to give bulk to the food. It is found that an animal fed on too concentrated a food becomes unhealthy. This occurs to a horse fed exclusively on oats, or a cow fed exclusively on oil-cake.

The mineral constituents of the food are required to supply the mineral matter of the body. Bone, muscle, &c., could not be built up in the first instance without mineral matters, and as the latter are wasted like the other constituents of the tissues, the food must always afford a fresh supply. If the food is deficient in phosphorus, the bone is weak, and the limbs unable to bear the animal. We have frequently seen young pigs suffering from weakness of the bone: now, this may be prevented, and, where it already exists, sometimes even cured by affording food rich in the substance of bone. Lime, which is a constituent of phosphate of lime, is required to build up the bone. Phosphate and carbonate of lime exist in the ashes of our pasture grasses and grain crops—the seed of the latter being particularly rich in phosphate of lime. The hard shell of the eggs of poultry is composed principally of carbonate of lime, and instinct teaches the common hen to pick up pieces of mortar, gravel, or chalk, which contain this substance. Iron is an essential constituent of the colouring matter of the blood. Common salt affords two most important constituents which appear to be necessary for digestion. Man obtains the saline matter necessary for his constitution in fleshmeat, milk, and the common salt which is so universally used at table. Our crops contain comparatively little common salt, and hence it was used so largely by those who lived principally on potatoes. The intelligent farmer also gives common salt to his live stock, knowing that it not only causes them to thrive better, but that it also prevents many diseases which would otherwise affect them. Full-grown cattle may get from 2 ozs. to 3 ozs. of it daily; full-grown horses, from 1 oz. to 2 ozs.; sheep and pigs about half-an-ounce. Grazing cattle and sheep should have access to lumps of rock-salt in the field. Lumps of it may be also placed within reach of stall-fed cattle, or it may be strewed over or mixed with their food. The best way of giving it to horses is by dissolving it in their mashes. It is given to pigs mixed up with their food.

SECTION III.

THE KINDS OF CATTLE BEST SUITED TO THE TENANT-FARMERS OF IRELAND.

LESSON VI.

All our breeds of cattle are generally regarded as mere varieties of one species, the *Bos taurus* of naturalists. Food and climate produce remarkable changes in the animal frame. The heavy Durham ox differs greatly from the diminutive ox of Kerry or Brittany. Each breed has valuable properties not found in any other; and the man who cultivates these properties benefits himself and the community of which he is a member. The West Highland ox fattens where a short-horn would starve. In the sheep we have an admirable illustration of the efforts of nature in providing the animal with a covering suited to the climate in which it is placed. Thus, in the torrid regions of the earth, the wool approaches the character of hair, whereas when we reach higher and colder latitudes it reverts to its true character. It has often been observed that when Leicester sheep are brought over from the dry atmosphere of the south and south-east of England, to the humid climate of Ireland, their wool becomes longer and thicker. This affords a good reason why we should not seek to displace the native stock of a country suddenly, or without due consideration. We ought rather to endeavour to retain those properties which nature has impressed upon the native races, and, when necessary blend with them the good properties of some other valuable breeds. The cost of introducing a herd of pure-bred cattle, or a flock of pure-bred sheep of great merit, is so very considerable, that tenant-farmers cannot afford it. At all events, it is quite certain that the only feasible way of improving the stock on the small farms of Ireland is by ingrafting some of the good qualities of the purest and best breeds of Great Britain on the native animals.

Before describing the leading breeds of cattle which may be used for this purpose, it may be well to explain the principal points by which good cattle are known. Cattle are reared and fed principally for beef and milk. On the continent they are used a good deal for draught; the ox is also worked in these countries, but not to the same extent as in other European countries. In discussing the merits of the several breeds of cattle these objects must be kept in view.

We judge cattle by the eye and hand, and, in case of pure-bred cattle, we also take into account their pedigree or breeding. The eye takes in the shape and symmetry of the animal. Viewed from either side, from behind and before, the outline of a well-formed ox, bull, or cow, should be a rectangle. It should also present this figure when a bird's-eye view of it is taken. We are not to expect that every angle of the figure will be filled up; but the animal becomes defective in proportion as it deviates from this outline. The back should, therefore, be straight and level; the lower line of the belly nearly horizontal; a plumb line, placed at the posterior part of the animal, should fall along the buttock; and a like line, passing up the front of the breastbone, should complete a rectangle when the animal is viewed from either side. This rectangle should be deep in proportion to the length of the limbs. It has been said, that while a horse, when viewed in profile, stands within a square of which his body occupies one-half, the ox stands within a rectangle of which his body occupies more than his limbs. The shorter the limbs are below the knee and hock, the less offal; and, other things being the same, the greater the weight of meat obtained from a given weight of food eaten by the animal. The legs should be fleshy to the knee and hock; and below these joints, they should be flat and thin. For the same reason, the head should not be large or coarse. In our best modern cattle it is small in proportion to the size of the carcase, and well set on to the neck; and the muzzle is fine and tapering. The horns should be oily and shining, fine, smooth, and well turned. A narrow forehead or brow also indicates a bad feeder; and, in bulls especially, a broad forehead is a material point.

The eye is a pretty good indication of the constitution of the beast. When sunken, the animal will generally be found an unprofitable feeder; whereas a clear and prominent eye is a pretty good indication of good health and aptitude to fatten.

When the skin of the nose of cattle, sheep, and pigs is not bedewed with moisture, we may suspect they are defective in constitutional vigour.

The neck should be free from coarseness, and taper gradually from the head to the breast. It should not be very thin and hollow immediately behind the ears. In a bull, it should be well developed, showing masculine vigour. In the cow it should be finer. Some of the shrewdest dairymen say, that a cow with a short thick neck will rarely be a profitable milker.

The breast should be deep and wide, and the brisket well developed.

It is desirable that the chest, which contains the lungs and liver, should be capacious. There is a difference of opinion among scientific men as to whether animals with small or large lungs and liver fatten best.

Without offering any decided opinion on this point, we think an animal intended for fattening should possess a deep and wide chest.

The body of an animal intended for meat should be as round as possible. The ribs in our best fattening beasts spring at right angles to the spine. This increases the size of the ribs themselves, and gives more meat on those valuable parts. A thin flat-ribbed animal eats largely, thrives badly, and is very liable to diarrhœa and other derangements of the bowels. When the fore ribs are well developed the animal girts well. It is held by some that the girt, taken immediately behind the shoulder, should closely correspond with the length from behind the ears to the rise of the tail.

A compact body indicates robustness as well as a tendency to fatten. Many farmers and graziers like to have a pretty lengthy body, as it gives more weight of flesh; but mere length, without depth and thickness of carcase, produces want of symmetry. It often happens that cattle with long bodies want breadth and strength in the loins, which is very objectionable.

LESSON VII.

In an animal intended for draught or speed the shoulder should incline backwards; and its obliquity actually varies in different animals with the degree of speed attained by them. In the breeds of cattle most fitted for draught, the shoulder inclines backwards more than in those which are best for fattening. In the latter the shoulder should be straight, broad at the top, and well covered with muscle; and it should join, without coarseness, to the neck before, and the chine behind.

The back is broad when the ribs spring well from the spine; and it should be broad and level across the loins.

The space between the last rib and the hip should be small; or, in the language of the farmer, the animal should be "well-ribbed home."

We like a fine tail, well covered with hair, placed at right angles to the back bone, and free from coarseness at the point of its attachment to the latter.

The hind-legs in well-formed beasts are pretty straight, and neither placed too close together nor too far forward under the body. The hind-quarters, which are so highly prized by the butcher, should be as full as possible. The upper line of the haunch, *i.e.*, from the prominence of the haunch backwards to the rise of the tail, should be lengthy. The haunch should also be deep and well covered with muscle down to the hock; too frequently it becomes light as it approaches the latter joint. What are called the hook or huckle bones should appear level, or nearly so, with the line of the back.

The aptitude of a beast for fattening, as well as the general tone of its constitution, are judged by handling the hide. If we place the tips of our fingers on the ribs of a well-bred ox, in good health and fair condition, we shall find the covering elastic and mellow. "If the animal is not healthy, or in a thriving condition, the hide loses its elasticity. A good feeder possesses a thick loose skin, floating as it were on a layer of fat, yielding to the least pressure, and springing back to the touch of the finger. But a thick, hard, unyielding hide always indicates a hard feeder, and an unprofitable animal."

A thin papery hide is a sign of weakness or ill-health. An animal is said to be hide-bound when the hide, instead of being loose, adheres so closely to the body, that when taken between the fingers, it cannot be lifted up. A hide-bound animal is never a profitable feeder.

The hair of our best animals handles very much like a deep pile of velvet. A good thick coat of hair is required to protect the beast from cold. Thin wiry hair is always objectionable.

Many of the qualities which indicate a beast that will fatten well are also sought after in a milch cow. In both, the eye must be clear and healthy. A longer head, but still thin, is looked for in the milch cow; and while the hide must be soft to the touch, many good judges do not object to its being less mellow than in a first-class grazier's beast. The width of chest so much prized in the latter, is not required in the milch cow; in fact, the majority of dairymen prefer cows narrow in this part for milking purposes. They also like the thigh to be thin. Generally speaking, cows of the Ayrshire breed, which are celebrated for the dairy, have narrow fore-ends and light hind-quarters. The probable explanation of this is, that when the fore-end is narrow and the thighs light, more of the blood is available for the secretion of milk. There is no reason, however, for believing that a good milker, when she becomes dry, should not fatten readily; and, now, that both beef and dairy produce bring high prices, we strongly recommend the blending of the two qualities in the small-farmers' cows. Not only do we find no difficulty ourselves in doing this, but we have seen it successfully carried out on an extensive scale in several large dairies in Dublin and elsewhere. We may be told that many short-horn cattle which show a remarkable tendency for fattening, are bad milkers. We fully believe that common well-shaped cattle yield more milk than the best short-horns; but this is partly because the milking property, which like every other quality is hereditary, has been neglected in the latter, and partly also because they have been fed on food better adapted for the production of fat than milk.

Innumerable instances occur in which first-rate milkers (both pure short-horn and common cattle) fatten well when they run dry. In order to make this combination of qualities more general, it is only necessary to unite in the animals from which we breed as many of the foregoing points as possible with those which are unmistakably indicative of milking in the cow. Generally speaking, a good milker is wide across the loins, and has good depth from the loin to the teats. The milk vessel, or udder, should be capacious; and its four quarters well developed, giving it a full and square appearance. On handling, it should be elastic, showing that it is muscular, rather than soft or flaccid (or in the language of the dairyman, "flabby"), which denotes the presence of too much fat. When the cow is viewed from the side, the greater part of the udder should appear in front of the hind quarters. The teats should be set evenly on the udder, and far enough asunder; should be large enough for the hand to milk them, but not larger; and taper gradually. Most people like them to incline forward a little. Long teats, very thick at the base and narrow at the point, are objectionable.

The superficial veins on the belly should be well developed, especially the large one called the milk vein, although it is not supposed to be connected with the glands that secrete milk.

LESSON VIII.

Having treated in the previous lessons of the principal "points" by which cattle are judged, we proceed to describe the leading breeds and their respective adaptation to the circumstances of the tenant-farmers of Ireland.

We will, first of all, notice the *short-horn* or *Durham* breed, which is the most famous race of cattle we possess. The north-east of England has long been occupied by a race of cattle with short-horns. It is supposed that these cattle were improved by cattle imported from the Continent. About the middle of the last century, it is said that Dutch cattle were imported into Holderness, in Yorkshire, which had some influence in moulding the character of the short-horns. Be this as it may, it is quite certain that the short-horn cattle in Holderness, along the Tees, and other districts in the north-east of England, were cultivated with care about the time referred to; and early in the last quarter of the last century, these cattle were established as a pure and distinct breed, which has since exercised a powerful influence on British farming. Among the men to whom the world is indebted for this improvement, the foremost place is generally accorded to the brothers Charles and Robert Colling, of Darlington. The history of the labours of these men, if fully written, would possess deep interest; unfortunately the materials for such a work are scanty and fragmentary. It is pretty certain that by careful selection of parents, by a remarkable application of skill in both crossing and breeding in-and-in, they improved the shape, diminished the bone and offal, and promoted the early maturity of cattle to a degree previously unknown.

The results of the labours of Mr. Colling and his contemporaries ought to teach our farmers a salutary lesson. In those early days, short-horns were ordinary cattle. Hubback, it is said, was purchased for £8. Old Favourite and Young Strawberry were also purchased at ordinary prices. It may be safely said that all the cattle with which Mr. Charles Colling commenced his career as a short-horn breeder would have then sold only at the ordinary market price, or a shade higher. In about a quarter of a century he brought them to such perfection, that forty-seven animals of all ages were sold for £7,115 17*s*., or an average of £151 8*s*. each.

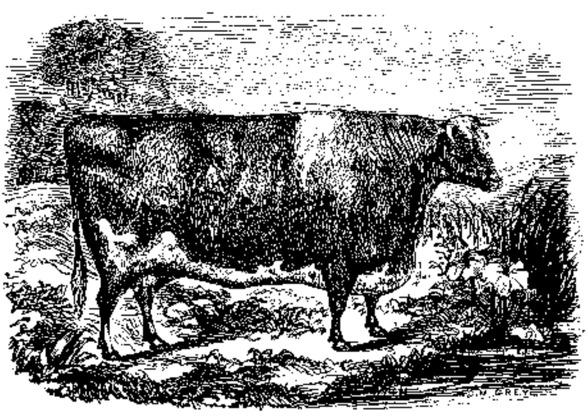
Mr. Colling had great confidence in the selection of parents. "Give me," he is reported to have said, after the sale of his own and his brother's cattle, "my sight and my touch, and I will, in half a dozen years, produce as good a herd as I or my brother have sold off."

The class of farmers for whom our remarks are intended cannot afford to procure a herd of pure short-horns. We consider, however, that the short-horned breed is the best for improving the cattle of Ireland; and we look to the co-operation of the landed interest of the country as the great agency for effecting this. They should all possess bulls of first-rate quality, not only for their own use, but also for the use of their tenantry. By the use of good and pure bulls of this breed on the one side, and by the use of the eye and the touch in selecting the cows, or rather in rejecting bad cows, our small farmers could, as already explained, rapidly improve their cattle. In fact, in a few years they could produce cattle little inferior, even for fattening purposes, to pure-bred animals. To effect this object it is not necessary that the bulls should be as good as Master Butterfly, which was sold in 1856 for £1,260. The better they are the more effectually will the object be accomplished; but we know, from experience, that a short-horn bull can be had for £30, good enough for the purpose. This system of crossing has vastly increased the wealth of the country, and kept down the price of beef. The crosses produced in this way are now forwarded to London from Scotland, Norfolk, and other districts, weighing from 45 to 55 stones of 14 lbs. each at two years old and under. Formerly so much weight and quality could not be produced under from three and a half to four years.

Pure-bred short-horns have good shape and symmetry, deep and level carcase, fine limbs, and that quiet disposition which is so favourable to fattening. They have a soft mellow hide, which is covered with a soft thick coat of hair. The animals transmit their own qualities to their offspring with much certainty. They are, on the whole, noted more for the production of flesh and fat than milk; but this has arisen, as already explained, from the fact that the milking properties have not received sufficient attention. In selecting bulls for the use of their tenants the landlords of Ireland should resort to herds in which the two properties are united.

The engraving, figure 51, represents a first-class cow of this breed.

FIG. 51.

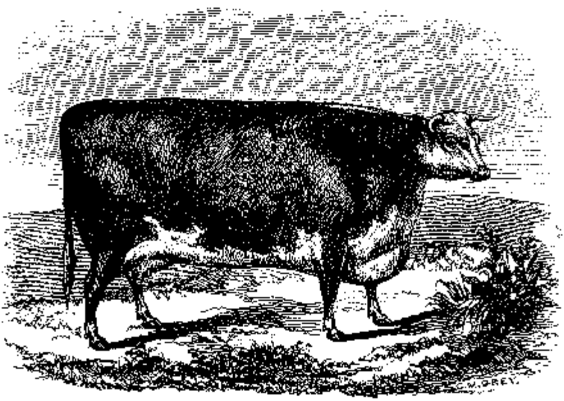


LESSON IX.

The *Hereford* breed is in great favour in many parts of England. It originated in the county where it is still the most prevailing race of cattle. One of the earliest authentic facts in the history of this breed is, that about 1769 Mr. Benjamin Tomkins, of the county Hereford, procured from his father-in-law two cows, purchased on the confines of Wales. These were called *Pigeon* and *Mottle*, respectively, from their colour; and the marking of these two cows can be discerned in their descendants at the present day. Mr. Tomkins and the early improvers of this breed adopted close breeding, and also used care and skill in the selection of animals for breeding.

Figure 52 represents a pure-bred Hereford cow.

Fig. 52.



This breed is better adapted for the grazier than the dairy farmer. The county of Hereford has long been a breeding county, and the animals are bought up by the stall-feeders and graziers of other districts, the land on which they are reared being, for the most part, too poor to fatten them. Hereford cattle are of good size. The horns are of middle size, generally set wide, and turned up. The colour at present most in esteem is a dark red, with white faces and bellies, and a streak of white generally along the back. Sometimes the face is mottled, and white hairs are freely distributed through the body, constituting a gray or roan colour. A very high authority states, that the truest standard of form is found among the mottle-faced animals. Compared with short-horns, the Herefords require a longer time to come to maturity, and do not milk as well. We have seen them thrive well in England on pastures not rich enough for short-horns. We do not, however, think they are as well suited as the short-horns for improving the cattle of the small farmers of Ireland.

The Devon breed.—In the north-east of Devonshire, which is pretty hilly, a useful breed of cattle has long existed, which is easily known from any other by its colour and shape. The skin is of an orange-yellow colour, and the hair a bright red, very fine, and tending to curl. The eyes are surrounded by a ring of the same colour as the skin. There is seldom any white except about the udder of the cow, or the belly of the bull. The horns are long, gracefully curved, and of a yellow colour. The shoulders are oblique, and the hind-quarters relatively long; and these points give them that facility for stepping which renders them the best breed of cattle we possess for draught. The breed is hardy, and the quality of the beef excellent. The milk throws up a high per-centage of fine rich cream; but the yield of milk is small. We cannot, therefore, recommend it for improving the cattle on the small farms of Ireland. It is essentially a grazing breed, and is found most profitable on the pastures of its cold native uplands. The cows are much smaller than the bulls.

Figure 53 represents a Devon cow.

Of all our pure breeds of cattle the *Ayrshire,* figure 54, is probably the best for the dairy. Generally speaking the best milkers give poor milk, while the milk of those that give little is rich in quality. A large bony cow may give from twenty to thirty quarts of milk in the day, but the milk may be so deficient in fat, that a cow which gives a less quantity may produce more butter. The Ayrshire cow gives a satisfactory return, both as regards quantity and quality. Enormous quantities of milk are said to have been yielded by animals of this breed. Upwards of 900 gallons of milk per annum have been obtained from an Ayrshire cow very frequently; and still higher returns are on record.

FIG. 53.

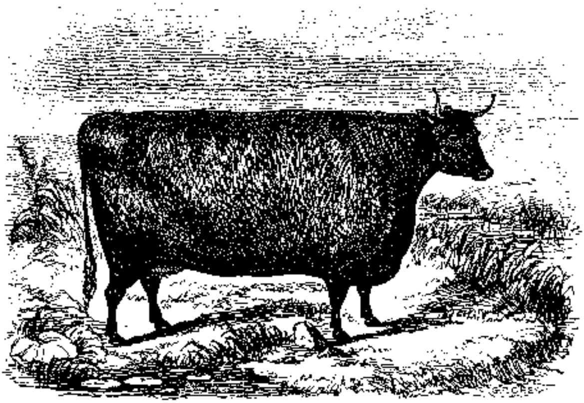
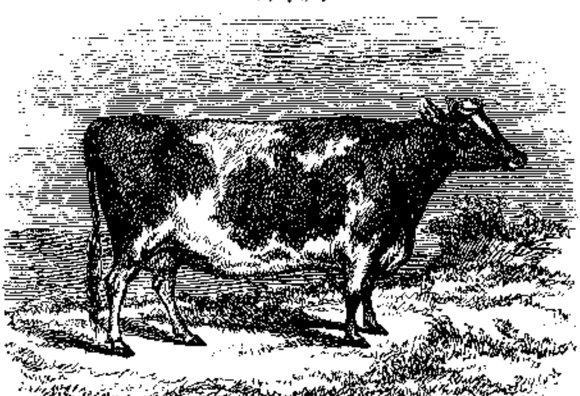


FIG. 54.



The valuable milking properties of this breed are known and appreciated abroad as well as in the British Islands. The demand for them at the Paris Show, in 1856, was very brisk. The breed is hardy, and capable of subsisting on pasture of moderate quality, such as that which prevails in many parts of Ayrshire. The limbs are slender, the neck fine, and the head nicely set on and free from coarseness. The usual colour is red and white, in spots, not marbled as in short-horns; it is sometimes white and black, and sometimes altogether red or brown. The horns are fine, and twisting upwards; the face long, with a lively, yet docile expression; the udder white, capacious, and coming well forward on the belly; the teats of middle size, set equally, and wide apart from each other, and the "milk" veins prominent and fully developed. "In young cows and heifers the udder should be loose, and wrinkled, showing capacity for expansion." The loins are broad and deep, which is a good point in milch cattle. The thighs are rarely well covered. The fore-end is rather narrow, or, in other words, the fore-quarters are light. For fattening purposes these are defects, and, accordingly, this breed is not highly esteemed by graziers or stall-feeders. The deficiency of the breed for fattening, however, has arisen very much from the fact that great attention has been bestowed on its milking properties. We have seen Ayrshire cattle which put up fat very rapidly, and this justifies us in saying that it is quite possible to blend the two properties to a greater extent than has been hitherto done. At the same time, we think the chief merit of the breed consists in its fitness for the dairy; and this merit is so great that we desire to see the breed kept pure, and cultivated with the greatest care. That it is capable of great improvement we have ourselves experienced. Well-bred Ayrshires, too, can be had at moderate prices, which brings the breed within the reach of tenant-farmers. But while fully admitting all this in favour of Ayrshire cattle, still we think the best stock for the majority of the small farmers of Ireland is to be obtained by crossing short-horn bulls with common cows, as already explained.

This does not involve a complete change of stock; the process is gradual, and requires no extra capital. And it is worthy of remark, that in our town dairies cross-bred cattle of this kind have surpassed any pure breed.

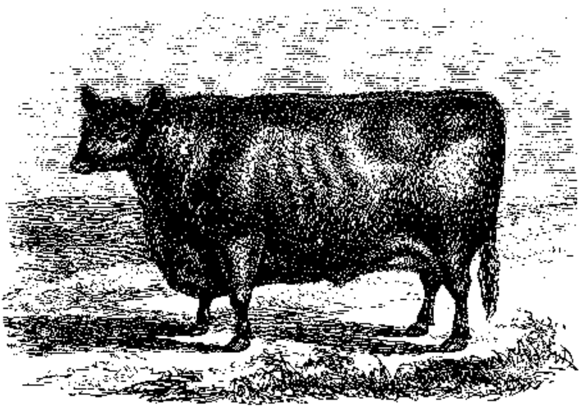
A brief reference to the history of this breed should afford an instructive lesson to the small and struggling farmers of this country. The soil of Ayrshire is not fertile; there is a great extent of upland; the rain-fall is copious, and the country is very much exposed to westerly winds. Its inhabitants have overcome these obstacles, introduced a productive and profitable system of grazing, and raised up this valuable breed of cattle in a short time. Mr. Low tells us that "within the memory almost of the living generation, the agriculture of Ayrshire was almost in a state of utter rudeness." And Mr. Culley informs us that, as late as 1790, the cattle of Ayrshire were not recognised as a distinct breed. The prevailing belief is that the first improvements were effected by the introduction of Holstein and Alderney cattle, especially the latter; and the resemblance which can be traced between some of the points of Alderney and Ayrshire cattle gives strong colour to this opinion.

LESSON X.

Scotland contains a great number of *polled*, or hornless cattle. Their points vary in different districts. Among the best-known may be mentioned the *Polled Angus*, *Polled Aberdeens*, and *Polled Galloways*. The colour is generally black, and there is a tuft of hair on the crown of the head. The Angus cattle are larger than the Galloway, but the latter are the hardier of the two. They are both grazier's stock, and cross well with short-horns. From their hardiness, the Galloways are said to be well adapted for stocking a moderately high district. Crosses of them with short-horns are really magnificent animals, being capable of becoming fully fat from two to two and a half years old. The polled Aberdeens are heavier cattle than either the Angus or Galloway, and capable of being fattened to immense weights.

Figure 55 represents a Polled Angus Bull.

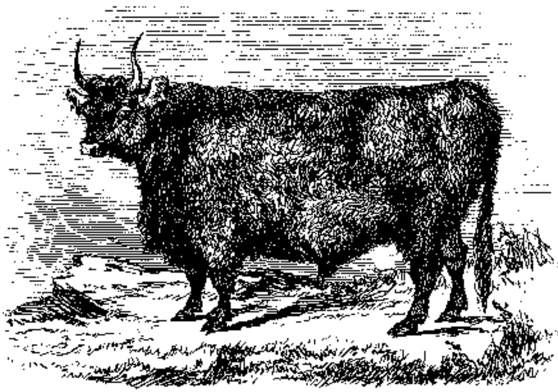
Fig. 55.



The *West Highland*, figure 56, is another breed peculiar to Scotland, which deserves a passing notice, and which is known by its shaggy coat of hair and long horns. There is no breed of cattle in the British Islands which so aptly illustrates the influence of climate on the animal frame as this. The climate of the Highlands and islands in which this breed exists is cold and humid, and in many places the soil is covered with heath and coarse herbage. In such a situation, other cattle would starve. Nature, ever bountiful, has given the West Highland ox its long and curly hair, and the hardiest of constitutions. The quality of the beef is not perhaps equalled, and certainly not exceeded, by any other breed.

The yield of milk is small and the cows go dry very soon.

FIG. 56.

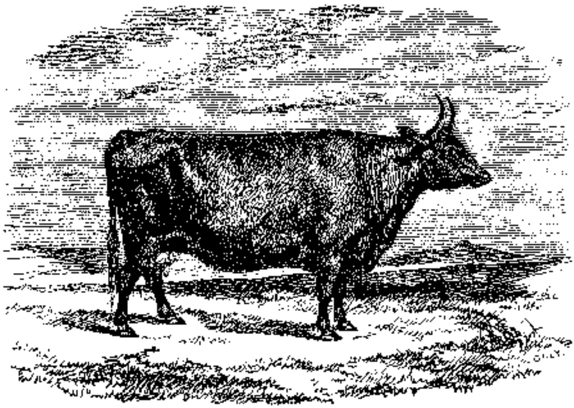


The true West Highland ox possesses a symmetrical carcase, round barrel, and short muscular limbs. The horns are long, fine, and turned up at the points, which are black. A prominent dewlap is characteristic of the breed. There is a tuft of hair on the top of the forehead, which is broad. The hide is remarkably thick and mellow. The colour is black, dun, red, or yellow.

The only breed of cattle peculiar to Ireland is the *Kerry*, figure 57: and even this valuable breed has not received proper attention. A few spirited noblemen and gentlemen have done much to uphold and improve it; but the examples are too few.

The Kerry is essentially a mountain breed. It is small in size, exceedingly hardy, and can subsist on poor and exposed pasture, and often bears a close resemblance in size, shape and colour, to the native cattle of Wales and Brittany. The colour preferred in Kerry is black, with a ridge of white along the spine, and a white streak along the belly. Cattle of true Kerry descent are met with of other colours. Thus, we have seen them brown, black and white, and black and brown. The horns are fine, somewhat long, and turned upwards at the points. The skin is soft.

FIG. 57.



unctuous, and of a fine orange tone, which is visible about the eyes, the ears, and the muzzle.

The beef is tender, well marbled, and commands the highest price in the market.

The milk is peculiarly rich and well-flavoured; and the quantity of it yielded, even on hard fare, is so great, that the Kerry has been styled the poor man's cow. Professor Low observes, "that in milking properties, the Kerry cow, taking size into account, is equal, or superior to any in the British Islands." Is it not, therefore, lamentable that so little attention has been bestowed on its improvement? Additional capital is not necessary. More care in the selection of parents, and more attention to food and shelter in the winter, are all that we ask to improve this race of cattle. We do not recommend it for our rich or middling pastures; but being one of the valuable *mountain* breeds we possess, it ought to be kept pure. It is well adapted for the hill pastures of its native county, and for parts of Clare, Galway, Mayo, Down, Donegal, and Wicklow.

SECTION IV.

ON THE REARING OF CALVES, AND THE MANAGEMENT OF STORE CATTLE AND COWS IN CALF.

LESSON XI.

The cow goes in calf about nine months. The great Earl Spencer made the average period 285 days. When a cow goes longer than the average time, she generally has a bull calf.

It is useful to be able to ascertain as soon as possible if a cow is in calf. By applying the ear to the right flank (the calf being situated in the right side), and shifting it up and down, and backwards and forwards, the existence of the fœtus can be detected in cows about four months in calf. In about six months the calf is felt by thrusting the fingers strongly against the right flank. As this is, however, a dangerous practice, and often causes cows to calve before their time, it should be avoided. At this stage, too, the calf is often observed to kick when the cow drinks cold water. About this time, or soon after, the right flank begins to enlarge, showing clearly the existence of the calf. "If a cow bears twins, they become at this age so crowded in the flank, that one appears to lie upon the other. When, therefore, the farmer observes the fœtus stirring high, he may expect twins."

Cows calve at various periods of the year. The farmer who is supplying new milk to towns and cities, finds it his interest to have cows calving at every season of the year. The small farmer who house-feeds his milch cows, and who, by providing roots for them in winter, endeavours to produce as much butter as he can at that season, finds it profitable to have a few cows calving even in winter. On the other hand, the ordinary dairy farmer, who lives principally on the summer produce of his cows, is anxious that as many of them as possible should come round just when the grass is forward enough to produce a good flow of milk, which occurs generally about the 1st of May. Again, the mere breeder, whose object is the production of a good class of young animals, either for the grazier or dairy-farmer, prefers that the calves should be dropped earlier than this, so that they may be weaned when the grass is ready for them, and that they should come out of a good size as year-olds or two-year olds. The breeders of pure short-horn cattle are anxious that their cows should calve early in the year: and, in practice, many of the calves are dropped in January and February.

The poor tenant-farmer, who wants to combine the rearing of young stock with the dairy, should steer a medium course. If he has a sufficient supply of roots to feed all his cows till the grass is fit for stocking, it would be an advantage to him to have a large number of cows calving early—say in the middle of March; for the roots would keep the cows in good milking condition till the grass would come round, and the calves could be put to grass early.

The milch cow should be run dry six weeks before calving. If she is milked longer the calf must suffer, the udder does not spring fully, and the cow will not yield the full quantity of milk that season. Some people recommend that the cow should be run dry three months before calving; this may be desirable in the case of pure-bred stock, which bring fancy prices; but with the tenant-farmer, who relies principally on dairy produce, and who gets ordinary prices for his young stock, so long a period is not necessary.

As we cannot determine beforehand the day on which the cow is to calve, she should be watched with more than ordinary care for some days before the expected time. There are symptoms which unmistakably show that the time of calving approaches. For a fortnight or ten days the udder is enlarging, and becoming harder and hotter to the feel, and as the period approaches still closer, it springs to its full dimensions, the belly sinks, and there is a manifest sinking of the parts adjoining the tail. When these symptoms present themselves the animal should be removed to a capacious and well-littered apartment if there is one to spare; or if the weather is fine, and that the animal is grazed, she should be placed in a clean and well sheltered paddock or field, as near to the house as possible. As soon as the cow feels the pains of calving she moans and gets uneasy. In most cases the cow brings forth her young without any aid.

After calving, the cow should get a warm bran mash, or white drink of some kind. Sometimes an aperient drink is useful. For a day she should be fed principally on soft food.

The first care of the cow after the calf is dropped is to lick it, and this appears to be so natural to both, that it should be always permitted. The first effort of the calf, too, is to suck its dam. The "beastings," or first milk, possesses peculiar properties, and is, no doubt, specially intended to supply the first wants of the calf. Experience tells us that this milk exercises a mild purgative effect upon the calf, which is beneficial to it.

LESSON XII.

The rearing of calves is a subject of the greatest possible importance. It is also a subject upon which there is a great diversity of opinion. The system adopted by the short-horn breeder would be too expensive for the ordinary farmer. We shall confine our observations principally to the wants of the latter.

Many farmers allow the calf to suck its dam for some days, believing it to be most natural and best for both.

Other farmers, again, who separate the calf from the cow at once, say that if they are allowed together for some days the latter becomes quite restless when the former is removed, and goes back in her milk in consequence. Our own experience is that it depends on circumstances whether the calf is to be removed at once or not. Some cows give more milk than their calves require, and must not be left altogether to the latter. Again, some cows do certainly go back in milk when the calf is removed after being allowed to suck them for some days; and it is better for the farmer who looks to the dairy for profit, to remove the calves from cows of this temperament as soon as possible. And again, in practice, the system of calf-rearing varies with the breed. Thus, many breeders of Herefords allow the calf to run with its dam all the season: the Herefords are indifferent milkers, and the great object is to rear young stock. This system would not suit the small farmers of Ireland for several reasons. In the first place, they can make more of the milk by a skilful system of dairy management; and, secondly, it is found that cows suckled in this way by their calves do not come round in due time for the bull.

All things considered, we are of opinion that it is best to allow the calf to suck its dam until the milk is fit for ordinary use, taking care to remove, by hand, morning and evening, as much of the milk as the calf cannot consume. The calf should be gradually withdrawn from its dam if she shows any great partiality for it.

As the milk of its dam is the most natural nourishment for the calf, the latter should be fed on new milk for about three weeks. An ordinary sized calf consumes about six quarts of milk daily for this period. It is sometimes given in two and sometimes in three or more feeds daily.

Farmers are aware, to their own heavy loss, that great numbers of calves die every year; and the loss arises principally, either from bad food or want of care in feeding. When the food is deficient in quality, the calf is liable to disease, and want of care and regularity in feeding causes derangement of the bowels, which is one of the most common causes, of the frightful mortality from which young stock suffers.

It is found very expensive to continue giving new milk to ordinary calves any longer than three weeks. Various substitutes are used, of which skim-milk is the most common. Linseed and oil-cake gruel, hay-tea, &c., are also used. In providing a substitute for new milk, two things should be observed; first, as new milk is the food intended by nature for the calf, we ought to imitate, as far as possible, the proportions in which the several nutritive constituents exist in milk; and secondly, we must provide a food which the young animal can assimilate.

Skim-milk contains nearly all the flesh-forming material, as well as the sugar and mineral matter of new milk, but it is extremely deficient in fatty matter. In other words, the nutritive constituents do not exist in proper proportion in skim-milk.

It may, therefore, be assumed that calves could be reared more economically, by substituting for some of the skim-milk, linseed, oil-cake, or other food, rich in fat-forming and heat-giving material, than by feeding them on skim-milk alone. Linseed jelly, in moderate quantity, is excellent food for calves; but if given too freely, it is apt to purge them. The small farmers of Ireland should carefully preserve the seed of the flax plant for the use of their calves. It is made into jelly by pouring hot water upon it in a common bucket, and covering it with a thick piece of old cloth to keep in the heat, taking care to stir it occasionally, and cover it up again.

Hay-tea, obtained by boiling some good hay in water, may also form part of the food of calves. We have had ample experience of the value of this beverage in rearing calves. It is still used in many parts of Ireland by the small farmers, and the mistake they make is to rely too much upon it. A mixed diet, composed of skim-milk, jelly made from flax-seed or linseed oil-cake, and hay-tea, and some ground corn, is a good substitute for new milk.

When the calf is a month old, it should be gradually accustomed to dry food. Mangold-wurzel (of which calves are very fond) or turnips, cut up into thin pieces, should be given in troughs; and farmers who can afford, or are willing to use oil-cake, should place a little of it, finely broken, within the reach of calves. A wisp of sweet hay should also be suspended in the calf's crib. This the calf will first lick or suck, and afterwards eat. As it eats more and more of dry food, the quantity of liquid food should be decreased; and at the age of about three months the latter may be withdrawn altogether.

In obedience to instinct, calves suck one another; and as this is injurious, it should be prevented by confining each calf to a separate crib for about six weeks, when there is accommodation enough for it, or by tying them up when taking their food, and letting them remain so for half an hour after each feed, and by putting nets or baskets on their heads when allowed to run together.

Bull calves, not intended for breeding, should be cut when three weeks or a month old. Young calves should get fresh water every morning; and as they differ greatly in their habits, we should study the peculiarities of each. Some drink very slowly, and we should see that they get ample time and are not disturbed by the others. For this reason, as well as for that just mentioned, some farmers, who allow their calves to run together, tie them up at meal time.

Calves are liable to several diseases, which are in a great measure prevented by providing them with adequate food, serving it out at regular intervals, mixing it well when composed of different materials, never giving it to them too warm, avoiding sudden changes of food, and by keeping the animals clean, dry, warm, and quiet.

Many breeders continue to feed the calves in yards, after the liquid food is withdrawn, giving them, during the first summer, green food (such as vetches, corn, or grass), with some hay and cake. We recommend this system when the farmer has sufficient accommodation and capital; but there are few small farmers in Ireland who possess these advantages. When calves are weaned from liquid food, they should be allowed to run into a clean, well-sheltered paddock; and they should be provided with other food, such as vetches, clover, hay, and cake, if available, according to the season and the quality of the grass.

As winter approaches, calves require to be carefully housed, and generously fed on roots and good oat straw, or hay. If the farmer should be short of roots, a pound of ground corn given to each daily, with a little flax seed meal, during the winter months, will aid him in bringing his stores to grass in good condition next season. In the second summer they are put to grass; in the second winter they are put on roots and fodder as before.

Short-horns, or good half-bred stock intended for the butcher, are at this age put on a fair allowance of food for fattening. Those which are not good enough for this purpose, are to be regarded as stores. Next year the bullocks, and heifers not good enough for breeding or the dairy, are put to grass to fatten, or sold to the grazier. The other heifers are allowed to run with the bull.

SECTION V.

ON THE FEEDING OF MILCH COWS.

LESSON XIII.

THE wealth of Ireland could be greatly increased by an improved system of feeding and managing milch cows. There are nearly one million of milch cows in the possession of small farmers, not one of whom holds over fifty statute acres. The average return from these cows does not amount to £6 per cow per annum. It is a moderate estimate to assume that by providing roots for these cows in winter, along with some straw or hay, and pursuing a skilful system of dairy management, this average could be doubled. Experience shows that a fair class of milch cows, fed with care and skill throughout the year, will give on an average 600 gallons of milk per head per annum; and as milk brings not less than 6*d*. a gallon, when the dairy is well managed, this gives £15 per cow. But assuming the increase at £6 a cow we have a gross increase in the produce of the milch cows on the small holdings of Ireland of not less than five millions sterling!

In many parts of Ireland and England milch cows are grazed in summer, and wintered on straw or hay in winter. In the Vale of Gloucester, one of the most celebrated dairy districts of England, the dairy farmers allow about three statute acres of land for each cow—viz., an acre and a-half for grazing in summer, and an acre and a-half for hay for winter keep. The cows milk freely for a period of five or six months—say from May till November—after which the greater number of them run dry. Some of the better class of dairy farmers in Ireland pursue the same course, which is certainly an unthrifty one. Many of the dairy farmers of Gloucester are well aware of this, and say they would grow more roots for winter feeding were it not for unwise prohibitory clauses in their leases. The majority of the small farmers of Ireland pursue a still worse system. Their cows are not only grazed in summer, but are also very frequently left to pick up a scanty bite on the same pasture throughout the winter months. Sometimes they get a little straw or hay in winter, and are put into a yard or "bawn" at night; but, as a rule, they are provided neither with adequate food nor shelter. The loss from such a system is immense. The wonder is how these poor people have been able to hold their ground at all; and the fact of their having done so, shows the possibility of increasing the prosperity of the country without any farther consolidation of farms. One of the first steps then towards improving the condition of the small farmers of Ireland would be the growth of a fair proportion of roots and hay for wintering their milch cows. Ordinary sized cows will consume about eight stones of roots daily, together with straw or hay. For the winter six months, say from the 1st November to the 1st May, we would require, at this rate, about nine tons of roots for each cow. An acre of roots fairly tilled yields about twenty tons, and affords a fair supply for two cows during the winter season. The small farmer who is working for himself, and who manures well, finds no difficulty in raising twenty tons of roots per acre. The two cows fed on the produce of the acre should, in the six winter months, yield at least 600 gallons (or 300 each) of milk, which, at 6*d.* a gallon, amounts to £15; and with cows of a good description the milk would be 800 gallons or £20. It may be said that as milch cows are, for the most part, in calf in winter (and as the yield of milk diminishes as pregnancy advances), our estimate is high; but we have allowed for this in our calculation. We are quite sure, too, that when the small farmers of Ireland come to see fully the value of providing good keep for their cows in winter, they will have some of them calving at different periods of the year.

Milch cows should be fed principally in the house during winter; they may be allowed the run of a paddock or grassfield for a few hours every fine day. In the house they should get three full feeds of roots in the day: one in the morning, a second at mid-day, and a third in the evening. In the morning they should get a little more than at any other feed, owing to the long interval between the evening and morning feeds. When the daily allowance is eight stones, three may be given in the morning, and two and a-half at the mid-day and evening feeds. The cow requires straw or hay at night, and a little between the meals occasionally. When chopped furze is given to cows during winter, it has the effect of increasing the flow of milk, renders it richer and of better colour than it is when the cows are fed even on roots and hay. A sufficient quantity of furze, in most cases, can be grown on the backs of ditches.

Some people divide the daily allowance of roots into six feeds, urging that the cows eat up their food cleaner in this way than when fewer and larger feeds are given, and that house-fed milch cows become such dainty feeders, that they require the troughs to be kept scrupulously clean. The troughs of all cattle should be kept clean, and free from the taint of decomposing food. If, however, the farmer or cattle feeder observes the habits of different animals, and never gives any of them more than they will eat up quite clean, he can keep the troughs as clean in the one case as in the other.

Pastured cows eat a good deal of grass at a time, and when pretty full lie down and ruminate, or, as we say, "chew the cud." In this way, we know they give the greatest quantity of the most valuable milk. Cattle which are fed six or eight times a day, or disturbed in any other way, do not thrive well. We have known a lot of cattle fed six times a day on roots and three times on straw, and the consequence was they were restless and fidgety, and went back in their milk. They did not ruminate properly, and the food not having been subjected to the full action of the stomach, passed into the dung without having contributed its full nutritive effects to the milk or carcase.

Some people say that when cattle get only three feeds of roots in the day they are liable to swell, or suffer from the disease called *hoove*. It is quite true that when cattle are allowed to eat a large quantity of roots, grass, or succulent food of any kind, more especially clover, the food ferments in the stomach, and gases are generated, which, if not removed or condensed, would cause immediate death. Cases of this kind arise frequently. But by cutting grass or clover six or eight hours before it is used no injury results from a moderate feed of it. And so it is with turnips and mangolds. A moderate feed of not more than three stones of turnips or mangolds taken from the pit in which they are stored is quite safe. Taken wet from the field, however, cattle have suffered from this quantity of roots. Some cattle are more liable to this disease than others, and require to be fed and observed with great care.

LESSON XIV.

The feeding of cows six or eight times a day involves a great deal of labour, and even when this labour is free, as on the majority of small farms, it is a great folly to use it mischievously or unprofitably. In no case, then, do we recommend that more than three or four full feeds should be given to milch cows in the day.

The farmer must take several practical considerations into account in determining the scale of feeding. For example, if he gives a daily feed of cooked or mashed food to his cows, it would be better to give it as the first feed in the morning, rather than raw roots, which have the effect of chilling the animal more or less; but it is not always possible to have the mash ready at this early hour. Again, as cattle fed on turnips, &c., are liable to accident of one kind or other, the midday feed should be consumed some time before the men leave for dinner. Then, again, the last feed of roots must be given at an hour sufficiently early to enable the feeder to see that the cows do not suffer from swelling or the lodging of small pieces of roots in the throat, before he retires for the night.

In addition to roots, milch cows require straw or hay. If fed on roots alone the animal system becomes deranged, the dung becomes watery, and the animal loses condition. Dry fodder counteracts this, and at the same time affords nourishment to the animal. We give about 10 lbs. of straw at night, or half that quantity of hay; and if this is not enough to keep the dung of proper consistence, we give a little after the morning or midday feed of roots, or after both, if necessary.

In addition to roots and dry fodder cows may have a small quantity of ground oats daily, mixed with turnips. The ground oats may be also given in water as a white drink, taking care to break the lumps. Bran, when it is cheap, may also be given; and, next to "grains," few purchased goods give a better return of milk than bran, at 4*s.* or 4*s.* 6*d.* a cwt. The best way of using bran is to make it into a mash. At present bran is very dear, being fully 5*s.* 6*d.* a cwt. Second-rate samples of oats bring very little more than this. In grinding, oats lose about one-tenth of their weight; or, for every ton of oats sent to the mill we get back 18 cwt. of meal. It costs 6*d*. a cwt. on the original weight for grinding. This brings up the price of the meal; still taking into account the nutriment which it contains, it pays better than bran at present prices.

Now, while it may pay very well in some places to give a few pounds of ground oats daily to milch cows (and more may be given when other feeding is scarce), it would not be equally if at all profitable to use good oats for this purpose. But we are confident that valuing milk at 6*d*. a gallon, it would be more profitable for the small farmers of Ireland to use all their tail corn and *inferior* samples of oats at the rate of a couple of pounds daily in feeding cattle, more especially if the cattle are of a good description, than to send it to market. Of late years we have known small farmers, not fifty miles from Dublin, who sold inferior samples of oats at 5½*d*. per stone, while their cattle were half starving!

The propriety of giving oats to milch cows, and the quantity to be given, depend on circumstances, one of which, viz., the price of milk, has been referred to already. It pays particularly well, at the present prices of corn and beef, to give a few pounds daily to cows while milking, when it is intended to sell them when they run dry. The quantity of milk is increased, the milk itself becomes richer, and the cattle increase in weight. About four lbs. of oats daily may be given, in addition to roots and fodder.

Some recommend a high system of feeding milch cows on oil-cake, rape-cake, beans, &c. It has been found, however, that cows will give the fullest flow of milk on succulent food, such as grass or roots, or "grains;" and accordingly, town dairymen, who look to quantity rather than quality, feed their cows principally on such substances. On the other hand, by the use of a moderate allowance of concentrated food, say two or three lbs. of ground oats, in addition to the soft food, there will be a slight increase in the quantity of milk, and a great improvement in its quality. Other things being equal, therefore, it is evident that oats and other concentrated food would remunerate the dairy farmer, who relies on butter or cheese rather than on new-milk. When the quantity of concentrated food is increased considerably above this allowance, there is no corresponding increase in the quantity or quality of the milk.

In summer, cows are housefed or pastured, or a mixed system of grazing and housefeeding is adopted.

A great deal has been said on the merits of housefeeding. We believe that there is no system which gives so great an income to the small farmer so long as the extra labour which it involves comes from his family; but when all this extra labour of cutting and carrying the grass, and feeding the cows, has to be paid for, the farmer may find a mixed system of soiling and grazing more profitable.

The housefeeding or "soiling" system has been followed with great success by the small farmers of several European countries, and by several small farmers in Ireland. It is peculiarly well adapted to the circumstances of the small farmers of this country, more particularly those small holders who have within their own families the labour for carrying it out. It takes from an acre and a-half to three acres of the pasture in the hands of the small farmers of this country to feed a cow during the summer season—say from the 1st of May to the 1st November. By putting the same land under a judicious rotation of crops, and growing artificial grasses, a far greater return is obtained. On good land, a statute acre of one-year-old artificial grass—rye-grass and clover, or a mixture of both—will give three cuttings, weighing about twenty tons in the year; and this will supply green grass or "soil" to two housefed cows for about six months. If there is a piece of vetches for summer use, part of the grass can be made into hay for winter use.

LESSON XV.

Soft succulent grass or clover is apt to cause *hoove*. Cattle have frequently died from the effects of eating a full feed of wet clover; and we have seen cattle in very great danger from a large feed of soft Italian rye-grass. To prevent this the grass should be cut some hours before it is required for use. In the heat of summer the evening's feed should be cut in the forenoon, and the forenoon's feed the evening before. The necessity for this precaution is greatest after rain. When the grass, fresh from the scythe, is thrown into a heap, as it frequently is, near the byre, it soon heats, and its feeding value is thereby diminished. Partly for the purpose of preventing this, and partly also for keeping the grass clean, it should be thrown in a layer, on a platform of spars, raised six or eight inches above the ground.

Milch cows should get three or four feeds of grass in the day. The morning feed should be given at an earlier hour than the roots in winter. The hour for feeding in the evening may also vary with circumstances. From eight to ten stones of grass in the day may be given, according to the size of the cows. This would keep them in good milking condition; and if it is desired to fatten them, a few pounds of ground oats and some hay may also be given.

Housefed cattle should get exercise for an hour or two daily during summer. If they have access to a piece of pasture they will eat less grass in the house. The five or even ten acre farmer who wants to make the most of his holding should have as little permanent pasture as possible, but a small enclosure in which to exercise his cows is very useful. The twenty-acre farmer who follows the four-course rotation should have a piece of permanent pasture for the same purpose; and the area should not be less than half an acre to each cow. When the five-course rotation is adopted, the cattle could be fed in the house on the first year's grass, and let out to graze on the second year's grass, if there are fences. A partial system of housefeeding, or a mixed system of housefeeding and grazing, is the best for farmers holding twenty acres of land and upwards.

Under a mixed system of this kind the cattle could be fed in the house morning and evening in the early part of summer and in autumn. In midsummer it would be better to confine them to the house during the heat of the day, and pasture them morning and evening, and even during night.

The small farmer who housefeeds in summer should have some vetches, rape, or cabbages, or all three, for supplementing the grass. Milch cows are greatly benefited by a change of food, and besides, in bad seasons, or at particular periods even in good seasons, the grass becomes scarce. This often occurs between the first and second cutting of the grass, at which juncture it would be well to have a piece of vetches. Whenever cattle are suddenly changed from one kind of soft food to another, as, for example, from grass to roots, they are liable to derangement of the bowels. The obvious means of preventing this is to change the food gradually, and to give, when necessary, a little straw or hay.

Near large towns and cities, distillery or brewery grains are available for feeding milch cows. They give a great flow of milk, but the milk is thin. In the winter season they often bring 2*s.* a barrel, or 6*d.* a bushel, in Dublin, Kilkenny, and Belfast. In the summer season grains are sometimes bought at 1½*d.* a bushel in Dublin, and at this price there is no cheaper feeding, and more particularly when the produce is sold as new-milk. As, however, cows fed exclusively on grains milk freely and are apt to lose condition, it is right to give richer feeding along with them. When stored in pits, and the air excluded, grains keep for a long time.

Mashed or cooked food of any kind increases the flow of milk, but it does not increase the butter or cream to a corresponding extent. In some places cooked food may pay very well, but it remains to be proved by carefully conducted experiments whether it pays for the increased labour and fuel in country districts, where butter is the principal object. The small farmer would, however, do well to give his milch cows an occasional mash;

and a little salt may be mixed with it. An occasional mash of this kind exercises a most salutary effect on the entire system of the animal. Milch cows are greatly benefited by a change of food. When the food is varied they eat it with a greater relish. The farmer should, therefore, vary the food of milch cows as much as possible, always taking care that they do not get any food which would throw them back in milk or condition.

The utmost regularity should be observed in the hours of feeding house-fed milch cows. When the hour of feeding arrives they become anxious, and if not fed then, they become restless and go back in their milk. House-fed cows require also to be cleaned and wisped once a day. To keep the air pure and the cows themselves clean, the dung should be removed from them three or four times a day.

SECTION VI.

ON THE FATTENING OF CATTLE.

LESSON XVI.

We slaughter annually in Ireland about half a million of beasts, and export to Great Britain about a third of a million. A large number of them are sent to market in very good condition by the graziers, large farmers, and landed gentry of Ireland. It is well known, however, to those who attend the Dublin and provincial markets, or witness the shipments of cattle from the Irish ports, that a great many beasts are sold either in a half-finished state or sent to England as stores. The loss on the former is very considerable; for, as every practical man knows, beasts pay better for their keep in the more advanced than in the early stage of fattening. And again, as our climate is on the whole better adapted for roots than that of England, we see no reason why a large number of the store cattle now exported should not be fattened in Ireland. It would increase the profit of the farmer and the gross produce of the country; the large quantity of valuable manure obtained would leave the land in better condition for other crops, and the labouring class would receive more employment.

The farmers who sell their cattle say stall-feeding does not pay. It may be admitted that the slovenly system of stall-feeding which many people follow cannot pay. It may also be admitted that the price of store cattle is sometimes so dear as to render it difficult to fatten them profitably. It may, however, be safely assumed that the intelligent farmers of England and Scotland who fatten a great many of our Irish cattle do not lose by the system. We have seen Irish cattle in the stalls of English farmers who pay a higher rent than is paid for the same class of land in Ireland.

Before a farmer embarks in stall-feeding he should calculate the cost of raising a ton of roots on his farm, and the quantity of meat which that quantity of roots will produce. On land fairly adapted for root-crop cultivation, roots can be raised at about *7s. 6d.* a ton. Now the results of several experiments conducted with great care show that when cattle are carefully selected and skilfully stall-fed, they pay not less than *6d.* a cwt. for the Swedish turnips consumed.

The fattening of cattle divides itself into two great divisions, grazing and stall-feeding. The former of these is practised principally upon what by way of distinction is called fattening land; and we think that this is a profitable way of managing this class of land. The ground is stocked about May, when the grass is pretty strong, and the animals are ripe about October. The land is usually stocked at the rate of one beast per acre. By stocking first-class land less closely it often fattens two sets in the year. Some graziers give cake in troughs on the grass at the rate of two pounds and upwards per head daily. Crushed oats is also used for the same purposes; and, considering the present low price of grain and the high price of beef, and the improvement which is effected in the land by the dung of the animals so fed, it pays very well.

The average increase in weight of grazed cattle varies very much. The late Mr. Peter Aungier, a most accomplished judge of cattle, used to say his top two-year-olds and three-year-olds increased at the rate of two pounds (live weight) daily from May to October. This is above the average; but we believe it is attainable by skill in breeding and feeding.

The grazier shifts his cattle from field to field, so that they may always have a good fresh bite. For this purpose his land may be divided into three or four sections. One is kept free from stock until the most forward beasts need it. The cattle are grazing on section two until section one is ready for them. Section three receives the less forward beasts or dairy stock; and store cattle and sheep may occupy a fourth section. The animals are regularly shifted from one division to another. Thus, when the stock in No. 4 is transferred to 3, the former is cleared and closed up till it is ready for the most forward beasts; and so on of the other divisions. It is worthy of remark that as fattening animals approach ripeness they require better keep, which, in the case of grazing cattle, means more succulent pasture. Grazing cattle also require a plentiful supply of water. It is found beneficial to place rock-salt within their reach so that they may lick it. The passages leading from field to field should be kept clean to prevent disease of the feet, which keeps up irritation and wastes food.

Most farmers, whose holdings are large, and who grow roots, fatten a number of beasts in houses during winter and spring. The system is usually called stall-feeding. The animals to be fattened are withdrawn from grass and placed under shelter at the approach of winter. Irish tenant-farmers generally do this in stalls, which answer exceedingly well for the purpose. The house should be warm, but not close; there should be good ventilation, but no drafts of air. The animals should be kept as quiet as possible in the stalls, because every movement of the limbs, as well as every excitement or irritation, causes a waste of the animal tissues, which is equivalent to a waste of food. Too much light causes stall-fed animals to be restless and retards the fattening process. The stalls should, therefore, be dark rather than lightsome.

For about ten days after cattle are put up to fatten they should get soft turnips, which prepare them for the more nutritive sorts. From the very commencement the strictest regularity should be observed in the hours of feeding, and the beasts should be kept clean and comfortable all through. Some farmers curry them once a day, and we have no doubt this extra trouble pays remarkably well, as it promotes the healthy action of the skin. The house, as already observed, should be warm, but not so close as to cause sweating, which is injurious. The greatest attention should also be paid to the dung, which should be neither too watery nor too hard. When the beasts are put up to fatten, the soft turnips generally scour them; but, if not allowed to go too far, this brings about a healthier action of the entire system, and by providing dry fodder, the excrements are soon restored to their proper consistence. The animals may now receive more fattening food, the kinds and quantities of which vary with the size of the beasts and the views of the farmer. The kinds of food most commonly given to stall-fed cattle are roots, straw, and hay, and oil-cake or corn. The state in which it is best to give these substances to cattle is a subject on which opinions differ widely. Some (but we believe they are few in number) cook the roots. It is the general opinion, however, that this does not pay. The advocates of the system say the animals can digest their food with less exertion (which means less waste of tissue) when it is cooked for them. Roots are, however, easily digested; and, besides, the large quantity of *saliva* secreted during the mastication of the raw roots is required for the proper action of the stomach. To prevent choking, the roots should be cut into slices not exceeding an inch in thickness.

Some again reduce the roots to shreds by what is called a pulping machine. The pulped food is often allowed to undergo a slight fermentation before it is used. The pulping machine appears to be serviceable when the farmer wants his cattle to consume and assimilate a large quantity of straw. By mixing the pulped roots with straw cut into what is called "chaff," by a chaff-cutting machine, and allowing the mixture to stand for a short time, cattle eat a great deal of straw. How far the feeding value of the straw is increased by this system has never been determined.

The use of the chaff-cutter for cutting up straw and hay has been warmly advocated. Animals can assimilate cut straw with less effort than long straw. It is also said, and with truth, that we can thoroughly mix bad and good straw, and bad and good hay, after they are cut into chaff, and so induce our farm animals to eat the bad along with the good. But the farmer should have neither bad straw nor bad hay. The chaff-cutter has special advantages, such as enabling us to mix roots and straw together in the way just explained; but it remains to be proved how much the feeding value of the straw is increased by cutting it.

When oil-cake is given to fattening beasts it should be broken very fine, and given by itself, or strewed upon the turnips. We have found the latter plan to answer very well. Some people who cut the straw or hay into chaff, make the oil-cake into a mucilage, and pour it upon the former. For feeding purposes corn should be either ground at the mill or crushed by a machine specially constructed for the purpose. The farmer who feeds horses and cattle on oats should have an oat "crusher," to be worked by hand on small and moderate-sized farms, and by water or steam power on large holdings. Every cwt. of oats given to thriving animals (along with roots and good oat straw) produces at least twelve lbs. of beef and tallow. If given to ill-shaped and badly reared cattle it would not produce this; but we are clearly of opinion that the beef and manure obtained from the judicious use of oats in cattle feeding would amount to more than the price at which immense quantities of it have been sold by the small farmers of Ireland of late years.

Stall-fed cattle should receive three feeds of roots, or roots and cake or corn, in the day,—one in the morning, one at noon, and one in the evening. They should also receive some good oat straw or hay at night. If fed oftener they are disturbed more than is desirable.

LESSON XVII.

The question, what are the proper quantities of the various kinds of food which ought to be given to stall-fed cattle, has never been fully answered. The usual practice is to give them as much roots and fodder as they can eat. This system often causes waste and loss. From eight to ten stones of roots in the day, according to the size and condition of the beasts, may be given, together with good straw or hay, and some ground corn or cake. For the first ten days or a fortnight, that is, while the animals are on soft turnips, no artificial food is needed, but when put on Swedish turnips, one lb. or two lbs. of corn or cake may be given daily to each, and the allowance may be increased to four lbs. as the period advances.

The grazier and stall-feeder should know the stage at which fat cattle should be sold, and also be able to form as correct an estimate as possible of their market value. It is difficult to convey instruction on this point by a written description. We can, however, explain a few points which the young farmer may find useful.

It has been already stated that as the fattening process advances a beast puts on more meat from a given quantity of food than in the earlier stages. This continues until the animal is ripe or matured; but if the feeding is carried farther, the animal does not pay so well for its food. It is important, therefore, to sell the animal when ripe. Now, ripeness means that the beast is well covered with meat on the outside, and well lined with fat or tallow inside. The eye and hand enable us to judge of the external condition of a beast; and, as a general rule, a beast that is well covered with flesh and fat on the outside is also well lined with tallow on the inside.

The eye distinguishes at once between lean and fat cattle, and after a little practice it enables us to judge the different degrees of fatness. Every part of a fat beast appears full to the eye. The bones on either side of the top of the tail appear full. When these are not well covered we need not look for flesh or fat anywhere else. In fat beasts the hipbones also appear round. The ribs in a lean beast are distinctly visible; in a fat beast they present an even surface, showing they are well covered with meat. In a fat beast the space along the backbone appears full to the eye.

The hand is a more certain guide in judging of the condition of a beast than the eye. In examining a beast we first place the tips of our fingers on the bones adjoining the tail, and, as just observed, unless they are well covered, we need not expect condition elsewhere. We then place the palm of the hand on the prominence of the hipbone; after which we take between the fingers and thumb the fleshy matter at the flank, which is always well filled in a fat beast. We next place the fingers on the ribs, and run them along the backbone, and feel the sirloin between the fingers. After this we examine the brisket, which is a pretty good index to the condition of a beast. We next take the point of the shoulder, which is not so soon covered as the parts already named; and finally, we examine the purse in the ox, and the veins and flesh in front of the udder of the cow or heifer. When these parts are well covered we may feel quite sure the animal is ripe.

In selling fat stock the farmer is supposed to get the full value of the carcase, or what is called the *dead weight*, calculated at the retail price of meat at the time, the butcher getting for his profit the hide, tallow, and offal, which are sometimes collectively called the *fifth quarter*. Some farmers in England sell their cattle by dead weight; and many people in Ireland sell their pigs in the same way. If this system could become general the selling of fat stock would become a simple transaction. In practice, the dead weight is approximated in a rough and ready way. Men of experience can approximate very closely to the weight of a beast; but young and inexperienced farmers, who trust to their eye, are frequently taken in by shrewd and experienced butchers and cattle dealers. Even the best judges are sometimes deceived.

We can approximate the dead weight of fat cattle very closely in two ways:—first, by ascertaining the actual live weight; and secondly, by measurement. The first of these requires the use of a good weighing machine; the other merely requiring the use of a tape line.

On an average the dead weight of cattle slaughtered in this country, is from fifty to sixty per cent. of the live weight. The proportion is lowest in our mountain breeds, and highest in short horns. It also rises as the condition of a beast improves. In mountain cattle in poor condition it is as low as forty per cent.; in short horns in very high condition it rises as high as seventy-two per cent.

By combining the effects of condition with the properties of the different breeds, the following proportions of carcase (or dead weight) to the live weight of cattle have been determined:—

Condition.	Per-centage of Beef to Live Weight.		
	Class 3.	Class 2.	Class 1.
Half fat,	45 to 50	50 to 55	54 to 59
Moderately fat,	51 ,, 55	56 ,, 60	60 ,, 62
Prime to very fat,	56 ,, 60	61 ,, 63	63 ,, 66
Extra fat,	61 ,, 66	64 ,, 68	67 ,, 72

Class 1 in the above includes short horns, Herefords, and Devons; class 2, the cattle of Galloway, Angusshire, Aberdeenshire, the better class of long-horned cattle in Ireland and England, and cross-bred cattle; class 3 comprises mountain cattle.

There are a great number of rules in use for determining the dead weight of fat cattle from measurement. The majority of these rules are too general and often cause great loss. We have found the rule laid down by Mr. Ewart, of Newcastle-upon-Tyne, exceedingly accurate. In Mr. Ewart's plan, as well as in all others, the dimensions taken are, the *girth* of the body immediately behind the fore legs, and the *length* of the back, from a point on the upper part of the tail from whence a plumb line will just include the whole beef of the buttock, to the junction of the vertebra or bones of the neck with those of the back. The latter point can be easily discerned by "raising the head of the animal so that the poll will be just level with the shoulder, when a slight hollow is seen in front of the withers in most beasts; and in bulls and other cattle in extraordinary condition the point will be shown by a slight plaiting of the hide on the upper part of the neck." Both dimensions are taken in feet and inches, and comprise a cylinder in which all the carcase is supposed to be contained. The solid contents of this cylinder is found by multiplying the square of the girth by ·07958, and this product, again, by the length. It has been found from observation on a great many beasts that every cubic foot of the cylinder so calculated will contain from two and a-half to four stones of meat, according to the breed or description of cattle, and their condition when slaughtered. Good cross-bred cattle, in a half-fat condition, give very near 3 stones of meat per cubic foot. Cattle in which the dead weight is 55 per cent. of the live weight give $2\frac{7}{8}$ stones of meat for every cubic foot in the cylinder. To simplify the calculation, Mr. Ewart gives the following table of multipliers, which are the products of the decimal ·07958 by the number of stones of meat in every cubic foot of the cylinder:—

	Class 3.	Class 2.	Class 1.
For Bullocks and Heifers—			
Half fat,	·22	·225	·23
Moderately fat,	·23	·24	·24
Prime fat,	·24	·245	·25
Very fat,	·24	·26	·262
Extra fat,	·25	·27	·275
For Bulls—			
Moderately fat,	·24	·25	·262
Ordinarily fat,	·25	·262	·275
Very fat,	·262	·275	·288
Extra fat,	·275	·288	·32

If we multiply the product of the square of the girth and length, in feet and inches, by the proper multiplier selected from the above table, we get the weight of the carcase in imperial stones. For those who wish to save the trouble of calculation, Mr. Ewart has devised a cattle gauge, which, from our own observation, we can safely recommend. Made of boxwood, the price of the gauge is 8*s.* 6*d.*

SECTION VII.

DAIRY MANAGEMENT.

LESSON XVIII.

We had in Ireland, in 1864, 1,346,217 milch cows. We produce annually above one million cwts. butter, of which we export about one-third. An enormous quantity of the butter offered for sale in our markets is very inferior. In one of the leading butter markets in Ireland, we find that of a total of 397 firkins, not a single one deserved the top price; 57 were second; 136, third; 164, fourth; 38, fifth; and 2, sixth quality!

By a good system of dairy management, all the butter produced in the country might rank first or second, and never should be lower than third. It is difficult to arrive at an accurate measure of the improvement that may be effected in this branch of industry; but we are quite safe in saying that if the dairy were well managed in all parts of Ireland, it would increase the average value of the butter produced at least 10*s.* a cwt., and add to the wealth of the country at least £500,000 a-year. The wide field for improvement is shown by the quotations of the London markets, as given in a paper now before us. While Limerick butter is quoted at from 100*s.* to 114*s.* a cwt., Friesland is from 118*s.* to 120*s.*, and Dorset, from 126*s.* to 130*s.*

Our best constructed dairies have three apartments—the kitchen or working-room, the milk-room, and store-room. There should be at least two apartments—

namely, the kitchen or working-room, and the milk-room or dairy proper; but inasmuch as the majority of the tenant-farmers, to whom we address ourselves, have the dairy attached to their dwelling, the common kitchen answers for the dairy-kitchen or working-room; and if in addition to this a suitable apartment were provided for the milk, first-class butter could be easily made. In this country the milk is too frequently kept in a bed-room, or some other apartment equally unsuited for the purpose. It is well known that milk is easily tainted. The effluvia of a bed-room is sure to prove injurious to it, and so is the damp atmosphere which exists where the house is badly drained, or where the floor is made of clay, or material which absorbs and retains a large quantity of water. When we bear in mind the state of the apartments in which milk, cream, and butter are kept by the small farmers of this country, we need not be surprised at the enormous quantity of inferior butter produced.

It is found by experience that the best temperature for a dairy is about 56° F. It is difficult to keep the temperature of a dairy which faces the south, and is exposed to the influence of the sun's rays, down to this degree during the heat of summer. It is usual, therefore, to give the milk-room or dairy a northern aspect; but if the situation be exposed, it should be protected from the winter's blasts. The small farmer's house and offices are usually thatched, and when a thatched dairy is ceiled, it answers admirably. As straw is a worse conductor of heat than slates or tiles, it keeps the dairy warm in winter, and cool in summer; but unless the house is lofted or ceiled, pieces of straw, and the dirt which collects in the thatch, are continually falling into the milk. The floor of the dairy is made of clay, bricks, tiles, wood, flags, &c. Clay is exceedingly objectionable, for the reason already assigned. Tiles are expensive; they are also too porous, and absorb and retain wet. Bricks are still more objectionable. Wood is also expensive, and retains milk and wet in its pores, which predisposes it to rot, and no sooner does it rot than it contaminates the air and taints the milk. Good *hard* flags, carefully set, and made plane on the surface, appear to us the best material for the floor of the farmer's dairy. Flags are to be had within reasonable distance everywhere. They do not absorb much wet, and if well set they are very durable. Whatever material is used, the floor should be well drained, and raised a few inches above the level of the ground outside.

A dairy requires to be well ventilated. In our best constructed dairies, the windows open from the top; but the farmer whose means are limited, could adopt the cheaper plan, of having one or more (according to the size of the dairy) of the window panes on hinges. It is certain that some means must be adopted for letting out the vitiated air, and letting in pure air in its place; for it is quite impossible to make first-class butter in an ill-ventilated dairy. We must, however, guard against strong currents of air, which would disturb the milk and chill the air more than is desirable.

Milk is disposed of in several ways, and the kind of dairy utensils used depends more or less on the system pursued. Near large towns and cities, milk is sent direct from the cow to market as new milk, and it brings most money in this way. Dairymen in and about Dublin get *3d.* a quart all the year round for new milk delivered at the door of the consumer; and, notwithstanding the mortality of dairy cattle, arising from contagious diseases, and badly ventilated cow-byres, &c., large sums have been made by this system. Milk is now brought long distances by rail from the country to the city. In many inland towns new milk sells for *2d.* a quart, and sometimes more, and this price pays better than butter making. The dairy utensils required for this system are milking pails, some tin cans and measures, and the necessary appliances for conveying it to town.

As the majority of farmers cannot sell new milk, they have to fall back on the manufacture of butter or cheese, or both. In England cheese is a staple article of dairy farming; in Ireland very little cheese is made, but the production of butter is, as we have already said, a most important branch of our industry. To make good butter, it is necessary to have not only a suitable dairy but also proper dairy utensils. Of these, the pans or "coolers," in which the milk is set, first require attention. They are made of different materials. Wood is the most common. It is also the most durable, and, on the whole, the cheapest. The staves are usually made of oak, and they are bound by iron hoops. Galvanized iron is the best material for hoops, as it does not require scrubbing. Whatever material is used, the vessel in which milk is set for cream should be shallow, because if there is a considerable depth of milk, the cream takes a longer time to rise than is desirable. From our own observation we should say the depth of milk in the cooler should not exceed three inches; and the depth of the cooler itself should not exceed four and a half inches.

An objection to wooden coolers is the difficulty of cleaning them. Milk sticks in the pores of the wood, and also at the juncture of the sides and bottom; and if this is not most carefully removed, the butter will not be first-class. In everything connected with the dairy, cleanliness should be most rigidly observed; and this applies to the floor, the walls, and ceiling of the dairy, and to the dairymaid as well as to the milk vessels and other utensils. Now, all offensive matter is removed from wooden milk vessels, by rinsing them with warm water every time they are emptied, and using a wisp of clean sweet hay for scrubbing them.

Milk is also set in vessels made of common earthenware which are cheap and easily cleaned. They are sometimes enamelled inside; and if enamelling be carefully put on, it answers very well, but it is often put on so badly, that it peels off under the action of hot water, and injures the milk.

Wedgwoodware is sometimes used, is easily kept clean, the enameling or glazing does not usually give way, but it is rather costly for small farmers: a dish about sixteen inches diameter and of the proper height, costs *4s. 6d.*, being about twice the cost of wood.

Glass has been recommended by amateur farmers. It has all the advantages of Wedgwoodware, looks remarkably nice and clean; but it is too dear and easily broken for ordinary use.

Metal milk pans are also in use. Lead is dear and otherwise objectionable, as it unites with the acid of milk and thus forms a poisonous salt. The objection applies, though in a less degree, to zinc. When the milk is skimmed at the proper time, little or no acid exists in it, but as other materials answer every purpose, it appears to us that we are exposing ourselves to unnecessary risk by using these metals. Milk vessels are sometimes enamelled on the inside to obviate the danger arising from the use of metal. We have used milk pans prepared in this way, and nothing could be better as long as the enamelling lasted; but when hot water is used in cleansing them, the enamelling soon cracks, owing to the expansion and contraction of the metal. On the whole, we think the small farmers of this country need use no more costly material than wood and common earthenware.

LESSON XIX.

In these countries butter is obtained from milk by churning either the cream or whole milk. The quality of the butter is influenced more or less by the kind of churn used, and the time consumed in churning, &c. In order to understand the merits of the several churns in use, as well as to be able to direct the operation of churning, it is necessary to understand the elementary principles involved in the process.

When we examine milk with a microscope we find a vast number of fatty globules or little sacs floating in it. Some of these are albuminous, but the great bulk of them contain fatty matter or butter. When milk is allowed to stand (as in coolers), the fatty sacs or globules rise to the surface, constituting cream. "Some of the albuminous globules have a tendency to descend, but some of them adhere to and rise with the others, so that cream does not consist solely of fatty matter. A portion of the sugar of the milk rises also with the cream.

It is owing to the presence of this sugar that cream becomes sour. The proportion of cheesy matter in cream depends on the richness of the milk and the temperature at which the milk is kept during the rising of the cream. In cool weather the fatty matter will bring up a larger quantity of curd and form a cream richer in cheesy matter."

Churning consists in breaking-up the coats of the fatty globules, and setting the butter free; and this is effected by the combined effect of friction, heat, and air. It is in the proper combination of these three agents that the perfection of churning consists. When the friction is too violent the butter is produced too speedily, and does not keep well. Heat facilitates the process of churning. If the temperature is too low the time and friction consumed in churning are so great that the butter becomes frothy, is deficient in flavour, and does not keep well. We have found from 56° to 58° the best temperature at which to put cream into the churn, and during churning it rises to 2° to 4°. For whole milk we begin at a temperature of 65°. The temperature of the cream or milk is kept down in summer by placing it in a cool place, or mixing it with cold water; and in winter the temperature is raised by hot water, or placing the cream or milk jar near a clear fire in a clean apartment.

The influence of air on the time consumed in churning, as well as on the quality of the butter, is not as well understood as it should be. The oxygen of the air aids materially in breaking-up the coats of the fatty globules. The churn should not therefore be filled with cream or milk. It is necessary to leave one-third of it for air. When the churn is quite filled it is next to impossible to produce butter. We have known ignorant people who filled the churn with cream, and who, finding that the butter would not come, ascribed the result to some evil influence exercised over them by a neighbour!

The churn most commonly used by tenant farmers is the *plunge or upright* churn. The friction is produced in this churn by a *dash*, which is moved down (plunged) and up by a vertical rod to which it is attached. There is a lid (through which the rod passes) for preventing the milk or cream, as the case may be, from splashing. It is worked by hand on small farms, and often by horse, water, or steam power on large holdings.

The plunge churn is cheap, and the quality of butter excellent. The time and labour consumed, however, are considerable, especially when, as in the north of Ireland, the whole milk, that is, the unskimmed milk, is churned.

The *barrel* churn is, on the whole, in great favour with the dairy farmers in the south of Ireland, who mostly churn cream. At the proper temperature and with the proper quantity of air it will churn cream in about half an hour. The ends of the barrel rest upon a frame, and the barrel is made to revolve by turning a wheel which is fixed at either end. The wheel should be heavy, so that by its weight or momentum it would (like the fly-wheel of a steam-engine) steady the motion. Barrel churns are made in all the towns and cities of Ireland. One of the best barrel churns in use is Tinkler's, which is made of well-seasoned oak; the axis rests on "friction rollers," by which the friction or labour of turning it is reduced very much; the plug for admitting air has a strong elastic spring, by pressing which air is admitted without the necessity of completely stopping the motion.* There is an opening in the middle of the barrel for putting in the cream or milk, for taking out the butter and buttermilk, and cleaning the churn. This opening must be large enough to admit the hand.

The barrel churn is sometimes objected to on the ground that it is difficult to clean; but in practice the difficulty is not as great as may appear. By pouring warm water into it, and turning it in opposite directions for a short time, the rinsing of it is greatly facilitated. It is durable, not liable to go out of order, and is, on the whole, a very good sort of churn.

* Mr. Tinkler recommends to press this spring or air-valve once for every five or six revolutions of the barrel for a few minutes at first; and afterwards the valve is pressed at somewhat longer intervals.

Before using a new churn for the first time, it requires to be washed carefully. Mr. Tinkler gives the following directions:—"Put six or eight gallons of cold water into the churn, give it a few turns every twenty minutes for six hours; then draw off the water, put in four gallons of warm water, and dissolve in it two ounces of soda; and, after turning as before for about three hours, draw off the water, and wash the churn thoroughly with warm water. While warm water is in the churn it is necessary to open the bung occasionally to allow the air to escape."

A churn, which from its shape is called the *box* churn, is very much recommended. The inside of the bottom of the box is cylindrical; the axis is horizontal, and carries the beaters, which revolve with it. Some improvements have been made in the box churn in America, where it is used very much. The beaters consist of two pieces of wood placed at right angles. Sometimes they are all perforated; sometimes only one-half is perforated. Sometimes, again, one side of the dasher contains a number of cells, presenting the appearance of a honeycomb. In this case, and indeed in all box churns, butter is produced in five or six minutes, and occasionally in less time. The churn is filled to the axis; and air passes freely through openings in the lid. The great objection we see to this churn is that it does the work so speedily that the butter will not keep well. When the butter is used fresh it answers remarkably well. Hence, we recommend it when a cow or two are kept for family use.

LESSON XX.

MILK newly drawn from the cow has a temperature of about 90° F., which is reduced before it reaches the dairy. It has almost always a slightly alkaline taste, which it gradually loses on exposure to air. It contains in every 100 parts about 87 parts of water, 4 parts of fatty matter or butter, 5 parts of a peculiar kind of sugar called milk-sugar, 3·5 parts of cheesy matter or curd, and ·7 mineral matter. "Butter gives it an oily richness, sugar its sweetness, curd its thickness, water its refreshing properties as a drink, and salts its peculiar flavour."

Various methods have been proposed for determining the quality of milk, some of which are too refined for ordinary farmers. A very simple instrument called a *lactometer* enables us to form a sufficiently approximate estimate of the per-centage of cream in milk. This instrument is a narrow glass tube, graduated from the top downwards to about one-fifth the entire depth. By allowing the milk to rest a sufficient time in this tube the per-centage of cream is shown on the graduated part of the tube. The comparative quantity of cream in the milk of different cows, or of the same cow under different treatment, is shown in this way; but it is not safe to rely on the lactometer much farther than this, as it is not difficult to cause poor milk to give an apparently high result with the lactometer.

Another instrument which is found useful in testing the quality of milk is the *hydrometer*. This instrument floats in the milk, and depends on the principle that as milk is heavier than water in the proportion of 103 to 100, the heavier the milk the deeper will the instrument sink in it. This instrument is, then, to some extent, a test of the extent to which milk is adulterated with water. It is not, however, a satisfactory test of the quality of milk. Thus, as cream is lighter than milk, it is evident that milk deprived of its cream is heavier, and would give a higher specific gravity than pure milk.

The business of the person who has charge of the dairy begins in the cow-house. She should milk the cows quite dry (or see that her assistants do so) twice a day, morning and evening. If any milk is left in the udder it will be absorbed into the system, lessen the secretion of milk, and ultimately run the cow dry. The cows should be milked at the same hours every day; if milked at irregular hours, they become restless, refuse to give the full quantity of milk, and go dry sooner than they otherwise would. Another reason for milking cows quite clean (if another reason be wanted) is that the "strippings," or milk last drawn, is the richest.

Before commencing to milk, the udder should be examined, and every particle of dirt on it removed.

As soon as the cows are milked, the milk is carried to the dairy; and the less it is stirred in conveying it the better, as milk which is agitated too much is injured in quality.

As milk newly drawn from the cow contains hairs, &c., it should be passed through a fine strainer before using it or setting it for cream. In the latter case the strainer should be held over the cooler as the milk is poured into it. When set for cream the milk remains undisturbed till all the cream rises to the surface, the time required for this varies with the temperature and the depth of the cooler. At a temperature of 56° milk is fully creamed in twenty-four to thirty hours. At a higher temperature it takes a shorter, and at a lower temperature a longer time. "At 34° to 37° milk may be kept three weeks without throwing up any notable quantity of cream; but at a temperature of 65° and upwards it throws up its cream freely and sours rapidly."

When the cream has risen to the surface it is removed (skimmed) by a skimmer, which is a hollow scoop of wood or metal, and poured into a deep vessel called a cream jar. The greatest possible care should be taken to remove the cream before the milk sours, for "cream off sour milk always makes bad butter." The cream is allowed to ripen, or acquire a slight degree of sourness in the jar, which facilitates the churning, and does no harm to the butter if not permitted to go too far. The time the cream takes to ripen depends on the temperature; in well-managed dairies it is allowed to remain two or three days, the temperature being 56°. The dairymaid knows when the cream is ripe for churning by its becoming thick throughout its entire mass.

If the cream of one meal or milking is enough to make a churning it is kept separate; when this is not the case, the cream of several meals is put into one jar. When a fresh quantity of cream is put into the jar the whole should be stirred with a clean wooden stick or long spoon.

When the cream is ripe it is put into the churn, on the mouth of which is placed a coarse but clean linen strainer to intercept impurities, if there are any. The best temperature at which to commence the churning of cream is, as already stated, from 56° to 58°.

The motion of the churn or dash should be somewhat slow at first, say twenty-five revolutions per minute in the barrel churn; it should be gradually increased till the cream is slightly broken or gets thinner, when it is increased to about thirty-five revolutions per minute, at which it is continued till the globules are well broken, and this is known by the unequal resistance felt against the dasher; the motion is then slackened to collect the butter. The collection of the butter is, in a barrel churn, facilitated by turning the churn backwards and forwards for a few minutes. When the butter is all collected the buttermilk is drawn off, cold clean water is put into the churn, and the barrel is turned round to wash the butter.

When whole milk is churned it is allowed to remain in coolers till it acquires the temperature of the dairy, which requires twelve hours, and sometimes twenty-four. Two or three meals or milkings are then put into a large vessel, where it remains till the whole acquires a slight degree of acidity, without which it could not be churned. The precise stage at which to churn is known by the appearance of a stiff *brat* upon the surface of the milk, which becomes uneven. This takes place in about thirty-six hours, more in winter, and something less in summer. The fact of all the milk not being of the same age does not affect the quality of the butter. The brat should not on any account be broken till the milk is put into the churn, as the admission of air would, by producing too much acidity, prove highly injurious. We require a higher temperature for churning whole milk than cream. We have found 65° is the best degree at which to commence churning the former; and, as stated before, this temperature is easily attained in summer by mixing cold water with the milk, and in winter by the use of hot water.

LESSON XXI.

When the butter is fully formed it is taken out of the churn and dressed. The dressing of butter requires great care and skill. It is done in a cooler or butter-tub specially made for the purpose, which requires to be kept most scrupulously clean. It is washed with the purest water that is to be had, and kneaded and cut-up with a *spatula* or butter-spade to facilitate the escape of the milk. When the water becomes milky it is removed, and fresh water added, and this is repeated until the water comes away quite free from colour; for if every particle of the milk is not removed, the butter soon becomes rancid. The inferior quality of an enormous quantity of our salted butter, arises from want of care in washing it. Buttermilk, particularly that obtained from whole milk, contains caseine or cheesy matter, and if much of this remains in the butter, it soon engenders rancidity. We know from observations the loss which this entails on the small farmers of Ireland, and hope that those into whose hands this manual falls, will use their best exertions to prevent it for the future.

After the butter is thoroughly washed, common salt is added to it. Salt has the valuable property of preserving animal substances from putrefaction. The quantity of salt added to butter depends on the length of time it is intended to be kept before using it. Butter, used in the fresh state, or within a short time, requires very little salt. For the London market our best dairy farmers use three-quarters of an ounce of salt to every pound of butter. Many people prefer a mixture of half an ounce of salt, a quarter of an ounce of yellow Jamaica sugar, and one-eighth of an ounce of nitre, to salt alone. Butter intended for the Colonies or long keeping requires about an ounce of salt to the pound of butter; and, in addition, sugar and nitre in the above proportions are sometimes added. Cattle fed on roots, more particularly swedes, yield butter of which the taste and flavour are disagreeable. To prevent this, nitre is dissolved in the milking pail, and, in this case, no nitre need be added to the butter in salting it.

The salt, or mixture of salt and sugar, or of salt, sugar, and nitre, requires to be thoroughly mixed with the butter. The hand is usually employed in doing this, as well as in working the milk out of the butter. Some object to the hand, alleging that the oily matter secreted from it injures the butter. The secretion of this matter is so copious in some persons that their hands should not be used in dressing butter; and if they have to be employed at all they should be called upon to use the butter spade. The female hand is, however, usually very delicate, and as dairymaids should be persons of cleanly habits, the hand may, in most cases, be safely used. At the same time we think the cleanest dairymaid may partly use the spade, no matter how delicate her hands; and she should occasionally dip her hands in clean cold water.

As the quality of the salt affects the quality of the butter, it should be procured from a respectable vendor who is known to keep a fine article fit for the dairy. It should be free from the soluble salts of magnesia and lime, and other impurities.

"Salt is rid of its impurities by pouring boiling water upon it, in the proportion of one quart of water to from half a stone to a stone of salt; stirring the whole occasionally for a couple of hours, and then straining it through a fine clean cloth. The water which passes through contains all the impurities, and may be used for ordinary culinary purposes, or mixed with the food of live stock. The salt which remains on the cloth is free from the soluble salts of magnesia and lime, and may be hung up in the cloth till required for use."

When salted, butter which is to be used fresh is made into prints or rolls, and if required for long keeping or export, it is packed into kegs, firkins, or casks. The firkin should be made of well-seasoned wood, and as staunch and air-tight as possible. It should also be thoroughly washed and afterwards dried, before butter is put into it. The extensive dairy-farmer makes as much butter at a time as fills the firkin or cask. The butter is packed tightly into the vessel, is made level on the top, a piece of clean muslin is laid carefully over it, and the whole covered with a tight-fitting lid. The small farmer requires the butter of several churnings to fill a firkin; and from want of care and skill in washing, dressing, and salting thé butter, the firkin, when bored through by the butter-buyer, often presents shades of colour and quality as numerous as the churnings from it was made up. This lessens the value of the whole very considerably. The loss, from want of care in packing the butter, is also very considerable. Sometimes a quantity of brine, or a strong solution of salt in water, is poured over the butter, which makes part of it too salt. Again, some people merely cover the butter by putting on the lid; and as a matter of course, the butter is soon tainted by the air between the lid and the butter. Now, the butter of each churning should be stored compactly in the firkin, and it should be covered on the top with a piece of fine clean muslin, over which an air-tight or close-fitting covering of wood, pasteboard, or parchment, should be carefully fixed. When the produce of another churning is to be added, the covering is removed, the butter on the surface scraped away and used in the house, the fresh surface is made uneven, the newly-dressed butter added, and the whole covered as before. From ten to twelve quarts of good milk produce a quart of good cream or a pound of butter.

SECTION VIII.

SWINE.

LESSON XXII.

The feeding of pigs has long formed a most important branch of the rural economy of Ireland. Every small farmer possesses one or more. The first-cost of a store pig is not high. The animal is fed principally on the offal of the house and the run of the yard and fields. It is readily converted into money at any time. The capital, too, is turned quickly; and in this respect it differs very much from store cattle; for while the farmer may not annually turn into money more than one-third of the capital he has invested in store cattle, he may fatten two lots of pigs in the year, and thus turn the capital twice. It is partly for this reason that the small farmers and peasantry of Ireland have reared and fed so many pigs. The enormous quantity of valuable pig feeding obtained from the offal of the table when the potato formed the principal diet of the people also encouraged the rearing of pigs. Before the potato famine about three-fourths of the pigs in Ireland belonged to cottiers and persons whose holdings did not exceed thirty statute acres. The famine forced the sale of more than one-half the pigs in the country, and swept away thousands of the farmers and cottiers who owned them. In 1841 we had 1,412,813 pigs in Ireland; in 1848 the number was reduced to 565,629. In 1864 we had 1,056,249, of which probably about one-half belonged to cottiers and farmers whose holdings were under thirty statute acres.

It has been estimated that about 1,000,000 young pigs are annually reared in Ireland; and something like the same number is annually disposed of; of the latter it is supposed that about one-third is exported alive, the remaining two-thirds being killed for the provision trade.

Valuing the pigs annually sold in Ireland at £3 10s. each, the agricultural classes derive about three millions and a half sterling from the sale of swine, which is a most important item in our national wealth. That this could be increased without any extra feeding is well known to everybody who is acquainted with the state of Ireland; for while it is true that a great improvement has been effected in the quality of our pigs, much remains yet to be done. Mr. Stearn, one of the most noted pig breeders in England, has expressed the opinion that by bestowing proper attention on the breeding, rearing, and feeding of swine, the quantity of meat could be doubled at little more than the present cost. If this be true of England it is, certainly, not less so of Ireland.

The greater portion of the wealth to be derived from improving the pigs of this country would accrue to the peasants and small farmers, not only because it is their pigs which are most in need of improvement, but also because the cottiers and farmers whose holdings do not exceed fifty statute acres own about two-thirds of the pigs in the country.

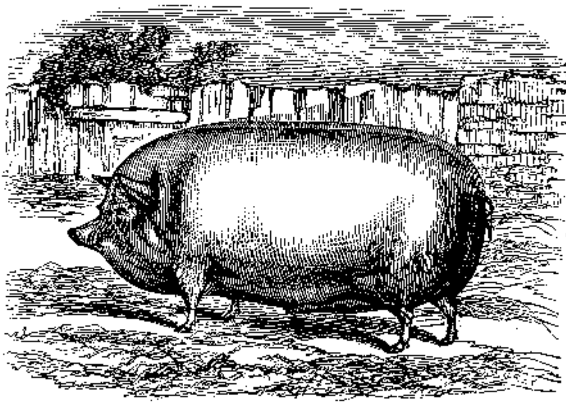
The pig has often been called the poor man's savings bank; it has also been called the poor man's friend. It is beyond all doubt that this animal is of immense advantage to the peasant. A store pig can be purchased at sums varying from a pound upwards. It consumes the offal of the table; and by a small weekly outlay, which would otherwise be spent on tobacco or intoxicating drinks, which weaken mind and body, the animal in a short time becomes worth from £3 to £4, and often more. It is in this sense that the pig can be correctly regarded as a savings' bank; and when the animal is fairly managed, the poor man cannot invest his savings in any other way that would pay him as well. But besides the profit of the animal, we hold that the feeding of pigs in this way is in other respects most beneficial to the peasantry of Ireland. It engenders in them habits of forethought and thrift, the want of which has been the ruin of hundreds of thousands of them. The peasant who saves a small sum weekly out of his limited income, and skilfully invests it in feeding a pig or two, is pretty sure to improve his own condition and to impress the best of all lessons on the minds of his children. We should, therefore, like to see every cottager in Ireland in possession of a pig.

Pigs cannot be profitably fed without proper shelter. The Irish peasant knows this too well. In too many cases he has been known to share a corner of his cottage with his pig. The owners of Irish cottages should prevent this by attaching a pig-stye to every cottage. It is their own interest to do so: for, in the first place, the cottager who has a pig is almost invariably a better mark for the rent than the one who has none. And, again, it is the interest of the employers of labourers to encourage thrift in the labourer. And surely it is the highest and most agreeable duty of the rich to promote the well-being of the poor.

Pigs may be classed in various ways. Thus, according to colour, we have black and white; according to size, small, large, and intermediate.* The relative merits of these classes depend on local circumstances, such as markets, and we must add, to some extent, caprice. At one time white pigs are in favour, at another black are preferred. In a few years we have noticed a change of this kind, very much the result of caprice, in our show yards. Then, as regards size, the farmer must be guided by the demand. In some places there is a great demand for small pigs for pork, whereas, in some of the manufacturing districts of England, and in the neighbourhood of some of our great bacon-curing establishments, we have observed a greater demand for good-sized pigs. Owing to the introduction of American bacon, which is the produce of large pigs, small and middle-sized pigs have, on the whole, been in great request in Ireland of late years.

Of pure breeds, the Yorkshire, figure 58, and the Berkshire are the kinds principally used in Ireland.

Fig. 58.

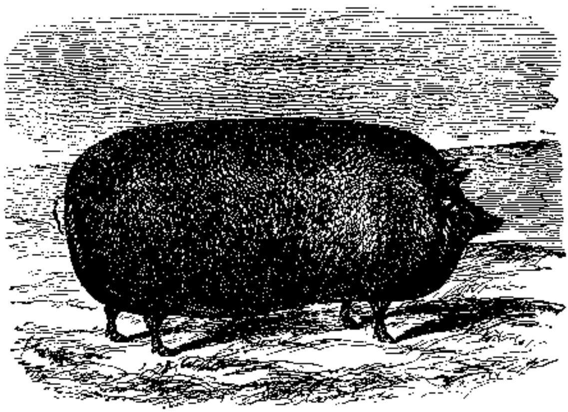


* "Pigs of the large breed weigh from	600 to	1,000 lbs. each.	
" intermediate or middle do.,	400 to	500	"
" small breeds do.,	200 to	300	"

"Youatt on the Pig," edited by Sidney, p. 6.

We have had a good deal of experience of these two breeds, the result of which may be briefly stated. The Yorkshire breed is white, and may be had of small, middle, or large size. The smaller kinds are tender, and require careful treatment while young. Their head and limbs are remarkably fine, and if well housed they are easily kept in condition, fatten rapidly, and give two cwt. of pork, dead weight, at the age of eight or nine months. They, therefore, make good porkers, and pay best for this purpose.

FIG. 59.



The colour of Berkshire pigs, figure 59, is black or dark brown. The improved Berkshire is well shaped, not coarse in head or limb, and possesses a stronger constitution, and bears rougher usage, than the Yorkshire. The Berkshire makes excellent bacon at a comparatively early age.

LESSON XXIII.

ALL the improved breeds of pigs possess many points in common; and the more of these points any pig, whether purely bred or otherwise, possesses, the better he is likely to pay. The head should be small, the face short, the snout very short and fine, and the forehead narrow and concave. The mouth in a good pig is small, and the cheeks full; the ears are thin and short, and slightly hang forward at the points; the eye is small and quick, and denotes docility, which is essential for profitable feeding. The neck is broad, rises well from behind the ears, and swells out as it joins the shoulders and breast, which is wide and deep. The line of the back should be straight or slightly curved, broad, and covered with flesh of good quality; the ribs should spring at right angles to the chine. The shoulders are thick, broad, and well covered; and the thighs thick and well covered within and without, and carrying flesh well to the hock. The bone is fine; the legs short and fine; the feet short and round, and furnished with clean claws. The hair is pretty long, fine, and silky, and contains few bristles. The skin is thin and supple—neither tight nor loose. The tail is small, curled, and set so that it is not seen at the top when the animal is fat. When viewed from the side, from behind, before, or when a bird's-eye view is taken, the carcase should present the outline of a rectangle. In pure breeds we like uniformity of colour; that is, all black or white. A pig possessing all or many of these points will always pay for its keep.

The farmer should take very good care that breeding pigs should possess as many as possible of the foregoing points. The boar, too, should be purely bred, and belong to the breed which is best adapted to the market and the treatment (as regards feeding and housing) he is to receive. A boar should be chosen (if there is power of selection) which possesses in a prominent manner any point or points in which the sow is deficient. As an example, it may be stated that an eminent English breeder of our acquaintance, whose pigs showed a slight falling-off about the tail, used, with great success, an Irish-bred boar whose back ran out quite level to the tail. In selecting a sire to improve defects in our own dams, we must, of course, see that he is not slack in other points.

Again, the breeding sow should possess a capacious belly. The body should be cylindrical, and lengthy enough not only to contain ten or twelve young ones, but also to enable them to suck her. There is some difference of opinion among our best pig breeders regarding the proper length of the body of the feeding pig. Some prefer compact pigs, others like a lengthy carcase. Our own experience is, that very long pigs fatten slower and pay less than those which are of moderate length. In this matter, as in others, extremes are to be avoided.

The sow goes in young about 113 days. Making allowance for the time she is suckling her young she can produce two litters in the year, and, when it is thought desirable, she gives five farrows in two years. The first litter is rarely as numerous or vigorous as subsequent ones. Good breeders who wish to keep up first-class pigs do not usually breed from pigs of the first litter. A profitable sow pigs at least ten young ones at a time, and it is not unusual for good sows to rear twelve. A sow which does not give a fair average number of young ones should be disposed of, unless she possesses superior merits or high breeding. A bad nurse, or a sow which eats her young, should also be fattened off as soon as possible.

Sows farrow at all seasons of the year. It is, however, difficult to rear young pigs in cold, harsh weather. It appears to us that for the ordinary farmers of this country spring, and towards the end of summer or beginning of autumn, are good periods for farrowing. In the former case there will be plenty of milk to spare for the young pigs at the time of weaning, and in the latter case they will be strong before the hard weather sets in.

The sow requires great care for some time before farrowing. As the critical period approaches she should be placed in a sty by herself, if she has not had one already; and the sty for this purpose should be roomy, say eight to ten feet square. Short straw should be used for litter, as young pigs are liable to be smothered in long straw. As many young pigs are also crushed by their dam against the wall, it is a very good plan to fix a piece of wood all round the sty, at a height of about eight or ten inches from the ground, and projecting about the same distance from the wall, so that the young ones may be forced under it rather than crushed against the wall.

When the time of farrowing arrives (and this is usually indicated by the animal becoming restless and going about the sty collecting litter), the sow must be carefully watched, and particularly so on her first litter, for if neglected she may acquire the habit of eating her young, a vice which is rarely, if ever, cured. Some pig breeders put the young ones as they are pigged into a basket containing some clean short straw, and cover the basket with a piece of old cloth to keep them warm. When all are pigged they are taken out of the basket, and put to suck the sow. This causes a little extra trouble, and is not necessary in ordinary cases. It is, however, a good plan when the young ones are delicate, and it has been found useful with sows on their first litter.

After farrowing, the sow should be fed on soft food or slops, which should be given in a warm (not a hot) state. A mash of bran or meal answers very well.

LESSON XXIV.

A sow giving suck to her young requires to be fed generously. For a time they live on her milk altogether, and if this be deficient they cannot grow big or healthy. Her food should, if possible, be given in a cooked state. Should she leave any food in the trough, it is to be removed and given to store pigs. Boiled vegetables, mixed with barley meal or Indian corn, are very good, and a little bean meal increases the quantity and improves the quality of the milk.

Should any of the young pigs be too weak and unable to provide for themselves, they should be helped to suck her, or hand-fed on milk out of a bottle to the top of which is attached an artificial teat made of Indian-rubber or some other soft material.

Young pigs generally suck from the same teats; and it has been remarked that those which suck the fore teats are strongest. It often happens that there are more young pigs than teats. The surplus number is sometimes reared by hand. It may happen, at the same time, that there is another sow which has fewer pigs than teats, and if so the surplus should be withdrawn from the former and put to the latter.

At the age of a fortnight or so they may get milk from the dairy. Valuable pigs reared for show purposes get new milk; for ordinary purposes they get skim milk or buttermilk. In a short time the milk may be thickened with a little farinaceous food, such as Indian corn or barley meal, which should be mixed with boiled roots or vegetables. When gradually accustomed to solid food in this way they are easily weaned.

When six weeks old the pigs of both sexes not required for breeding are cut, and about a fortnight after they are weaned.

Young pigs should be gradually weaned, and not separated from the dam all at once. At this age they suck her very often.* When we begin to wean they should be allowed to suck her six times a day, then four times, three times, twice, and once a day, after which they may be withdrawn altogether. In this way we avoid sudden changes of food which are injurious to young pigs, and gradually dry up the sow's milk.

In a week or two after weaning, the sow may be served again.

Skim-milk and buttermilk are very good for newly-weaned pigs. The supply of boiled roots and cabbages, and steamed or boiled potatoes, to which they were accustomed before weaning, may now be increased. No matter what system of feeding is adopted afterwards, roots and vegetables given for a fortnight after weaning should be cooked. Immediately after weaning, too, young pigs must be fed often, say six times a-day, the number of feeds being gradually diminished to three, which is the proper number for stores and fattening pigs.

* It has been ascertained that for some days after they are farrowed, young pigs will suck on an average once an hour, day and night.

Young pigs should also have access for a few hours daily to a grass paddock or field, as moderate exercise promotes health and vigour; and a plentiful supply of good clean water should be within the reach of all kinds of pigs, young and old.

It is found very beneficial to mix a little common salt with the food of pigs. Some say it produces scab; but if the animals are otherwise properly fed and housed, and the quantity of salt used not in excess, it will not produce this effect. We recommend it more particularly for young pigs, as it prevents indigestion, to which they are subject.*

From this time till the pigs are put on fattening food they are called *stores*. The management of store pigs varies with circumstances. When intended for pork they are kept almost constantly in the sties and yards, so that by gaining condition rapidly rather than size they become fit for sale at the age of nine months or thereabouts.

Stores intended for bacon usually get more exercise. Many farmers feed them principally out of doors during summer. It happens very frequently that this class of store pigs is sadly neglected. They have to subsist on such offal and refuse materials as they can pick up. In this state they may be called the "natural scavengers of the farm." Pigs eat offal and refuse material which would otherwise, perhaps, go to waste, and they pay the ordinary farmer best when they consume the refuse of the farm and garden, kitchen, dairy, barn, and corn-fields. It is even doubtful if it is profitable to feed ordinary stores on high or expensive feeding. Offal and refuse substances are not, however, always adequate; and when this happens, store pigs require other keep. In the winter months, say from the end of October to the beginning of May, some roots, cabbages, and small or damaged potatoes, may be given to them; and in summer they are kept economically on clover, vetches, and cabbages, which

* It has been recommended to mix a little sulphur occasionally with the food of pigs of all kinds; it purifies the blood and promotes digestion.

may be given to them in yards or on grass. To prevent the grass from being injured pigs are usually ringed.

In fattening pigs we ought to be guided greatly by the broad principles of animal nutrition which we applied to the fattening of cattle and sheep. There are, however, points of difference between the food and feeding of swine and of ruminants (cattle and sheep). The latter have a set of four stomachs, which enable them to digest straw and hay, and other bulky substances containing a large quantity of woody fibre. The pig, on the other hand, has only one stomach, and requires more concentrated food; that is, food containing less fibre.

Again, a fat pig contains a higher per-centage of fat than a fat cow or fat sheep; in other words, the ratio which the dead weight bears to the live weight is much higher in pigs than in cattle or sheep. Thus, while 90 per cent. of the live weight of a fat pig may be pork, a fat cow rarely gives 70 per cent. of beef from its live weight, and it is considered very good for a sheep to give 70 per cent. of mutton.

It is evident, therefore, that fattening pigs require food richer in farinaceous, or starchy material than cattle or sheep.

The economy of cooking the food of fattening swine is, at the present day, very generally admitted. They delight in cooked food; and do not, like cattle and sheep, chew the cud, which suggests that their food ought to be given to them in a state more easily assimilated than to ruminants. After cooking it, the food of pigs is often allowed to undergo a slight degree of fermentation before it is given to them. The application of heat in cooking has the effect of changing the starch of the food into sugar, which is considered to be more easily assimilated. By allowing the food to sour, the same change is brought about. We are satisfied that a slight degree of souring is beneficial; but we must prevent the souring from merging into strong fermentation, which would result in the production of alcohol and vinegar at the expense of the sugar or fattening properties of the food.

LESSON XXV

Omitting offal and refuse substances, the staple food of fattening pigs, at all events in England, is furnished by some of the grain crops, Indian corn, and the leguminous seeds. We know farmers who have fattened pigs on ground grain alone, and others who have used Indian meal alone. Many farmers give along with these some boiled roots, small and damaged potatoes, bran, pollard, barley, oats, &c.

Of all the substances named, barley meal is most abundantly used in England; in fact, the greater portion of the inferior samples of barley are used for this purpose. According to the experiments of Lawes and Gilbert, pigs, whose average live weight on the 9th May, 1850, was $149\frac{1}{3}$ lbs., consumed $68\frac{1}{2}$ lbs. barley meal each, per week (the food being given *ad libitum*), and gained on an average 12·12 lbs. live weight per week for eight weeks; which gives an increase of nearly 20 lbs. live weight for every cwt. of meal consumed.

There are few substances richer in farinaceous matter or better adapted for pig feeding than Indian corn; and, accordingly, a great quantity of it is now used for this purpose both in America and in the British Islands. It is supposed to be one of the most economical kinds of food we can buy for the purpose. It is richer in farinaceous matter than barley meal. Inferior Indian corn can be had at a very great reduction, and pays remarkably well, especially when pork is dear. It is given whole or as meal, raw or boiled. A good plan is to make the meal into stirabout, by pouring hot water upon it in a vat or tub, and covering it over with a lid or an old sack to keep in the heat. In the investigations of Lawes and Gilbert, pigs, whose average weight was $143\frac{2}{3}$ lbs. each on 14th February, 1850, consumed $45\frac{1}{4}$ lbs. Indian meal (the food being given at will) each, per week, for eight weeks, and gained on an average 9·21 lbs. per week in live weight in the same time. This gives an increase in live weight of $22\frac{3}{4}$ lbs. for every cwt. of Indian meal consumed.

The grain of the oat crop is also used for pig feeding. Some farmers even prefer it to barley. Weight for weight we think barley produces more pork.

All kinds of grain should be used in a ground state for pig feeding. They are improved by cooking. They are sometimes boiled; but a readier and simpler plan is to make the meal into a sort of porridge by pouring hot water upon it and covering it up to keep in the heat, and allowing it to cool before using it. In using hot water care must be taken that the meal does not collect into lumps, which may remain unbroken, and be likely to bring on indigestion. When skim-milk, buttermilk, or whey is abundant, a highly fattening food is obtained by using them instead of water for making the meal into porridge.

The leguminous seeds are also considered very good feeding for pigs. Beans, pease, tares, and lentils are used in this way. They are said to impart a degree of firmness to the meat, which increases its value; but if they are used largely the meat does not boil well. Pease produce meat of better quality than beans.

We think it does not pay to feed pigs wholly or even principally on leguminous seeds. But as they contain a great deal of flesh and bone-forming matter, a moderate quantity of them may, in the absence of milk or other suitable feeding, be given to young pigs; and they may also form part, but not the whole of the food of fattening pigs.

Of late years potatoes have been too dear to be given to pigs. Diseased and small potatoes may, however, be used for this purpose. They should, if possible, be steamed; and the water which collects in the steaming vat, as well as that in which potatoes are boiled, should never be given to animals of any kind. Potatoes do not fatten pigs rapidly, and the fat of the pork fed on them is said to be rather soft; hence it is usual to give some harder feeding along with them.

Of roots, the parsnip is, weight for weight, the best for fattening pigs. It appears to have been abundantly used for this purpose in the island of Guernsey. The flesh of pigs fed on this root wants firmness, which is, however, imparted to it by a little beans or pease. The parsnip cannot, however, prove profitable for this purpose unless where the soil and climate are peculiarly well adapted to its growth. We doubt much if it can be raised profitably in this country for pig feeding. Mangolds and turnips, more particularly the softer kinds of turnips, are too watery for pigs. Boiled mangold and swedes have been used occasionally, but some concentrated feeding should always be given along with them.

Fattening pigs are fed three times a day,—in the morning, at noon, and in the evening. They should be fed at the same hours day after day, and get as much food as they will eat up clean, and no more. If, at any time, a little food is left it should be given to stores. The troughs should be washed quite clean at regular intervals, for if any food is allowed to remain long in the corners of them it is sure to taint the fresh food. Metal troughs are preferable to wooden ones, as they are more easily cleaned, and not only is the food more likely to stick to the wood, but the wood itself rots and taints the food.

The pig is, in the minds of a great many people, associated with dirt and filth; but the truth is, he is, in many respects, cleanly in his habits. For instance, he does not usually dung in his litter, but retires to the yard. It is quite certain that the fattening of swine is eminently promoted by cleanliness. The most careful feeders wash them once a week. If this is thought too troublesome they ought to be rubbed with a good brush or wisp of straw.

Fattening pigs, like other fattening animals, eat more at first than afterwards. When they have put on a good deal of fat the appetite becomes less voracious, and better flavoured food is required. It is for this reason that when pigs are put up to fatten they often get more of bulky and succulent food, and as the fattening advances they get more of the richer and more palatable grains.

The market value of fat pigs may be pretty closely approximated by the use of the following table of the ratio between live and dead weight, which we quote from Mr. Ewart:—

Live Weight.	Per-centage of Pork or Bacon.
Under 15 stones,	75 to 77
15 to 20 stones,	78 to 79
20 to 25 "	80 to 81
25 to 30 "	81 to 82
30 to 35 "	83 to 84
35 to 40 "	84 to 86
Above 40 stones,	87 to 88

SECTION IX.

SHEEP.

LESSON XXVI.

A GREAT many farmers make most money by feeding sheep on the produce of their land; but there are many other cases in which the land can be turned to better account in other ways. Thus, if a small farmer who holds ten or twenty acres of land of average quality were to depend solely or principally on sheep he would not be able to support his family, while by following a good system of cropping, and feeding dairy cattle, he could not only live comfortably but save money. Tillage and dairy husbandry give full employment to every member of his family who is fit to work. The farmer and his sons till the land and feed the stock; his wife and daughters milk the cows and attend the dairy. He derives from tillage not only the ordinary profits of farming, but reaps the wages of the labour of his wife and children. It is not so when he relies on sheep. The farmer himself would be quite capable of attending five times as many sheep as his small holding could maintain.

That sheep pay well, however, is beyond all doubt. The number of sheep in this country could be greatly increased, and their quality greatly improved. The average value of the sheep in Ireland could be increased 10s. a head in a short time by bestowing proper attention on their breeding, feeding, and general management; and as there are 3,363,068 sheep in the country, this would increase our wealth to the amount of £1,681,534.

It is in regard to the sheep in the hands of the small farmers that the greatest improvement remains to be effected. They are frequently ill-shaped, require three or four years to come to market, and do not weigh as heavily as well-bred and well-fed sheep at the age of fifteen or sixteen months. Food is thus wasted, the farmer's capital is turned slowly, and the profit is extremely small, or, as sometimes happens, there is none at all.

Sheep are reared for their flesh and wool. The weight of the carcase and the quality of the mutton, as well as the weight of the fleece and the quality or "staple" of the wool vary greatly with the breed. The longer time a sheep takes to come to maturity the better the quality of its mutton, and accordingly the mutton of large and fast-growing, improved sheep, is not as good as that of unimproved or mountain sheep. The Cotswold breed is one of the largest and fastest growing breeds we possess, and so the mutton is very low in quality, and sells for a penny a lb. less than good mutton. The Black-faced sheep of Scotland, Welsh sheep, and the mountain sheep (*e.g.*, the Wicklow sheep) of Ireland, give tender and savoury mutton which always commands the highest price. The mutton of the Southdown breed of sheep is also very good, and brings a higher price than Leicester, and other favourite breeds.

All our breeds of sheep are usually classified into *long-woolled*, *short-woolled*, and *intermediate*, according to the length of the wool. Leicester and Cotswold sheep, whose wool is fully seven inches long, belong to the long-woolled class; when, as in Southdown sheep, the staple of the wool is from two to four inches, the breed is said to be short-woolled; and the Cheviot breed is an example of the intermediate class.

The Merino breed of sheep gives the best wool. Formerly its price was very high; but since the introduction of the breed into Australia, the price has fallen considerably. The price of Merino and other descriptions of fine wool has been brought down, and the price of long wool advanced by the remarkable change that has taken place in men's dress. This change consists in the use of a greater quantity of tweeds and other coarse woollen fabrics, instead of the broad cloth so much worn thirty years ago.

The most important breed of sheep in the British islands is the *Leicester*, which we owe chiefly to the labours of the late Robert Bakewell, of Dishly Grange, Leicestershire. Bakewell commenced his career as an improver of the breed about 1758; and in a short time produced a class of sheep which has added vastly to the wealth of the empire. The original sheep of Leicestershire (with which it is supposed Bakewell commenced) was a long, thin, flat-sided, and bony creature, weighing about 25lb. a quarter, and requiring at least three years to bring it to maturity. The wool was about twelve inches long. Bakewell saw that the aptitude of an animal to fatten could be judged by its outward appearance. He found that well-shaped sheep, with small limbs, gave a greater quantity of mutton, from a given quantity of food, than large and coarse animals.

Very little is known of Bakewell's system of breeding; but it is pretty certain that he succeeded in applying to Leicester sheep the principles which the brothers Colling applied, with equal success, to the improvement of short-horns. In his hands the wool became shorter, the body more compact, and the animal became fit for the butcher in two years less than before. In accomplishing these ends, he must have exercised great skill in the selection of parents. He probably crossed in the first instance, and resorted to close breeding afterwards. There can be no doubt that the early maturity of the breed was effected by breeding in-and-in. Bakewell paid greater attention to the production of mutton than wool. In his time long wool was not as valuable as it is now. He is reported to have said that he did not care if his sheep produced no wool at all. He carried his views on this point too far; but modern breeders have rectified his error. At present pure bred Leicester flocks clip 7lb. of wool per sheep. Bakewell was also disposed to reduce the carcase too much. It is said, too, that in his time breeding in-and-in was so closely followed that many ewes did not breed.

LESSON XXVII.

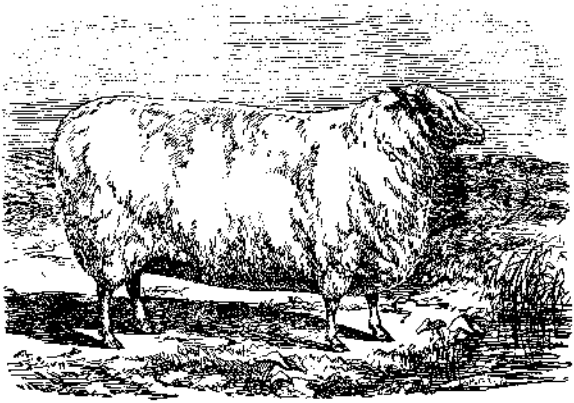
A GOOD Leicester sheep, presents the outline of a rectangle. The head is small and covered with white hair; the countenance is open and the muzzle clean; the eyes are full and show a quiet disposition; the ears are long and thin; the neck fine and tapering; the chest is deep and wide; the back is straight and wide, and ends in a square rump; the shoulders are full and deep; the ribs spring at right angles to the backbone, and are well arched, and go back very close to the pelvis; the bone is fine; the offal light; the hind-quarters are deep and full; and the skin is soft and elastic. In the unimproved sheep the fore-quarter was worth very little; but Bakewell soon remedied this defect. Some breeders of our own day are rather neglecting the hind-quarters or legs of mutton, which is a great mistake, as the leg is one of the most valuable joints of the sheep.

The engraving, figure 60, represents a prize animal of this breed.

The Leicester is now brought to market at fifteen months old, weighing 25lbs. a quarter (dead weight). The quality of the mutton is fair; but when the animal is in very high condition the lean and fat are badly mixed, which lessens the value of the mutton. The farmer is, however, amply compensated for this by the rapidity with which the animal grows and fattens.

Leicester sheep require good pasture and shelter. It is a mistake to put them on poor pasture, or in exposed situations; but no breed of sheep pays as well on first class sheep land.

FIG. 60.



The Leicester is the best breed for improving the sheep of Ireland. In peculiar situations one or other of the breeds described further on might answer better; but we think as highly of the Leicester for improving our sheep as of the short-horn for improving our cattle. There is the most ample practical experience to support this view. The fine sheep which are met with in many parts of Ireland under the name of *Ballinasloe sheep*, have been produced by crossing the native sheep with Leicester rams. The most skilful and enterprising flock masters in the country regularly use Leicester rams, and by doing so have enriched themselves and benefited the community. We desire to see this example followed by the small farmers. It is true that a small farmer cannot afford to buy or hire a pure-bred Leicester, but by clubbing together a number of small farmers could make up the five or six guineas for which a pure-bred ram of very fair quality can be had.

The *Cotswold* breed, which takes its name from a range of low hills on the east of Gloucestershire, is one of the oldest of the established breeds of England. The wool is long and somewhat coarse, and weighs about 8 lbs. per fleece. The frame is large, the carcase deep and wide, and the weight per quarter fully 30lbs. at the age of fifteen or sixteen months. The quality of the mutton is not good, but it grows rapidly. The chest, ribs, and quarters are well developed; and although the limbs (owing to the hilly nature of the ground and the distance these sheep have sometimes to travel) are and must be a little longer than in some other breeds, the sheep are well shaped. The Cotswold breed is larger than the Leicester, and is distinguished at once from the latter by a tuft of wool on the forehead.

Cotswold land is for the most part poor, and the pasture is indifferent enough. The sheep are folded on roots in winter; and as the country is high and open they have become very hardy. The ewes are prolific and good nurses. They grow so rapidly that wether lambs are sent off turnips to market in January, at the age of ten months, weighing 20 lbs. a quarter.

The *Southdown* is the most valuable breed of short woolled sheep in the kingdom. It takes its name from a range of low chalk hills called the Downs, five or six miles broad and about sixty miles long, in Sussex. To the south these hills dip into the sea, and on the north they are bounded by a narrow strip of good arable land. The Downs are covered with short sweet grass. Each sheep-run has attached to it a piece of the good arable land to the north, on which winter keep is raised for the sheep.

The original sheep of the Sussex Downs was as much inferior to the modern Southdown as the old Leicester was to the new. About 1780, Mr. John Ellman, of Glynde farm, near Lewis, in Sussex, began to improve this breed. At that time short wool was in great request. Mr. Ellman, like his contemporary Bakewell, saw that the aptitude of an animal to fatten varied with its shape and symmetry. Seeing, too, the power which animals have of transmitting their properties to their young, he bestowed great attention on the selection of parents. Ellman did not follow close breeding to the same extent as Bakewell.

The introduction of the Merino breed into Australia, certain changes in fashion, and other circumstances have, as already pointed out, caused an extraordinary change in the relative price of short and long wool.

The Southdown breed is distinguished from other breeds by the brownish gray, or speckled colour of its head and legs; and by its short, thick-set wool, which averages about 3lbs. per fleece. "The head is small and hornless; lips thin; the space between the eyes and nose narrow; under jaw fine and thin; ears pretty wide, and well covered with wool; the forehead and the space between the ears also well covered with wool as a defence against the fly; eyes full and bright, but not prominent; neck of medium length and gradually reclining towards the shoulders; ribs coming out horizontally from the spine, and extending far backwards, and the last rib projecting more than the others; back broad and large from the shoulder to the setting on of the tail; rump long and broad; belly as straight as the back; legs of medium length; the forelegs straight from the breast to the foot, and not bending inwards at the knee; hocks having a direction rather outward; twist or meeting of the thighs behind particularly full; bone fine, yet without weakness; belly well defended with wool, which should come down to the knee and hock; wool close, curled, fine, and free from any spiry projecting fibres." In addition to these points the Southdown, in common with other breeds, should possess a wide deep chest, broad loin, wide hips, and general shape and symmetry.

Southdown sheep are very prolific, giving 120 and 130 lambs for every 100 ewes. They are hardy, fold well, and bear close stocking. They are brought to market at the age of fifteen or sixteen months, weighing 20lbs. a quarter. They are also very docile. Altogether they have been found very profitable on the Southdown hills and similar situations. Southdown sheep have been found very useful in many parts of Ireland; but at the present price of long and short wool, long woolled sheep are more profitable in this country.

A ewe and lamb of the breed are illustrated in woodcut figure 61.

FIG. 61.

Southdown sheep are sometimes retained till five years old for the table of the rich. At this age the mutton has the flavour of venison, and brings a very high price.

LESSON XXVIII.

A CLASS of sheep called *Shropshire sheep* has been recently recognised as a pure breed. From an early period a race of sheep known as *Morfe Common* sheep (a name which they took from a tract of land on the borders of the Severn) has long existed. The Bristol Wool Society, in their report for 1792, observe that the "Morfe Common sheep are considered a native breed, with black, brown, or spotted faces." The modern Shropshire has been produced by crossing these sheep with other breeds, more especially the Southdown. The Morfe Common sheep had horns; the modern Shropshire sheep has none. The faces and legs are of a gray or speckled colour. The neck is thick and well set on. In shape and symmetry they bear a resemblance to the Southdown; but compared with the latter they are larger, weigh more per quarter, and have longer wool, which clips 6 lbs. per fleece. The Shropshire sheep is hardy, thrives

FIG. 62.

well on moderate keep, comes to maturity about the same age as the Southdown, and gives mutton of good quality. The ewes are prolific and good nurses. Mr. Hamilton of Hamwood (who possesses a first-class flock of this breed) states that he sometimes gets as many as 150 lambs from every 100 ewes. They yean early, and as the lambs are hardy and of good size, a good many of them are sold as "market lambs." Irish farmers who have a market for fat lambs would find it very profitable to cross the common sheep with rams of this breed.

The *Cheviot* is the most valuable breed of mountain sheep we possess. It takes its name from the range of conical hills which form part of the boundary between England and Scotland. These hills possess an elevation of from 2,000 to 3,000 feet; nevertheless, they are covered with pretty good pasture. The Cheviot sheep, in common with all the established breeds of

Great Britain, underwent a great improvement. The number of sheep in a flock is immense, but much attention is bestowed on the selection of the ewes, by "culling" out and selling all the small and unpromising ewe lambs; the rams also are selected with great care.

Cheviot sheep have no horns. The legs and faces are white, and sometimes grayish or mottled. The head is erect, long, and clean. There is no wool on the forehead; but the neck and throat are well covered with wool. The ears are open, long, and well covered. The legs, in this as in all mountain breeds, must be moderately long, but they are fine and clean; and the animals are less restless than other mountain breeds. The general outline of the carcase is good. The hind quarters are deep and full; and the fore quarters, though much fuller than formerly, are still rather light. Good ewes weigh 15 or 16 lbs. a quarter; and wethers 18 to 20 lbs. The quality of the mutton is inferior only to the Blackfaced. Though the ewes are prolific and nurse well, yet, owing to the climate, it takes good management to rear eighteen lambs from every twenty ewes.

Cheviot wool is of a soft rich quality, and is in much request for the manufacture of the best description of Scotch tweeds, &c., as well as other purposes. At present the fleece averages from 3½ lbs. to 4 lbs. of wool.

This breed now occupies the greater portion of the mountain pasture of Scotland. They are rarely sent to market by the breeder, who usually occupies the highlands, and who sells them to the feeder. A regular division of labour is thus established. Many of the flock masters possess thousands of these sheep, which are divided into flocks or *hirsels*. Each hirsel contains about 500 ewes, or 600 to 700 hogs, and is given in charge to a shepherd who, with his faithful dog is responsible for them. This breed bears very severe weather and subsists on the hardest fare. There are plantations and enclosures sometimes formed of dry stone walls about six feet high to which they have access in very severe weather; a stack of hay is also placed near these enclosures.* We know from the writings of Hogg, the Ettrick Shepherd, and others, that Cheviot sheep are often exposed to hard and stormy weather.

The Cheviot sheep have been introduced into several mountain districts in Ireland, where they pay very well. They possess fully as hardy a constitution as the native mountain sheep, and surpass the latter in shape, symmetry, in coming to maturity earlier, and in profitableness. They cross well with other breeds. Probably no sheep pay as well on lands of moderate elevation in the North of England and Scotland as a cross between a Leicester ram and a Cheviot ewe; and there are extensive tracts of land similarly situated in Ireland on which the same cross would pay well.

Another breed peculiar to Scotland is the *Black-faced Heath sheep*, represented in figure 63. This breed is said to have originated in the range of mountains that run from Derbyshire into Scotland, and which yield only coarse heath, furze, and the less valuable grasses. The Cheviot has been gradually encroaching on the Black-faced sheep in Scotland. When the land is capable of improvement, and bears grass of any kind, the Cheviot pays better. The Black-faced sheep subsists on coarser herbage than the Cheviot; and when the latter ceases to thrive the former yields a profit.

The Black-faced breed has horns. The horns of the ram are longer than those of the ewe; and they have also two or three spiral twists. The legs and face are black or mottled; there is a tuft of wool, of a light shade of colour, between the horns, and the muzzle and lips are of the same hue. The muzzle is long and clean, and the face is particularly clear of wool. The ears are moderately long. The limbs are strong, and the carcase long and square. The tail is naturally short and never cut. The wool is shaggy and coarse; usually contains *kemps* or wiry filaments; is destitute of the

* A store of hay is generally provided for three months, calculated at the rate of $1\frac{1}{2}$ lbs. for the older, and 1 lb. per day for the younger sheep.—*Low.*

Fig. 68.

property of felting, and is only fit for the manufacture of coarse fabrics. The fleece weighs about 3 lbs. The flesh feels firm and elastic, and the mutton possesses the best flavour, and brings the highest price. At the age of three or four years the carcase weighs from 15 lbs. to 18 lbs. a quarter.

This breed has been successfully crossed with the Leicester. It is not usual to go further than one cross. "It is a curious fact that when a Leicester ram of the purest and best stamp is put to Black-faced ewes, the faces and legs of the produce are almost perfectly white, but quite grey when the ram is coarse and of indifferent breeding. A ram should not be put to the same ewes more than one season, the produce of the second season partaking more of the character of the dam than of the sire." The Southdown has also been successfully used for crossing the Black-faced sheep, and Mr. Naper of Loughcrew has used Shropshire rams in the same way with great effect. The Cheviot does not cross well with this breed.

LESSON XXIX.

Ewes should be made to yean when there is good grass for them. When the farm is exposed, or the climate cold and cutting in spring, lambs should not be dropped early. "Thousands of lambs," says Mr. Youatt, "die every year from the cold to which they are exposed by being dropped too soon. And on the other hand there may be danger and inconvenience if the period of lambing is too late. Hot weather is as fatal to the mother as cold is to the young. It frequently induces a dangerous state of fever; and both the mother and the lamb may then be injured by the luxuriance of the grass. If the lamb falls late in the season, it will be longer ere the ewe can be got ready for the butcher, if she is a draft ewe; and the early lambs become larger and stronger and better able to resist the cold of the succeeding winter. The yeaning time will, therefore, be regulated by the situation of the farm, the nature of the pasture, and the demand from the neighbouring markets."

As good condition promotes fertility in ewes they should be put on generous keep, such as good grass, or a piece of rape (which is in great favour with sheep farmers for this special purpose) for some time before the breeding season commences.

The sheep farmer and shepherd should be on the alert at the lambing season. It is a very good plan to put the ewes into a shed or house when they are to yean. Extensive sheep farmers should erect sheltersheds through their sheep walks; but the farmer, to whom our observations are principally addressed, could use an empty barn or other apartment for the purpose. Any lamb which is weak and unable to suck its dam, should be either helped to suck or hand-fed. Should any ewe lose her lamb, the lamb of a deceased ewe, or one of the twins of a living one could be put to her.

Very soon after ewes yean they are drafted to fresher and better pasture. The change is not made until the ewes have recovered from the effects of yeaning, and both ewes and lambs have come to know each other. As one field or piece of pasture begins to fail the sheep should be changed to a fresh bite, always taking care to remove them in dry weather and in the afternoon. "Continued damp, rainy, or cold wet weather renders new grass so soft and fermentable as to be almost certain to produce disease in lambs, although that sort of weather increases the milk of the ewe."

The lambs run with the ewes till they are weaned. In this country lambs are usually weaned about July, by removing them to a separate and more succulent pasture. The ewes and lambs should, if possible, be removed sufficiently far apart to prevent them from hearing each other. We have met farmers in England who, in weaning, remove the sheep from the lambs, leaving the latter where they were before the separation. In any case the ewes should be removed to poorer pasture after the lambs are weaned. After shearing (which usually occurs before weaning) some lambs do not recognize their dams and wean themselves.

When, on being gently plucked, the wool comes away readily the sheep ought to be shorn. Sheep in high condition lose their wool earlier than those which are lean. In this country the sheep-shearing season occurs in May and June.

As dirt collects in the wool, sheep should be washed in a running stream before being shorn. Many farmers lose very considerably by the filthy state in which they send wool to market. They think that as the dirt adds to the weight of the wool it does not pay them to go to the trouble of washing and preparing it. Common sense should teach them that the buyer will not only cut down the price, according to the impurity of the wool, but make an adequate deduction for the labour of cleaning it.

The sheep to be washed are brought to the bank of a river and penned there. They are passed one by one into the stream, turned on their back, and after being washed, let out on the grass again. If the land on both sides of the stream can be used for the purpose the sheep should be passed across the current obliquely, taking care that one sheep could not by possibility be passed into the water in which another was washed. By giving the banks a gentle slope the washing is greatly facilitated. The water removes what is called the *yolk* of the wool along with the dirt. The yolk of wool is a peculiar soapy secretion which gives softness and pliability to the wool. It sometimes amounts to one-half the weight of an unwashed sheep. We find most of it where the wool is finest and softest, such as on the breast and neck. The yolk is regarded as an essential part of the fleece. The sheep should not, therefore, be shorn until the yolk is restored to the wool; and this occurs in about a week after washing. In the meantime the sheep should be kept on clean dry pasture.

An expert hand will shear from thirty to forty sheep per day.

LESSON XXX.

As soon as the lambs are weaned, and the ewes quite dry, the shepherd goes through his flock very carefully, and "culls" or drafts from it as many of the worst of the old ewes as he can replace from the young flock. The following are some of the points for which ewes are disqualified for breeding.—"Bareness of hair on the crown of the head, which exposes the sheep to the attacks of the fly in summer; defective eyesight, which incapacitates them for choosing the best part of the pasture; loss of teeth, or the presence of ill-shaped teeth and jaws, which prevents them from properly masticating the food; hollow neck, which indicates breeding too near akin; hollow back, which renders them too weak to carry lambs to advantage; flat ribs; drooping tail-head; bad feet; coarse bone, which denotes coarse flesh; thin coat of wool; diseased udder or teat, which diminishes the supply of milk for the lamb; scantiness of milk, which stints the growth of the progeny; not proving in lamb, or aborting—qualities likely to be perpetuated; tendency to scour, or the opposite state of the bowels." A farmer is often reluctantly compelled to retain in his flock sheep which are far from being up to his standard of quality; but a ewe which possesses one or more of the foregoing defects should be drafted as soon as possible. "Culled ewes" are either fattened off at once, or, as in the case of mountain farmers, sold to farmers who have feeding wherewith to fatten them.

Pasture is the most natural, as it is the most universal food of sheep. In Ireland thousands of sheep never get anything else. An acre of first-class grass will fatten a good sized ox or about eight sheep of average size. Land of this rich description is devoted more to the fattening of cattle than sheep. We know excellent sheep pasture, whose letting value at present would be at 27*s.* 6*d.* an acre, the occupiers of which consider it very good indeed if they keep three sheep and their lambs to the acre.

Roots are used largely for fattening sheep in winter and spring. In the light lands' districts of England sheep are folded on roots. Some farmers in this country adopt the same system. The droppings of the sheep enrich the land and put it into good condition for the grain crop (usually barley) which follows. So long as grain fetched a high price, this system paid uncommonly well; but many regard it as a slovenly system of consuming roots, and prefer to give them to the sheep on grass. This involves more labour; but it would vastly improve the grass and give more mutton and wool. The system of folding off the root where they grow, is clearly preferable where the land is so light and poor as to be unable to bear a crop of grain without the dung of the sheepfold.

Average sized sheep fed exclusively on roots consume about a stone and a half of swedes daily. On this keep a sheep will increase about 5 lbs. a quarter in from four to five months. The increase of the wool in the same period would be about a pound. Roots should be cut and given to fattening sheep in troughs. In this way none of the roots are wasted. By cutting the roots sheep eat more of them and fatten quicker. Roots are not usually cut for store sheep.

In addition to roots, sheep, when intended for fattening, get a little hay. The large farmer gives it in well-constructed sheep racks. A barrel-shaped crib, composed of a number of spars of wood bound together at the top and bottom, and with a few strong spars in the bottom to keep the hay off the ground, would answer the small farmers of this country well enough.

Many farmers give a little cake or corn along with roots to fattening sheep. At the present prices of meat and wool we believe it pays fully as well to give artificial food to sheep as to cattle. When given, the cake should be broken very fine, and the oats crushed or "cracked." About half a pound of oil-cake or a pound of oats per sheep per day may be given with advantage; and when this is given, along with a good allowance of roots, the period of fattening is shortened about a month, and the sheep turned out in better condition. In this way roots are saved; a greater number of sheep can be fed, more manure is obtained, and as a matter of course the land improves in quality; and so long as the farmer does all this judiciously, his own circumstances must improve.

In severe winter and spring weather the sheep and breeding ewes should get hay or roots, or a little of both, if they can be spared. Some farmers give artificial food when hay or roots are not available. It is certainly a mistake not to provide sheep with adequate keep at those seasons.

Ewes which yean before there is a good growth of grass should also have some roots. Mangold wurzel is excellent for this purpose. The allowance of roots must vary with the state of the grass.

Several intelligent flockmasters put rock-salt within the reach of sheep. They readily lick it; and in addition to its useful effect in promoting digestion, it is also said to prevent rot and other diseases to which sheep are liable.

SECTION X.

THE FARM-HORSE.

LESSON XXXI.

We have to treat of the horse as a beast of burden, or rather as a motive power for tilling the land and carrying the produce to market.

There are in Ireland about 600,000 horses, of which two-thirds are used for agricultural purposes. A large proportion of these do not give an adequate amount of work for the food they consume. They are badly shaped and ill adapted for farm work. Little or no care is bestowed on their breeding, and their feeding, especially while young, is also neglected. Horse labour is one of the most expensive items of tillage. It is usually estimated that a pair of horses is required for every fifty acres of tillage land of average quality, or one horse for twenty-five acres. A horse kept in fair working condition costs, in round numbers, about ten shillings a week, exclusive of the labour of the ploughman or carter. This gives a charge of at least £1 an acre for the keep of the horse, which shows the necessity of obtaining the greatest possible useful effect from horse power. And this can only be accomplished by keeping a class of horses suited to the work which they have to perform, by feeding and caring them with the utmost skill and economy, and employing their time to the best advantage. We shall offer a few remarks on each of those points, but before doing so it may be well to impress on the minds of the rising youth of the country that a horse should not be kept on a small farm of five or even of ten or twelve acres, unless in special cases. We know small farmers who are extremely poor, and one cause of their poverty is that the horse eats up all the profit. In going through the country lately we saw a ludicrous instance of the loss of employing horse labour where the spade should be used. In passing through one of the midland counties, early in the forenoon, we saw a small farmer and his son, a stout fellow of eighteen, putting an old plough and a horse into a field whose area does not exceed one acre. In passing by the same place in the evening, we found that the horse and two hands (the two were actually engaged at the work) had ploughed, indifferently, thirty statute perches of potato ground in seven hours. Had the farmer and his son gone to work vigorously with two good digging forks or even spades, they would have gone over more ground, and tilled the soil much better. This farmer rented thirteen acres of poor land, and his own appearance and the state of his holding afforded unmistakable evidence of poverty. There may have been many causes for his haggard and anxious look, as well as for the wretched condition of the land; but one thing is certain, that he never will make a competent living on this farm until he sells the horse, and sets to work vigorously with the spade, and alters his mode of farming. In this case it is no exaggeration to say that the horse eats up the profit of the farm.

The minimum size of holding on which a horse can be profitably kept varies with the nature of the soil and the system pursued. Near large towns and cities, where the land is cultivated for "market-garden" purposes, a horse is kept on a very few acres. The market gardener often raises three crops off the same ground in the twelve months, while the ordinary farmer is content with one. In determining whether a horse should be kept on a given farm, we should calculate the total number of days' work we are likely to have for him in ploughing, carting, marketing, &c. If this falls considerably short of the total number of working days in the year (which in Ireland is about 200) a horse should not be kept. We should also take into account the facility that may exist of hiring horses at the time they are wanted for ploughing and other purposes.

Horse labour comes cheaper on a farm which is large enough to give constant employment for a pair of horses than on a farm which gives employment for one horse.

It has been already said that the breeding and rearing of horses for agricultural purposes, are sadly mismanaged by many of the farmers of Ireland. It is a very common practice with them to breed from animals which age or disease has incapacitated for work. Now, there is no farm animal in which care and attention are so much required in the selection of parents as the horse. For, in the first place, as he is required for work he should be the offspring of healthy and vigorous parents. Again, horses are subject to several diseases, partly brought on by labour and hardship, from which other domestic animals are free, and which are transmitted from both parents to their offspring. And again, many of the evils that result from want of care and skill in breeding horses, are more liable to be perpetuated than similar mistakes in the production of cattle, sheep, and pigs. If a farmer rears an unpromising heifer, or an ill-shaped hogget ewe, he can sell her to the butcher; but if he is so unfortunate as to rear an ill-shaped, diseased, or unthrifty mare he is tempted not only to work her, but also to breed from her; and thus the mistake is likely to be perpetuated.

The farm horse should be suited to his work. We require stronger horses on clay than on sandy or light land. The agricultural horse should possess a short compact body. A horse which is long in the back is unfit to bear the heavy weight which is often thrown on him in carting. The limbs should be strong and well placed under the body. To the hock and knee they should be full and muscular; below these points the limbs should be strong, clean, and flat.

The pasterns should not be too long or fine. The hoof should be strong, clean, and free from sandcracks. A very flat or very upright hoof is objectionable.

"In a well-formed horse, the line from the fetlock joints to the elbow joint, is equal to the line from the elbow joint to the top of the withers."

The head should be small and clean; the eyes prominent, and the ears set nicely on the crown of the head. When the ears are set very close, the horse is generally vicious; when too far apart, he is generally dull and slow in action.

The shoulder of the cart-horse need not incline backwards as much as the shoulder of the hunter or hack.

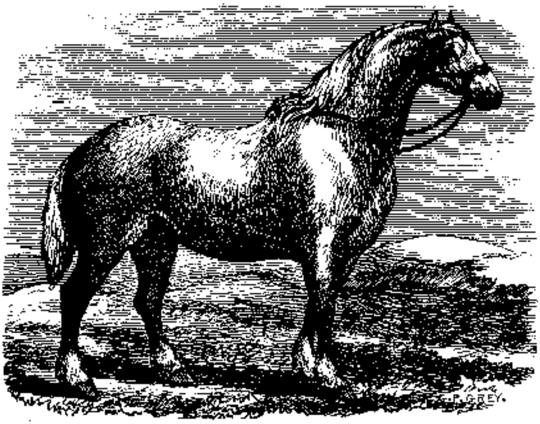
Neither should it be too upright, as this would render the animal deficient in action and liable to stumble. "The sloped position of the shoulder affords a proper seat for the collar, and provides the muscles of the shoulder blade with a long lever to enable them to throw the forelegs forward easily." Good action is one of the most essential qualities of the horse; and the action should be suited to the use to which the animal is applied. The draught-horse should step out freely. At work the speed of a horse should vary inversely with the draught. A good horse, well fed, will travel in the plough at the rate of two and a half miles an hour, with a pull of from 2 cwt. to 2½ cwt. or more. Supposing the number of working hours to be eight the animal would travel twenty miles a day. Now, a pair of horses travelling at this rate, and ploughing a furrow slice nine inches wide, would go over 1A. 3R. 11P. (statute) in a day. In practice the average area of ground ploughed by a pair of horses, on the small farms of Ireland, is between two and three roods. A good deal of time is lost in turning at the headlands, owing to the smallness of the fields and shortness of the ridges; but making due allowance for this, the work done is far short of what it ought to be, and of course tillage is far more expensive than it need be. One great cause of this is that the horses employed want strength and action. It must also be admitted that the food of farm-horses is often inadequate, and their general treatment entirely defective.

LESSON XXXII.

In order to increase the strength and improve the action of farm-horses we must begin by bestowing more care on the selection of parents for breeding. The improvement must be very slow; but it ought to be commenced at once and encouraged in every possible way by the landed gentry of Ireland. The supply of horses must be kept up; and for some time mares far below the proper standard must be used for breeding. But mares which are worthless or wholly unsuited for breeding should be rejected, and a little extra attention bestowed on the selection of the sires.

Of the pure breeds which may be used for improving the draught-horses of Ireland, we will notice only a few. The first of these is the Clydesdale, figure 64, which takes its name from the valley of the Clyde. This is generally regarded as the most valuable pure breed of farm-horses we possess. A Clydesdale horse is above the average size of farm-horses in this country. Black is the prevailing colour of the breed, but brown and gray are not uncommon. The limbs are heavy and strong, and sometimes the legs are rather long; but there is no difficulty in procuring animals free from this defect. Generally speaking the size of the head is well proportioned to the size of the body. Compared with the limbs the body is often deficient in strength.

Fig. 64.

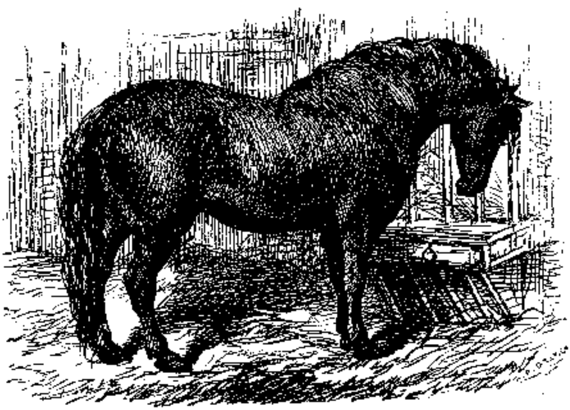


CLYDESDALE HORSE.

Clydesdale horses are covered with long hair about the pastern, and this, together with their heavy limbs, gives them a clumsy appearance in the eyes of farmers who have been accustomed to lighter and smarter looking horses. But the action of the Clydesdale is better than their appearance would indicate. Many Clydesdale horses grow very big. The tenant-farmers of Ireland should select moderately sized animals with clean, good limbs, compact well-knit bodies, and with free action. By crossing a horse of this description with a common mare of good points, we get good draught-horses for ordinary farm work.

The Suffolk Punch, figure 65, is another valuable pure breed of farm-horses. The breed is called Suffolk after the county of that name in England; and the appellation *Punch* is prefixed because of the short and stout or punchy shape of the breed. The colour is almost invariably chesnut. The limbs are finer than

FIG. 65.



those of Clydesdale horses; there is less hair on the legs and pasterns. The barrel is round and the body compact, and the action is remarkably good. The Suffolk Punch is lighter and smarter than the Clydesdale; and on many small farms of light land in this country, we should prefer the Suffolk Punch to the Clydesdale for crossing with the native mares.

The first foal rarely turns out a first-rate animal. Many horse-breeders prefer the second to any other foal which a mare produces. A mare which is well cared continues to breed up to the age of from twelve to fifteen, and if she does but very little farm work, she may give good foals up to the age of twenty.

The mare goes from eleven to twelve months with foal. In regular labour the period is about 340 days. She is not unfrequently worked till the day of foaling. This, however, is not right; and all prudent, intelligent farmers allow her a rest of about a fortnight before the time she is expected to foal, which is known by the peculiar adhesive matter that collects on the teats. About six months after conception she is liable to slink, and requires, therefore, the most vigilant attention at this time. Moderate and regular exercise, and judicious feeding, invariably prevent this. A mare which slinks once is very apt to do so again and again.

The age of thoroughbred horses dates from the 1st January, no matter when they are foaled; while the age of common foals is counted from the 1st May. About the 1st of May is considered a very good time for the farmer's mare to foal. The weather is then very mild for the young animal; the grass is plentiful and succulent, and the farmer has had the benefit of the mare at his spring work.

Sometime before foaling the mare should be removed to a good roomy stall (say two ordinary stalls made into one), or to a nice clean paddock, if the weather be fine. She likes seclusion when foaling; and the foal is usually dropped so quickly that human eye seldom sees her in the act.

It is desirable to keep the mare idle for about a month after foaling. Unless the foal is dropped very early, or in severe weather, the best place for both mare and foal for about a month, is a well sheltered paddock or field; and if possible it should be near a house, or have a shelter-shed into which they could run. When the mare foals early, and while there is yet no luxuriant pasture, she should get a liberal allowance of oats, the quantity to be gradually diminished as the grass advances.

The first work to which a mare is put after foaling should be comparatively light.

Foals are generally weaned at the age of five months; or before the first winter sets in. In weaning they are put under shelter, and having been gradually accustomed to the oats, hay, and other feeding on which their dams fed, they soon learn to do for themselves. During the first winter they should get a little bruised oats, good sweet hay, with carrots or roots. They are also benefited by an occasional mash. There is no greater mistake than to stint a young horse; too high feeding must at the same time be avoided, as many a valuable young horse has been destroyed by pampering.

The work of training the young horse should go on from the very commencement. He should be occasionally approached by the farmer and brought gradually under his influence. The vicious habits of horses arise principally from the want of good early training. A cross-tempered ploughman or carter should never be allowed near young horses. Gentleness and firmness are the two great qualities in the horse-trainer. If these two qualities are brought to bear on the training of the colt he is not likely to give trouble afterwards.

After the colt has passed two winters, its training should be particularly attended to. If not accustomed to the bit before, it should be used regularly now, taking care at first to use one that will not cut his mouth violently. After a short time he may be accustomed to the harness piece after piece, and when well accustomed to a full set he may be yoked to a log of wood, the weight being gradually increased; after which he may be yoked to the plough along with a steady old horse.

In training young horses it is usual to trot them round and round in a ring. This is indispensable for saddle horses as it improves their action. Light farm horses, which are used occasionally for the saddle, should also be trained in the ring: but with heavy draught horses it may be omitted. The ring should be pretty large, and the horse should not always step in the same direction, else he would acquire the habit of occasionally making a longer step with one leg than the other.

From the time the training of the young horse begins he should be accustomed to back, so that when put into harness he would back freely without any weight behind him, and that when put into the shafts he would back the empty cart, and, after a little, the loaded one. Great caution is necessary in training the young horse to back. Much mischief is done by attempting this in a rough or thoughtless manner.

The farm-horse is usually put to plough or harrow in his third spring. At first he should only be worked for a few hours; if there are two young horses, one should be yoked with a steady old horse in the forenoon, and the other in the afternoon. A horse should not be put into the shafts till the fourth spring. If subjected to a full strain sooner he is liable to become stiff in the joints, or suffer in some other way.

In training young horses to plough or harrow an equalizing swing tree should be used; that is, the main swing should be so constructed that the young horse could pull from a longer arm than the old one.

LESSON XXXIII.

The intelligent farmer of the present day knows that horse labour is most economical, when the animal is provided with a healthy stable, and when he is generously fed and carefully groomed. It is an old and true saying that one may determine the character of the farmer from the condition of his horses.

The horse is stabled either in a loose box or a stall. The former consists of square roomy apartment in which the horse is loose. We believe the loose-box system is the best for hunters and thoroughbreds; but for ordinary tenant farmers it takes up too much space and costs too much money. Some people who adopt this system allow the manure to accumulate under the horse for weeks and months, and merely put on fresh litter as it is required. We are totally opposed to this practice, which is apt to bring on disease of the hoofs and eyes.

For ordinary farm horses, then, we recommend stalls. Each stall should be six feet wide, and at least fifteen feet from the front to the back wall. The average length of farm-horses is about eight feet. They require ten feet to stand on; the manger is about eighteen inches in breadth; the channel for carrying off the urine about six inches, and a passage about three feet wide is required behind the horses. When the stable is lofted the height to the ceiling should not be less than twelve feet; so that each horse would have at least a thousand cubic feet of air. The higher the stable is the more pure air the horse has to breathe, and the less liable he is to catch cold, provided the ventilation is effected (as it ought to be) by giving egress to the heated air as high up as possible. When the stable is low the air becomes heavy and unwholsome during a long winter's night. Again, in many low stables in this country fresh air is admitted through openings on a level with the horses. Currents of cold air rush through those openings, and strike on the horse while he is hot after his day's work, often causing disease.

The stall should have a fall of two inches to the channel to carry off the urine and keep the bedding dry.

The stable is provided with a *rack* for hay or straw, and a *manger* for corn. In the majority of old stables the rack is placed over the manger, but in most modern stables both are on a level. The objections urged against the high rack are, that the horse pulls some of the hay under his feet and wastes it, and that his eyes are liable to be injured by hayseed, and bits of hay falling into them. The low rack is also the more convenient of the two. By placing a few bars across it the horse cannot throw out any of the hay. If not cleaned out regularly the stuff that collects in the bottom gets fusty, and this gives the horse a distaste for the fresh hay. The simplest way of preventing this is by raising the bottom of the rack a few inches above the ground. The bottom of the rack should also incline upwards to the wall to prevent dirt from lodging in it. The top of the manger and rack should be about three feet three inches above the ground. The depth of the manger should be about a foot, which is just enough to enable the horse to reach the food in the bottom of it.

Neither the solid nor liquid excrements of the horse should be allowed to accumulate in the stable. The latter should pass directly into the liquid manure tank; and the former, as well as all decomposing straw, should be carefully removed every morning and added to the manure heap. The dry litter should be lifted and collected at the head of the stand, and the floor cleaned and left, during the day, exposed to the sweetening influence of the atmosphere. When these matters are neglected decomposition takes place, and the ammonia and other gases produced, render the air disagreeable and injurious. Some people sprinkle gypsum on the stable-floor or on the window sills, for the purpose of fixing the ammonia; but gypsum does not fix ammonia unless when moisture is present. Others use common salt, which, by checking decomposition, prevents the formation of ammonia. Nothing of the kind is necessary if ordinary care is bestowed on keeping the stable clean and the air sweet and wholsome. The stable should admit plenty of light. A sudden transition from a dim stable, perhaps without a glass window, to the full light of day, and *vice versâ*, must, when repeated day after day, prove injurious to the sight. Darkness is also a cloak for negligence or carelessness on the part of servants.

The intervals for labour and rest, into which the day is divided for horses and men, vary with local customs and seasons. The more general custom is to divide the day into three intervals throughout the year; that is, to work the horses from six o'clock in summer, and from daylight in winter till breakfast; allow an hour for breakfast; work from breakfast till dinner; and, after allowing another hour for dinner, to work again till six o'clock in summer and till dusk in winter. We approve of the subdivision of the long days of summer into three intervals; but in winter we prefer the custom that prevails in some parts of the north of Ireland and England of breaking the day's work into two intervals, by a mid-day rest for dinner. In this case the men have breakfasted, and are ready to start for the field at daylight; they work till twelve, when they get an hour and a-half for dinner; and work again till dusk. In this way less time is wasted in yoking and unyoking, and in going to and from the field; and, of course, more time is available for effective work.

The first care of the ploughman or groom in the morning is to water the horse, after which he gets his first feed; and when this is eaten the harness is put on, and the day's work begins.

After each interval of labour the horse is fed.

When brought home after his day's work the horse requires careful grooming, more especially in wet weather. If the legs are dirty it is usual to wash them down by the hand or to walk the horse through a shallow stream of water. The legs should not be wetted above the knees and hocks; and we should be particularly careful not to wet the belly, which would bring on inflammation of the bowels. Some people object to washing the feet of the farm-horse at all, on the ground that it is difficult to dry the long hair at the pasterns, and that if not dried up disease is liable to ensue. They urge that it is enough to wisp the feet of slow-working horses clean and dry. The horse's legs and feet can, however, be more thoroughly cleaned by washing them; and the friction required to dry them afterwards is beneficial; but it is absolutely necessary to dry them thoroughly after washing. When the horse is watered and groomed he gets his feed. He should be cooled from the heat of the day's work before he is put into the stable; and the necessity for taking this precaution becomes all the greater when the stable is small and badly ventilated. Horses very frequently take cold from sudden changes of temperature. Mr. Youatt observes that "many a horse which travelled without injury over a bleak country, has been suddenly seized with inflammation and fever when he has, immediately at the end of his journey, been surrounded with heated and foul air:" and the same may be said of many a farm-horse.

The horse's feet should be carefully picked every evening before he is put into the stable. He should also be carefully wisped all over to dry the coat and remove dirt, and afterwards curried and brushed. The farmer who is trusting to others should visit the stable every night after the servants have finished their work. He should see that the animals are properly littered; pass his hand over them to see that they are quite dry, and give them a slap with his hand on one or two points to see if the dirt and dust have been removed.

LESSON XXXIV.

THE quantity and quality of the horse's food should vary with his work; and this again depends on the season and other circumstances. For practical purposes we may divide the year into twelve weeks of spring, eighteen weeks of summer, six weeks of autumn, and sixteen weeks of winter. The work is much harder in spring and autumn than in summer and winter. The kinds and quantities of food which horses receive at these several seasons of the year vary very considerably. Probably there is no point in farm practice on which there is so great a diversity of opinion as this. One thing appears pretty certain, namely, that as labour wastes the tissues the horse requires food richer in the substance of muscle than the cow, the sheep, or pig. Again, the stomach of the horse is small in proportion to the size of his body. Anatomists tell us that the stomach of an ordinary sized horse is about the size of the stomach of man.

Oats is, perhaps, the most universal food of horses in these countries. Oats is sufficiently concentrated and agrees remarkably well with the digestion of the horse. Mouldy or musty oats should never be given to horses. Many horses do not thoroughly digest their oats, and this remark applies more especially to the small grained varieties. To prevent this, the oats should be bruised or cracked in a mill; and when there is no mill, it is a good plan to mix a little bran with the oats, which induces the horse to chew and digest the latter more completely.

Beans, which are richer in the substance of muscle than oats, are often given to hard-wrought horses, more especially in the large manufacturing and trading cities and towns. Owing to their costive nature they should be given sparingly, particularly at first; and when used in liberal quantity, bran or some other food which would counteract their costive effect, should be given along with them. To farm-horses they may be given in spring and autumn in the proportion of two-thirds oats to one-third beans. They should be a year old before use, and free from mouldiness, or insect injuries; and for old horses they should always be split.

Oats and hay may be said to form the staple food of horses. A working horse should not be fed solely on hay, as the quantity which would afford the necessary nutriment is too bulky. Hay is sometimes so badly saved that it is little better than straw; and working horses fed on this class of hay lose condition. Mouldy hay often produces the disease known as broken wind.* 'Good hay is long, large, and tough. Its colour inclines to green rather than white. It has a sweet taste and fragrant smell, and when infused in hot water produces a rich dark colour. In damp weather good hay absorbs moisture and becomes heavier.'

In summer horses get green food, such as cut grass and vetches; and many farmers put their horses out to grass at night during that season.

The word condition, as applied to horses is a very wide one. In the racer and hunter we require the muscular and nervous systems to be in good condition; in draught horses we want muscular strength and weight of carcase, because draught is effected, not only by the power of the muscles, but also by the weight which the horse is capable of throwing into his collar. The fat which adds weight and power to the cart-horse would render the racer or hunter unfit for his work.

The quantities of oats and hay necessary to keep the farm-horse in suitable condition, depend on the nature of his work, his size, and the quality of the food. Cavalry horses get 10 lbs. oats and 12 lbs. hay of good average quality daily. In spring and autumn a stone of oats, and a stone and a half of hay per day, with a mash twice a week, will keep an averaged sized farm-horse in good working condition. In summer he may get about 100 lbs. of grass and 7 lbs. of oats (more or less according to the work) daily; and in winter a stone

* Broken wind is caused by injudicious feeding, such as giving an excessive quantity of hay, or allowing the horse to drink water freely before hard work, &c.

and a half of hay, with from 7 to 10 lbs. of oats daily, according to the work, may be taken as a fair allowance.

When farm work is slack during the winter months, good oat straw is often substituted partially or wholly for hay. When it is intended to use a mixture of hay and straw, it is a very good plan to mix them together in the rick. The dry straw prevents the hay from heating, and the hay improves the taste and flavour of the straw. We should always select the nicest, cleanest, and shortest straw for horses.

Of root crops the carrot is the best for horse feeding. It imparts a nice glossy coat to the animal and improves his condition. It is almost invariably given raw. The carrot is, however, too innutritious to be solely depended upon as the food of the working horse. Boiled potatoes are very good for horses; but they are now too dear to be used in this way. Swedish turnips and mangold wurtzel have been also used. They are too watery to enter largely into the diet of working horses; but a mash of boiled Swedish turnips, or mangolds, mixed with a little salt, may be given at night twice a week with great advantage.

In many parts of Ireland and elsewhere horses are fed on furze from October till spring. Only the tender shoots of the plant are used, and they are prepared by being chopped and bruised. A daily allowance of three stone of furze prepared in this way will keep a horse in a sleek and fair working condition throughout winter. Furze alone is not adequate food for a farm-horse at full work in autumn or spring.

Furze pays best on poor land which refuses to give more valuable crops, on the sides of steep and craggy hills, or when it is planted in the fences. We are informed, on good authority, that furze formed the staple forage of the cavalry-horses under Wellington in the north of Spain. It is estimated that an acre of furze will feed four or five horses for four months.

Furze is heating food. This property is readily counteracted by mixing with it hay, straw, or roots. When the horse is fed principally on furze he passes too much urine; but this is prevented by mixing a little common salt with the food.

APPENDIX.

PART I.—SOILS and MANURES.

1. *Chemical Analyses of Soils.*—The analysis of a soil, as hitherto made, merely professes to give the kinds and quantities of the several ingredients in the finely divided matter. It does not in every case profess to tell even the states of combination in which these ingredients exist in the soil. The variations in samples of the soil of the same field, taken from different parts of it, are so numerous as to render it impossible to select a specimen that would give average results.

We will first place before the reader an analysis, published by Professor Johnston, of a soil which was kept in a fertile state by moderate and regular applications of manure. Every 1,000 parts of the finely divided matter contained—

Organic matter	50
Silica in the sand and clay	833
Alumina in clay	51
Lime	18
Magnesia	8
Oxides of iron	30
Manganese	3
Potash	trace
Soda	do.
Chlorine	do.
Sulphuric acid	$\frac{3}{4}$
Phosphoric acid	$1\frac{3}{4}$
Carbonic acid	$4\frac{1}{2}$
	1000

2. *Composition of two specimens of Clay Soil.*—No. I. is a heavy surface soil from the neighbourhood of Cirencester, analyzed by Dr. Voelcker; No. II. gives the composition of the soil and subsoil of the farm attached to the Agricultural School at Belfast, which is an exceedingly stiff and unmanageable piece of ground, and which was examined by Dr. Hodges.

	No. I.	No. II.	
		Soil.	Subsoil.
Organic matter and water of combination,	3·38	13·71	4·26
Oxide of iron,	8·82	4·51	8·40
Alumina,	6·67	3·84	5·16
Carbonate of lime,	1·44 lime	1·06	·47
Sulphate of lime,		·67	·93
Carbonate of magnesia,	·92 magnesia	·82	·26
Potash,	1·48	·03	·05
Soda,	1·08	·11	·16
Chloride of sodium,	.	·33	·36
Phosphoric acid,	·51	·01	·01
Silica soluble in acids,	.	·07	·03
Insoluble matters (chiefly silicates),	72·83	74·75	79·84
Carbonic acid and loss,	2·87	.	.
Sulphuric acid and chlorine,	trace	trace	trace
	100·00	99·91	99·83

3. Composition of two samples of sandy soil from the neighbourhood of Circencester, analyzed by Dr. Voelcker. Every 100 parts contained:—

	No. 1.	No. 2.
Organic matter and a little water of combination	5·36	4·82
Oxide of iron and alumina	5·78	12·16
Carbonate of lime	·25	·15
Potash, soda, and magnesia	·49	·46
Phosphoric acid	none	faint trace
Sulphuric acid	trace	trace
Chlorine	trace	trace
Insoluble siliceous matter (chiefly quartz sand, with but little clay)	88·12	82·41

4. Analysis of a calcareous soil, from Southross, Gloucestershire:—

Lime	52·23
Magnesia	0·31
Oxide of iron and alumina	2·86
Phosphoric acid	traces
Sulphuric acid	do.
Silica	0·26
Carbonic acid	44·60
	100·26

5. Analysis of a specimen of marly clay:—

Moisture	1·51
Organic matter and water of combination	11·08
Oxide of iron and alumina	14·25
Carbonate of lime	10·82
Sulphate of lime	0·71
Magnesia	0·51
Potash (in acid solution)	0·32
Soda (in acid solution)	0·05
Phosphoric acid	0·10
Insoluble Silicate (chiefly clay)	60·65
	100·00

6. A sample of peat from the Bog of Allen, contained in every 100 parts:—

Water		13·20
Organic or combustible matter		84·35
Inorganic matter or ash:		
Sulphur	0·22	
Oxide of iron and alumina	0·27	
Lime	0·40	2·45
Earthy matters	0·49	
Alkalies and loss	1·07	
		100·00

7. Composition of the soil and subsoil of part of the Albert Model Farm:—

	Soil.	Subsoil.
Organic matter	14·21	3·64
Potash	0·36	0·07
Soda	0·18	0·04
Alumina	1·32	0·75
Oxide of iron	1·82	4·22
Lime	5·57	6·56
Magnesia	0·06	0·02
Sulphuric acid	0·22	0·19
Phosphoric acid	0·06	0·03
Chlorine	0·28	0·18
Silica	0·55	0·07
Carbonic acid	4·33	5·02
Insoluble silicious matters	70·82	78·66
	99·78	99·45
Nitrogen, per cent.	0·29	0·18
Water in the sample analysed	22·30	14·20

In speaking or writing to farmers about this soil we generally call it a rich loam. It contains too little alumina to be called a clay loam; and it is too heavy to be called a sandy loam. It is a good soil, capable, under fair management, of yielding good crops of cereals and roots. The subsoil is many feet in depth. Neither soil nor subsoil was derived from the disintegration of the underlying rock which is calp limestone.

MANURES.

1. An approximate estimate of the quantity of mineral matters removed per acre, by the principal farm crops:—

Crops.		Average Produce.	Potash.	Phosphoric acid.	Soda.	Magnesia.	Lime.	Sulphuric acid.	Silica.	Peroxide of iron.	Chloride of sodium.
		tons.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Turnips:	Bulbs,	20	126	33	23	12¼	38	42	12	4	27
	Tops,	6	76	28	16	9¾	70	36½	2½	2½	38
Potatoes:	Tubers,	8	223	50	7½	21	8¾	54½	17	–	18½
	Tops,	4⅓	50½	14	29	13	30½	12¾	7	2	22
Wheat:	Grain,	2,000 lbs.	10	15	1¼	4	1	1	1	3	·04
	Straw,	4,000 ,,	24	11	1¼	5¼	12½	8	138	2	0½
Oats:	Grain,	2,000 ,,	10	10½	1½	4¾	2¼	0¾	27¼	1½	·1
	Straw,	3,333⅓ ,,	32⅓	4⅓	16½	6½	14	5½	82	8½	–
Barley:	Grain,	2,000 ,,	9	17	1¾	4	1	0⅓	12	0¾	·2
	Straw,	2,500 ,,	28	5	1	6	12	3	82	2½	10¼
Beans:	Grain,	1,890 ,,	27	28	8	6	4	0¾	1	0⅓	0½
	Straw,	3,360 ,,	107	14½	3	13½	40	2	44	–	8½

2. The quantity of phosphoric acid annually removed from the soil of Ireland.

For some time past we have been annually exporting from Ireland upwards of 300,000 oxen, upwards of 400,000 sheep and lambs, and upwards of 300,000 swine; in one year upwards of 100,000 native born Irish emigrated, and about 133,000 died: all contained at least 25,000,000 lbs. phosphoric acid.*

* According to Liebig, an ox weighing about 5 cwt. (550 lbs.) contains 183 lbs. bones, of which nearly 120 lbs. is phosphoric acid; and in the hide, flesh, and other parts there are 15 lbs. of phosphates. The skeleton (bones) of an adult is said to weigh from 10 to 13 lbs. According to the ultimate analysis tabulated in the Kensington Museum, the body of a man weighing 154 lbs. contained of—

	lb.	oz.	grs.
Phosphorus	1	12	190
Nitrogen	3	8	0
Potassium	0	0	290

The total population of Ireland is about five millions; and assuming the excrements voided daily, at the average for all ages and sexes, to be—

Of urine	2 lbs.
Fæces	3 oz.,

the total phosphoric acid voided by the population is about—

In urine	240,000,000 lbs.
In fæces	22,000,000 lbs.
	262,000,000 lbs.

It is exceedingly difficult to determine how much of this is returned to the soil. In towns having each a population of 2,000 and upwards, the excrements are for the most part lost; and as these towns have an aggregate population of 1,000,000, or one-sixth of the whole, we will assume that there is, in these towns alone, a loss of about 44,000,000 lbs. of phosphoric acid.

A great portion of the fæces of the inhabitants of small towns, villages, and rural districts may be supposed to be utilised; but a very considerable portion of their urine is wasted. Taking the waste at one-fifth, there is a loss of 40,000,000 lbs. of phosphoric acid. Summarizing these figures, we find that 114,000,000 lbs. of phosphoric acid were removed out of the agricultural soil of Ireland in 1858.

3. *Composition of Farmyard Manure.*—In order to give an adequate idea of the complex nature of farmyard manure, we give the following complete analyses of two specimens recently examined by Dr. Voelcker. Every 100 parts by weight contained:—

	Farmyard Manure.	
	Fresh.	Well-rotted.
Water	66·17	75·42
[1] Soluble organic matter	2·48	3·71
[2] " ash	1·54	1·47
[3] Insoluble organic matter	25·76	12·82
[4] " ash	4·05	6·58
	100·00	100·00

	Farmyard Manure. Fresh.	Farmyard Manure. Well-rotted.
[1] Containing nitrogen	0·149	0·297
Equal to ammonia	0·181	0·36
[3] Containing nitrogen	0·494	0·309
Equal to ammonia	0·599	0·375
The manure contains ammonia in free state*	0·034	0·046
" in form of salts*	0·088	0·057

The soluble ash consists of—		
Soluble silica	·237	·254
Phosphate of lime	·299	·382
Lime	·066	·117
Magnesia	·011	·047
Potash	·573	·446
Soda	·051	·023
Chloride of sodium	·030	·037
Sulphuric acid	·055	·058
Carbonic acid and loss	·218	·106

[4] The insoluble ash consists of—		
Silica	·967	1·424
Insoluble	·561	1·010
Oxides of iron and alumina, with phosphates	·596	·947
Containing phosphoric acid	(·178)	(·274)
Equal to bone earth	(·386)	(·573)
Lime	1·120	1·667
Magnesia	·143	·091
Potash	·099	·045
Soda	·019	·038
Sulphuric acid	·061	·063
Carbonic acid and loss	·484	1·295

4. *The oozings of dung-heaps.*— A good idea can be formed of their fertilizing properties from the following analysis of the drainage matters of a heap of dung exposed to rain in the ordinary way.

* In the analyses the amount of ammonia contained in the manure, in the state of volatile ammoniacal compounds, is, for the sake of brevity, called free ammonia. The portion mentioned in the state of salts is that which, after the volatile ammonia compounds are distilled off, remains behind in the manure in a fixed state.

An imperial gallon contained of—

	grains.
Ammonia	9·6
Organic matter	200·8
Inorganic matter	268·8
Total,	479·2

The inorganic matter consisted of—

Phosphate of lime and magnesia	25·1
Alkaline salts	207·8
Carbonate of lime	18·2
Carbonate of magnesia and a little loss	4·3
Silica and a little alumina	13·4
Total,	268·8

5. Composition of the urine of man and the principal farm animals :—

	Man.	Horse.	Cow.	Pig.	Sheep.
Water,	93·30	87·61	88·31	97·92	86·50
Organic matter,	4·86	7·88	7·01	1·05	8·89
Inorganic matter,	1·84	4·51	4·68	1·03	4·61
	100·00	100·00	100·00	100·00	100·00
Per-centage of nitrogen,	1·45	1·55	0·44	0·23	1·31
Per-centage of phosphoric acid,	0·25	trace.	trace.	0·04	0·004

A distinction has always been made between the urine of man and swine on the one hand, and of the horse, cow, and sheep on the other. "The chief difference between the urine voided by the domestic animals and man, is in the composition of the inorganic or saline matters which each contains. In the urine of the horse and the cow, merely a trace of phosphoric acid is found; the inorganic matter which it affords consisting chiefly of alkaline carbonates, sulphates, and common salt; while the urine of man and of swine is distinguished by a large amount of the compounds of phosphorus."

In some of our text-books it is stated that the average quantity of urine voided by man is about 3 lbs. daily, or

1,000 lbs. per annum; by the horse and sheep about the same, and by the cow 13,000 lbs.*

6. The composition of bones varies with the kind of animal, its age, the portion of the animal from which they are taken. The following is the result of an analysis made for the author of this work:—

Water	12·58 per cent.
Organic or combustible matter (Containing nitrogen capable of producing of ammonia, 3·24.)	33·59 ,,
Phosphate of lime	37·13 ,,
Phosphate of magnesia	trace.
Carbonate of lime	14·85 ,,
Soda	1·81 ,,
Silica	0·04 ,,
Fluoride of labium	trace.
	100·00

7. The changes that take place in the manufacture of superphosphate are exceedingly interesting, and may be thus popularly explained. Phosphate of lime is composed of phosphoric acid and lime. Sulphuric acid has a stronger affinity for lime than phosphoric acid; when, therefore, the former acid is added to phosphate of lime, it seizes upon some of the lime, forming sulphate of lime (or gypsum); the phosphoric acid forms with the remaining lime, superphosphate, or biphosphate of lime, which is a soluble salt, containing more phosphoric acid than phosphate of lime, and is therefore called superphosphate.†

The composition of every 100 parts of the two substances has been given by Way, as follows:—

	Phosphate of lime.	Biphosphate.
Phosphoric acid,	$48\frac{1}{2}$ lbs.	$71\frac{1}{2}$ lbs.
Lime,	$51\frac{1}{2}$,,	$28\frac{1}{2}$,,

In converting phosphate into biphosphate of lime, we require 45 lbs. of real acid for every 100 lbs. of phosphate,

* This estimate appears too low for the horses and cattle of this country. In a trial made for us, horses gave 12 lbs. of urine daily, and cows highly fed gave as much as 70 lbs.

† Super means above or more. Chemists are not agreed as to the precise chemical composition of phosphate of lime, or of the changes that take place in dissolving bones. For a long time the phosphate of lime in bones was expressed by the formula 3 Cao., PO_5. More recently it has been regarded as a combination of eight chemical equivalents of lime, with three equivalents of phosphoric acid, or 8 Cao., 3 PO_5. The usual formula for the biphosphate of lime is Cao., 2 Ho., PO_5.

or for every ton of pure phosphate we have to add 1,008 lbs. of real acid, which are supplied by 1,236 lbs. of the best vitriol of commerce. If phosphate of lime were not associated with carbonate of lime, the cost of the raw material employed in producing a ton of biphosphate of lime could be stated thus:

	£	s.	d.
A ton of phosphate of lime, in coprolites, would cost, ...	6	0	0
To this add the value of the necessary acid—viz., 1,236 lbs., at 1*d.* per lb., . .	5	3	0
	£11	3	0
From this sum deduct the value of the sulphate of lime produced—viz., 1,725 lbs., at 30*s.* per ton, ...	1	3	0
	£10	0	0

And we get 1,523 lbs. of biphosphate of lime for £10, or about £15 per ton. But phosphate of lime does not exist in nature as a distinct compound. In coprolites, bones, &c., it is associated with carbonate of lime. And as carbonate is a weaker salt than phosphate of lime, the sulphuric acid does not act on the phosphate of lime until it has combined with all the lime of the carbonate, and thereby expelled the carbonic acid, and formed sulphate of lime. It would take 4,000 lbs. of the specimen of coprolites to which our calculations refer, to contain a ton of phosphate of lime; this would be associated with 600 lbs. of carbonate of lime, to neutralize which 600 lbs. sulphuric acid would be required, or a lb. of acid for every lb. of carbonate of lime.

	£	s.	d.
These additional 600 lbs. sulphuric acid would cost, ...	2	10	0
From which deduct the value of 1,020 lbs. sulphate of lime thereby produced, at 30*s.* per ton, ...	0	13	8
	£1	16	4
Add cost of the biphosphate, as determined in preceding calculation, . . .	15	0	0
And we get .	£16	16	4

the total cost of the raw material (at retail prices) employed in producing from coprolites a ton of biphosphate of lime; and by similar calculations we could determine the cost of producing it from bones, &c. It may be safely assumed that farmers would be able to procure the raw material necessary for producing a ton of biphosphate of lime at a cost not exceeding £20.

The manure manufacturer charges at the rate of from £30 to £50 a ton for biphosphate of lime, £40 being a full average.

We give here the average composition of superphosphate as made by a most respectable manufacturer:—

Moisture,	13·32
Organic matter and salts of ammonia,	9·68
(Capable of yielding of ammonia),	1·12
Phosphate of lime,	13·95
Biphosphate of lime,	15·65*
Hydrated sulphate of lime,	40·80
Salts of soda and potash,	2·50
Insoluble matters,	4·10
	100·00

It will be seen by this analysis that all the phosphate is not changed into biphosphate, the prevailing idea being, that it is quite enough to produce as much biphosphate as will give the young plants a good start; and that the remaining phosphate of lime will be made available by natural agents in autumn, when the plants are coming to maturity and require phosphate of lime.

8. *On determining the value per ton of manures from their chemical composition.*—The following scale of the value per ton of the principal constituents of manures may, at present prices, be adopted as a fair standard:—

	£	s.	d.	
Organic matter, when it contains little or no nitrogen,	0	10	0	per ton.
Organic matter, rich in nitrogen like that of guano,	1	0	0	,,
Ammonia,	56	0	0	,,
Phosphate of lime,	7	0	0	,,
Biphosphate of lime,	40	0	0	,,
Alkaline salts, when chiefly soda compounds, such as carbonate and sulphate of soda,	1	0	0	,,
Potash,	20	0	0	,,
Sulphate of lime or gypsum,	1	0	0	,,

In the application of the above scale to the determination of the value of a ton of a compound manure, the simplest plan is to regard the analysis as representing the composition of 100 tons; to calculate the value of the several constituents in 100 tons of the manure, and to divide by 100 to get the value of one ton.

As an example, we will estimate the value of a ton of

* Equal to 24·66 parts of what is commonly called soluble phosphate of lime.

the superphosphate whose analysis is given above. One hundred tons of that manure would contain—

	Tons.	£ s.	
Of organic matter, . .	13·32 ×	0 10 =	6·66
,, Ammonia, . . .	1·12 ×	56 0 =	62·72
,, Phosphate of lime, . .	13·95 ×	7 0 =	97·65
,, Biphosphate of lime, .	15·65 ×	40 0 =	626·00
,, Sulphate of lime, . .	40·80 ×	1 0 =	40·80
,, Alkaline salts, . .	2·50 ×	1 0 =	2·50
Value of 100 tons, ...			= 836·33
Value of one ton, ...			= £8 7s. 3d.

Appendix to Section III., Crops.

I.—The Kinds and Quantities of Grass Seeds to sow per statute acre under different circumstances.

1. *For alternate Husbandry.*—On good rich land no grass equals Italian rye-grass for one year, particularly for forage. The quantity of seed per statute acre is two and a half or three bushels, when sown with corn, to four bushels when sown by itself. For hay, a mixture of Italian and perennial rye-grass, in the proportion (when sown with corn) of two bushels of the former and one of the latter, is very good. On land suitable for clover, and not sick of that plant, a mixture composed of one bushel of Italian rye-grass, one bushel of perennial, and from a quarter to half a stone of red clover, may be useful.

2. When, as in the five-course rotation, the land remains in grass two years, and the first year's produce is mown for hay and forage, and the second is pastured, the following mixture may be used:—

	lbs.
Italian rye-grass, . . .	10
Perennial ,, . . .	20
Red clover, . . .	5
Yellow clover, . . .	1
Timothy, ...	3

For one year's hay or forage and two years' pasture two or three pounds of cocksfoot are added to the above.

3. In laying land of good average quality down to permanent pasture the following mixture may be used:—

	When sown with corn. lbs.	When sown alone. lbs.
Italian rye-grass,	6	7
Perennial ,,	9	11
Cocksfoot,	5	6
Timothy,	3	3½
Meadow foxtail,	2	2½
Rough-stalked meadow grass,	3	4
Common fescue,	4	5
Hard fescue,	4	5
Red clover,	5	5
Yellow clover,	1	1
White clover,	2	3

4. For sheep-walks, and more especially in elevated situations, Italian rye-grass is left out, the quantity of perennial diminished, and the fescues increased, giving the following mixture:—

With a Corn Crop.

	Per Acre. lbs.
Perennial rye-grass,	4
Timothy,	3
Meadow foxtail,	1
Rough-stalked meadow grass,	2
Hard fescue,	3
Sheep fescue,	3
Common fescue,	2
Red clover,	2
Yellow clover,	2
White clover,	3

5. Permanent pasture for lawns:—

	Per Acre. lbs.		Per Acre. lbs.
Italian rye-grass,	5	Hard fescue,	3
Perennial ,,	7	Sheep fescue,	2
Cocksfoot,	3	Common fescue,	3
Timothy,	1	Sweet-scented vernal grass,	1
Meadow foxtail,	1	Red clover,	2
Rough-stalked meadow grass,	2	Yellow clover,	1
Wood meadow grass, (more if there are many trees.)	2	White clover,	4

A pound of Alsike clover is sometimes added.

6. Grasses for laying down land to be irrigated.

	Per Acre. lbs.		Per Acre. lbs.
Italian rye-grass,	6	Spiked fescue (*festuca loliacea*),	2
Perennial rye-grass,	10	Floating meadow grass (*glyceria fluitans*),	3
Timothy,	3	Glyceria aquatica,	2
Meadow foxtail,	2	Fiorin,	3
Rough-stalked meadow grass	3		
Meadow fescue,	2		

Meadow foxtail and the rye-grasses are omitted from marshy land, and the quantities of floating meadow grass and rough-stalked meadow grass are doubled; and when it is necessary to protect the banks of running streams, the quantity of glyceria aquatica may be increased to 8 lbs., and 4 lbs. of phalaris arundinacea added.

7. For reclaimed bog or deep mossy land:—

	Per Acre. lbs.		Per Acre. lbs.
Italian rye-grass,	6	Fiorin,	2
Perennial ,,	8	Yellow clover,	2
Timothy,	4	White clover,	4
Meadow foxtail,	1	Large bird's-foot trefoil (*lotus major*),	2
Rough-stalked meadow grass,	2		
Hard fescue,	2		

8. For extremely poor and dry gravelly soils which resist the growth of the better kinds of grasses:—

	lbs.		lbs.
Perennial rye-grass,	10	Festuca rubra,	4
Smooth-stalked meadow grass,	4	Agrostis vulgaris,	3
Holcus lanatus,	4	Arrhenatherum avenaceum,	8
,, mollis,	4	Yellow clover,	8

9. For drifting or blowing sands:—

Elymus arenarius,	8 lbs. to 15 lbs.
,, geniculatus,	2 lbs. to 4 lbs.
Ammophila arundinacea,	8 lbs. to 15 lbs.

The Messrs. Lawson observe, that "the most effectual means of preventing the encroachments of shifting sands is to sow the seeds of the above-named grasses over a breadth of twenty to fifty yards, and in certain instances over even as much as 100 and more yards, immediately in advance of such sands. The breadth and the quantity of seeds per acre, of course, will depend on the obstacles to be overcome. It must, however, be borne in mind that the liability of such sands to be shifted at all times, especially in dry windy weather, almost entirely precludes the possibility of binding them by the agency of seeds alone. Accordingly, various plans have been resorted to for that purpose, but the most generally applicable is to deposit turf at regular and short intervals over the surface, and afterwards to sow the seeds of ammophila arundinacea and elymus arenarius in the interstices, by mixing them with clay, attached to small pieces of straw rope, and dibbling these into the sand."

II.—TABLE showing the Constituents of the several Crops; also of the several kinds of Artificial Food:—

Kind of Food.	Every 100 parts (by weight, say lbs.), contain as follows.					
	Water.	Flesh-forming Matter.	Starchy and other heat-giving Matter.	Fatty Matter.	Woody Fibre.	Ash.
1. *Seeds.*						
Wheat,	15·0	12·0	66·5	2·0	2·7	1·7
Oats,	14·0	11·5	58·5	6·0	7·0	3·0
Barley,	16·0	10·5	65·0	2·0	3·5	3·0
Bere (mean of 4 analyses)	14·2	10·1	62·6	2·0	9·03	2·02
Rye,	16·0	9·0	(66·0)		8·0	7·0
Beans,	14·8	23·3	47·0	1·5	10·0	3·4
Pease,	14·1	23·4	48·3	1·7	10·0	2·5
Linseed,	7·5	24·4	30·7	34·0		3·3
Tares,	15·3	20·1	53·9	1·8	5·3	3·4
Indian corn,	14·5	10·0	61·0	8·0	5·0	1·5
Rice,	14·0	5·3	(78·5)		2·5	0·7
2. *Fodder, Straw, Hay, &c.*						
Wheat,	14·2	1·79	29·9	1·1	45·4	7·5
Oats,	12·1	1·63	36·6	1·2	43·6	4·8
Barley,	14·3	1·66	38·9	1·0	39·8	4·2
Rye,	14·3	2·29	(37·1)		43·2	3·1
Meadow hay (average of 25 samples),	14·6	8·4	(43·6)		27·1	6·1
Meadow hay, very inferior, one year old,	13·1	4·0	(77·6)			5·2
Bean straw,	19·4	3·3	6·5	1·0	65·6	5·7
Pea do.,	12·0	12·5	19·6	2·3	47·5	6·0
3. *Green Food, Roots, &c.*						
White Turnips (white Globe),	90·4	1·1	(5·45)		2·3	0·6
Purple top, Aberdeen, collected 5th Oct.,	89·9	1·06	(8·2)			0·9
Swedes,	89·5	1·4	(5·9)		2·5	0·6
Mangold-wurzel,	87·8	1·5	(8·6)		1·1	0·9
Carrots (white Belgian),	87·3	0·7	(11·2)			0·7
Parsnips,	82·0	1·3	(15·7)			0·9
Cabbages { outer leaves,	91·1	1·6	(5·06)			2·2
Cabbages { heart,	94·5	0·9	(4·1)			0·6
Potatoes, White rocks (seed sample),	76·0	2·0	15·0	0·2	5·5	1·0
Vetches,	82·5	3·8	(12·4)			1·3
Rape (green),	87·0	3·1	4·0	0·6	3·5	1·6
Rye (green),	75·4	2·7	9·1	0·9	10·5	1·3
Furze,	72·0	3·2	8·2	1·2	13·3	2·1

TABLE showing the Constituents of the several Crops—*con*

Kind of Food.	Every 100 parts (by weight, say lbs.) contain as follows.					
	Water.	Flesh-forming Matter.	Starchy and other heat-giving Matter.	Fatty Matter.	Woody Fibre.	Ash.
4. *Artificial Food.*						
Linseed cake, . .	12·4	27·3	34·5	12·8	6·5	6·1
Rape cake, . .	10·7	29·5	30·9	11·1	10·0	7·8
Cotton cake from whole seed, . . .	11·3	23·7	31·0	6·2	21·2	6·5
Do. with some of the husk removed,—the "decorticated" cotton cake of commerce,	9·3	41·2	16·4	16·0	8·9	8·0
Poppy cake, . .	6·6	34·0	23·2	11·0	11·3	13·8
Bran, . . .	12·8	13·8	50·1	5·5	11·5	6·1
Brewers' grains, .	75·8	0·6	1·1	?	21·2	1·2
Do. (draff), .	74·7	3·6		(20·3)		1·3
Hemp cake, . .	7·2	21·5	22·5	7·9	25·1	15·8
Malt dust, . .	6·2	25·6		(59·4)		8·7
Oat dust, . . .	5·5	4·8	45·7	3·6	35·3	5·0
Barley dust, . .	11·0	8·4	69·7	3·5		7·3
Palm kernel cake, .	10·7	13·4	27·4	11·4	33·0	4·0
Thorley's condimental food, . . .	11·4	11·4	64·0	4·1	6·2	2·8

This table is a mere approximation to truth. An accurate table cannot be prepared in the present state of science; for, in the first place, it is well known that soil, climate, &c., influence the composition of the same plant very much, and samples of crops raised on soils and in circumstances alike in every way have not been analyzed; secondly, there are defects in the present mode of determining some of the constituents of food; thirdly, such a table does not take any cognizance of the mechanical condition in which the different kinds of flesh-formers, heat-givers, &c., exist in the food. For example, flesh-forming material may exist in a more digestible state in one food than in another. And so also, in accordance with the old saying, that "What is one man's meat is another man's poison," a constituent of food may be easily digested in the stomach of one animal, while it may be digested with difficulty, or altogether incapable of undergoing digestion, in the stomach of another.

III.—Table showing the average Weight per Bushel of the principal Grasses described in the preceding pages, with the average Number of Seeds contained in one Ounce of each:—

Name of Grass.	Average weight per bushel.	Average number of Seeds in an ounce.
	lbs.	
Agrostis stolonifera (fiorin),	13	500,000
Do. vulgaris (creeping rooted bent),	12	425,000
Alopecurus pratensis (meadow foxtail),	5½	76,000
Ammophila arundinacea (sea-sand reed),	15	10,400
Anthoxanthum odoratum (sweet vernal grass),	6	71,000
Arrhenatherum avenaceum (tall oat grass),	7	21,000
Cynosurus cristatus (crested dog's-tail),	26	28,000
Dactylis glomerata (cocksfoot),	11½	40,000
Do. gigantea (gigantic cocksfoot),	10	31,000
Elymus arenarius (sea-sand lyme grass),	40	2,320
Festuca duriuscula (hard fescue),	9½	3[illegible],000
Do. lolinacea (spiked fescue),	15	21,700
Do. ovina (sheep's fescue),	13½	64,000
Do. tenuifolia (fine-leaved fescue),	13	88,000
Do. pratensis (meadow fescue),	13	26,000
Holcus lanatus (Yorkshire fog),	17	95,000
Do. mollis (creeping soft grass),	6	85,000
Lolium Italicum (Italian rye-grass),	15	27,000
Do. perenne (perennial rye-grass), light-seeded varieties,	18	16,000
Do. perenne, heavy-seeded varieties,	30	13,700
Phalaris arundinacea (reed-like canary grass),	48	12,000
Phleum pratense (Timothy),	34	74,000
Poa aquatica (water sweet grass),	13½	58,000
Do. fluitans (floating sweet grass),	14½	33,000
Do. nemoralis (wood meadow grass),	15	178,000
Do. pratensis (smooth-stalked meadow grass),	13¾	243,000
Do. trivialis (rough-stalked meadow grass),	15¼	217,000
Lotus major (bird's foot trefoil),	64	51,000
Medicago lupulina (yellow clover),	63¾	16,000
Do. sativa (lucerne),	60	12,600
Onobrychis sativa (sainfoin),	26	1,280
Trifolium pratense (red clover),	64	16,000
" " perenne (perennial red clover),	64	16,000
Trifolium repens (couch grass),	65	32,000

IV.—Prices of First-class Agricultural Seeds.

1. Clover.*

	Per cwt.	Per lb.
Red (*Trifolium pratense*)—		
Foreign,	72*s.* to 86*s.*	8*d.* to 9½*d.*
English,	90*s.* to 108*s.*	10*d.* to 1*s.* 0*d.*
English Cowgrass or Perennial Red (true),	96*s.* to 117*s.*	10½*d.* to 1*s.* 1*d.*
Alsike (*Trifolium hybridum*),	125*s.* to 160*s.*	1*s.* 2*d.* to 1*s.* 7*d.*
White (*Trifolium repens*),	96*s.* to 117*s.*	10½*d.* to 1*s.* 1*d.*
Yellow, or Trefoil (*Medicago lupulina*),	30*s.* to 40*s.*	3½*d.* to 4½*d.*
Crimson (*Trifolium incarnatum*)	—	6*d.*

Inferior quality of seeds to be had at lower prices.

2. Rye Grass.

The prices quoted are for fine clean samples, best quality, of the several kinds.

Rye Grass—	Per bush.	Per lb.
Perennial,	4*s.* 3*d.* to 5*s.* 0*d.*	3*d.*
Lighter class of seed,	2*s.* 6*d.* to 3*s.* 9*d.*	2½*d.*
Ayrshire (produce of two years' old grass),	4*s.* 9*d.* to 5*s.* 6*d.*	3*d.*
Stickney's,	4*s.* 9*d.* to 5*s.* 6*d.*	3*d.*
Pacey's, fine heavy seed,	6*s.* 0*d.* to 7*s.* 6*d.*	3½*d.*
Annual,	4*s.* 0*d.* to 4*s.* 6*d.*	3*d.*
Italian, Foreign seed,	5*s.* 0*d.* to 5*s.* 9*d.*	3½*d.*
,, English seed,	4*s.* 6*d.* to 5*s.* 3*d.*	3½*d.*

3. Natural or Pasture Grasses.

	Per lb. *s.*	*d.*
Agrostis stolonifera—fiorin grass,	0	8
Alopecurus pratensis—Meadow foxtail, per bush., 6*s.* 0*d.*,	1	0
Ammophila arundinacea—sea-sand reed,	1	0
Anthoxanthum odoratum—sweet vernal,	1	2
Cynosurus cristatus—crested dog's-tail,	0	9
,, Extra superfine,	0	11
Dactylis glomerata—cocksfoot, per bush., 6*s.* 0*d.*,	0	9
,, ,, heavy seed, very fine,	0	10
Elymus arenarius—sea-sand lyme grass,	1	3
Festuca duriuscula—hard fescue, per bush., 6*s.* 6*d.*,	0	6
,, ovina—sheep's fescue, per bush., 9*s.*,	0	7
,, pratensis—meadow fescue, per bush., 11*s.*,	0	9

* Clover seed is liable to great fluctuation in price, according to the state of the markets.

	Per lb. s. d.
Holcus lanatus—Yorkshire fog, per bush., 1s. 9d.,	0 3
„ mollis—creeping soft grass,	1 0
Phalaris arundinacea—reed canary grass,	1 0
Phleum pratense—Timothy grass, . 4½d. to	0 6
Poa aquatica—water sweet grass,	0 10
„ fluitans—floating meadow grass,	0 10
„ nemoralis—wood meadow grass,	1 0
„ pratensis—smooth-stalked meadow grass,	0 11
„ trivialis—rough-stalked meadow grass,	0 11

4. Miscellaneous Plants.

Bird's-foot Trefoil—Lotus corniculatus,	3 3
„ „ Greater—Lotus major,	2 0
Buckwheat—Polygonum Fagopyrum, per bush., 8s. 6d.	—
Cabbage, Cow or Tree,	2 6
„ Large Drumhead Cattle,	2 6
„ „ Robinson's Champion,	3 0
„ Large York,	3 6
„ Battersea,	3 6
„ Enfield Market,	3 6
„ Large Drumhead Savoy,	3 6
„ Thousand-headed (Kale),	2 6
Lucern—Medicago sativa,	1 0
Agricultural Mustard, White, per bush., 18s., Sinapsis alba,	0 4
„ „ Brown,	0 9
Parsley, Field—Petroselinum sativum, per bush., 26s.,	0 8
Rape, best broad-leaved, per bush., 15s.,	0 4
Sainfoin—Onobrychis sativa,	0 4
„ Double yielding,	0 4
Tares, Spring, per bush., 9s. 6d.	—
„ Winter, per bush., 10s. 6d.	—
Whin, Gorse, or Furze—Ulex Europæa,	2 3
„ French,	2 3
Jerusalem Artichokes, per bush., 7s. 6d.,	—

5. Field Roots.

Turnips—Swedish—	
Purple-top,	1 2
East Lothian, superior,	1 2
Matson's,	1 2
Dickson's,	1 2
Skirving's,	1 2
Extra selected stock,	1 4
Marshall's,	1 3
Ashcroft's,	1 2
Laing's,	1 4
Bangholm Improved, original stock, very fine, large,	1 6
Champion,	1 3
King of the Swedes,	1 3

	Per lb. s.	d.
Green-top,	1	2
River's Stubble,	1	3
Bronze-top, superior,	1	3
Shepherd's Golden Globe,	1	4
White-fleshed,	1	4
YELLOW—Green-top Bullock or Aberdeen,	1	4
Extra select stock, large,	1	6
Golden Yellow Aberdeen,	1	6
Early Improved, good for late sowing,	1	6
Orange Jelly,	1	6
Tankard,	1	0
Dale's Hybrid, true, original stock, very superior,	1	6
Fosterton Hybrid,	1	6
Purple-top Bullock or Aberdeen,	1	4
Border Imperial,	1	4
Extra select stock,	1	6
Skirving's,	1	4
Extra select stock,	1	6
Tweeddale Improved,	1	6
WHITE—Round or Norfolk,	1	0
Globe,	1	0
Pomeranian, best sort White Globe,	1	0
Six-week or Stubble,	1	0
Tankard,	1	0
Green-top Round or Norfolk,	0	10
Globe,	0	10
Tweeddale Improved,	1	0
Tankard,	1	0
Red-top Round or Norfolk,	1	0
Globe,	1	0
Lincolnshire Improved,	1	0
Tankard,	1	0
Gray Stone, largest growing white turnip, fine,	1	0
MANGOLD WURTZEL—Long Red,	1	0
Elvetham, superior,	1	3
Yellow,	1	0
Globe Yellow,	1	0
Dobito's, choice selected,	1	3
Orange,	1	0
Ward's Oval, choice selected,	1	3
Red,	1	0
BEET—White Sugar,	0	9
CARROT—Large Green-top White Belgian,	1	0
Yellow Belgian,	1	2
Long Red Cattle,	1	6
Altringham, Large Red, improved,	2	0
James's Intermediate Red,	2	0
PARSNIP—Large Cattle,	1	3
Large Guernsey,	1	3

WEIGHTS AND MEASURES.

THE Imperial weights and measures are used throughout this book.

The Commissioners are most anxious that the National Teachers should impress on their pupils the utility and convenience of using these standards, and no others.

It has been deemed advisable to append the following tables:—

TROY WEIGHT.

[Unit of Measure* the Imperial Pound Troy of 5,760 grains.]

			Marked
24 grains	make	1 penny-weight, .	*dwt.*
20 penny-weights	,,	1 ounce, . . .	*oz.*
12 ounces	,,	1 pound, . . .	*lb.*

1 lb. = 12 oz. = 240 dwts. = 5,760 grs.

This weight is used for gold, silver, platina, liquors, and jewels (except diamonds); also in expressing the strength of spirituous liquors, and in comparing different weights.

Diamonds, and other precious stones, are weighed by carats; the carat is divided into halves, quarters, eighths, sixteenths, &c. The ounce Troy weighs $151\frac{1}{2}$ diamond carats; the carat is, therefore, $3\frac{1}{6}$ grains Troy.

Pearls are weighed by the Troy standard; but the penny-weight is divided into 30 grains instead of 24. The ounce contains 600 Pearl grains and 4 grains Troy = 5 Pearl grains.

The term, carat, is also used to estimate the fineness of gold, which, when perfectly pure, is said to be "24 carats fine." If there are 23 parts gold, and 1 part some other metal, it is "23 carats fine;" if 18 parts out of the 24 are gold, it is "18 carats fine," &c.

AVOIRDUPOIS WEIGHT.

[Unit, the Pound, containing 7,000 grains Troy.]

			Marked
16 drams	make	1 ounce, . . .	*oz.*
16 ounces	,,	1 pound, . . .	*lb.*
28 pounds	,,	1 quarter of a cwt. .	*qr.*
4 qrs. or 112 lbs.	,,	1 hundred-weight, .	*cwt.*
20 hundred-weight	,,	1 ton, . . .	*T.*

This weight is used for bread, meat, groceries, corn, wool, butter, and goods in general, especially such as are subject to waste, and for all metals, except those which are called the *precious*, as gold, silver, and platina.

14 pounds = 1 stone. 8 stone = 1 hundred-weight.

1 ton = 20 cwt. = 80 rs. = 160 st. = 2,240 lbs.

* The Imperial Unit of Measure, means the unit or individual denomination established by Act of Parliament, as the basis or standard of any particular measure.

APOTHECARIES' WEIGHT.

[Unit, the Imperial Pound Avoirdupois.]

The Medical Council of the United Kingdom, in 1864, directed the ounce avoirdupois to be used instead of the ounce troy, and the use of the drachm and scruple to be discontinued in prescriptions.

The following are the weights and symbols now adopted:—

$437\frac{1}{2}$ grains (gr.)	equal	1 ounce, . .	℥
16 ounces (7,000 grains)	,,	1 pound, . .	℔

APOTHECARIES' FLUID MEASURE.

			Marked
60 fluid minims	make	1 dram, . .	*fl. drm.*
8 fluid drams	,,	1 ounce, . .	*fl. oz.*
20 fluid ounces	,,	1 pint, . .	*O.*
8 pints	,,	1 gallon, . .	*C.*

LONG MEASURE.

[Unit, the Imperial Yard.]

			Marked
12 lines	make	1 inch, . .	*in.*
12 inches	,,	1 foot, . .	*ft.*
3 feet	,,	1 yard, . .	*yd.*
$5\frac{1}{2}$ yards	,,	1 perch, . .	*per.*
40 perches	,,	1 furlong, . .	*fur.*
8 furlongs	,,	1 mile, . .	*mil.*
3 miles	,,	1 league, . .	*lg.*
60 geographical or equatorial miles, or $69\frac{1}{10}$ British miles	make	1 degree of the Earth's circumference,	*deg.*

SQUARE OR SUPERFICIAL MEASURE.

[Unit, the Imperial Square Yard.]

$12 \times 12 = 144$	square inches	= 1 square foot.
$3 \times 3 = 9$	square feet	= 1 square yard.
$5\frac{1}{2} \times 5\frac{1}{2} = 30\frac{1}{4}$	square yards	= 1 square perch.
$7 \times 7 = 49$	square yards	= 1 square perch Irish.
$4 \times 4 = 16$	square perches	= 1 square chain.
40	square perches	= 1 rood.
4	roods	= 1 acre.

LIQUID AND DRY MEASURES.

[Unit, the Imperial Gallon of $277\frac{1}{4}$ cubic inches, containing 10 lbs., Avoirdupois, of distilled water.] In *wine*, *ale*, and *dry measure*, the gallon and inferior denominations are the same.

4 naggins	make	1 pint,	=	$1\frac{1}{4}$	lbs.	water
2 pints	,,	1 quart,	=	$2\frac{1}{2}$	lbs.	,,
2 quarts	,,	1 pottle	=	5	lbs.	,,
2 pottles	,,	1 gallon,	=	10	lbs.	,,
2 gallons	,,	1 peck,	=	20	lbs.	,,
4 pecks	,,	1 bushel,	=	80	lbs.	,,
4 bushels	,,	1 barrel,	=	320	lbs.	,,
2 barrels, or 8 bushels		1 quarter,	=	640	lbs.	,,

4 quarters make 1 chaldron. 10 quarters 1 last.

These divisions supply the bases of the various measures used for all liquids, and most dry goods. None larger than the gallon is used for liquids. The peck, bushel, and quarter are confined to dry goods. Some liquids, as wine, ale, &c., have other measures, arising from the *names* of the vessels in which they are usually contained; and in England, *dry measure* branched into other denominations.

CUBIC OR SOLID MEASURE.

[Unit, the Imperial Cubic Yard.]

1,728 cubic inches	make	1 cubic foot.
27 cubic feet	,,	1 cubic yard.

This measure is used in computing the solid contents of logs of timber, masonry, &c.

40 cubic feet of rough timber, or 50 do. of hewn timber, } 1 ton or load.

42 cubic feet, ... 1 ton of shipping.

$24\frac{3}{4}$ cubic feet, { $16\frac{1}{2}$ feet long, 1 foot high, 18 inches thick. } 1 solid perch of masonry.

$12\frac{3}{8}$ cubic feet = 1 solid perch of brickwork.

IRISH CORN WEIGHT.*

20 stone	make	1 barrel of	wheat, rye, beans, and peas.
16 stone	,,	1 ,,	barley.
14 stone	,,	1 ,,	oats.
12 stone	,,	1 ,,	malt.
$14\frac{1}{2}$ stone	,,	1 ,,	flour.
16 stone	,,	1 bag of	do.
20 stone	,,	1 sack of	do.
18 stone	,,	1 barrel of oatmeal.	
20 stone	,,	1 sack of	do.
6 stone	,,	1 barrel of bran.	
20 stone	,,	1 ,,	potatoes.
2 barrels	,,	1 quarter.	
$\frac{1}{2}$ cwt.	,,	1 load of hay or straw.	

* In some markets in Ireland these measures are still used.

IRISH LAND MEASURE REDUCED INTO IMPERIAL.

Irish.	Imperial.				Irish.	Imperial.			
A.	A.	R.	P.	Y.	A.	A.	R.	P.	Y.
1	1	2	19	5¼	28	45	1	16	26
2	3	0	38	10½	29	46	3	36	1
3	4	3	17	15¾	30	48	2	15	16¼
4	6	1	36	21	31	50	0	34	11½
5	8	0	15	26¼	32	51	3	13	6¾
6	9	2	35	1¼	33	53	1	32	22
7	11	1	14	6½	34	55	0	11	27¼
8	12	3	33	11¾	35	56	2	31	2¼
9	14	2	12	17	36	58	1	10	7½
10	16	0	31	22¼	37	59	3	29	12¾
11	17	3	10	27½	38	61	2	8	18
12	19	1	30	2½	39	63	0	27	23¼
13	21	0	9	7¾	40	64	3	6	28½
14	22	2	28	13	41	66	1	26	3½
15	24	1	7	18¼	42	68	0	5	8¾
16	25	3	26	23½	43	69	2	24	14
17	27	2	5	28¾	44	71	1	3	19¼
18	29	0	25	3¾	45	72	3	22	24½
19	30	3	4	9	46	74	2	1	29¾
20	32	1	23	14¼	47	76	0	21	4¾
21	34	0	2	19½	48	77	3	0	10
22	35	2	21	24¾	49	79	1	19	15¼
23	37	1	0	30	50	80	3	38	20½
24	38	3	20	5	100	161	3	37	10¾
25	40	1	39	10¼	200	323	3	34	21½
26	42	0	18	15½	300	485	3	32	2
27	43	2	37	20¾	500	809	3	26	23½

RATES ASSIMILATED.

Rate per Irish Acre.			Rate per English Acre.			Rate per Irish Acre.			Rate per English Acre.		
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
0	1	0	0	0	7½	0	15	0	0	9	3
0	1	6	0	0	11	1	0	0	0	12	4
0	2	0	0	1	2¾	1	5	0	0	15	5
0	2	6	0	1	6½	1	10	0	0	18	6
0	3	0	0	1	10¼	1	15	0	1	1	7
0	3	6	0	2	1¾	2	0	0	1	4	8
0	4	0	0	2	5¼	2	5	0	1	7	9
0	4	6	0	2	9¼	2	10	0	1	10	10
0	5	0	0	3	1	2	15	0	1	13	11
0	10	0	0	6	2	3	0	0	1	17	0

GLOSSARY.

Acid.—Any substance which, like vinegar, has a sour or sharp taste, is, in common language, said to be acid. In chemistry it is applied to substances which, in addition to a sour taste, combine with bases, such as potash, soda, &c., to form salts. Acids change vegetable blue colours to red.

Afterbirth.—A term applied to that which comes away after the birth of a calf, lamb, &c.

Albumen.—The name given to the glary substance found in the white of the egg. A substance analogous to it, called vegetable albumen, is found in many vegetables, and especially in their seed. Albumen contains nitrogen, carbon, oxygen, and hydrogen, and is one of the "flesh-formers."

Alkali.—In chemistry a name given to bodies which have a caustic taste, and form what are called neutral salts on combining with acids. Alkaline bodies change vegetable yellow to brown, and blue to green. Ammonia being a gas, is called the volatile alkali; potash and soda are fixed alkalies; lime and magnesia are called alkaline earths.

This word is said to be derived from the Arabic, in which *al* means the, and *kali* a plant from the ashes of which soda, the first known alkali, was and may still be obtained.

Alumina.—One of the constituents of the earth. It is composed of two simple bodies, oxygen and the metal aluminium. It exists in greatest abundance in pure clay, and imparts stiffness to clay soils.

Alternate husbandry.—An agricultural expression, which means growing crops in regular succession or rotation; as, for instance, in the Norfolk four-course, or Northumberland five-course rotation.

Ammonia.—A gaseous body, composed of two gases, nitrogen and hydrogen. It has a sharp, pungent smell, and an acrid or alkaline taste It is called the volatile alkali. The pungent smell given off in badly ventilated stables is owing to the escape of ammonia. It is the most valuable constituent of manure, and ought to be preserved with the greatest care.

Ammoniacal Manures.—Substances like sulphate of ammonia, which depend for their use as manures wholly or chiefly on the presence in them of ammonia.

Analysis.—In the language of chemistry and farming, the determination of the component parts of soils, manures, and food.

Antiseptic.—A substance, like common salt, which checks or prevents putrefaction, is said to be antiseptic.

Argil.—Argillaceous.—Argil means white clay or potter's clay. When a soil contains much argil or alumina it is said to be argillaceous.

Apatite.—A mineral containing a large quantity of phosphate of lime.

Aphis.—A plant louse.

Artificial.—That which is made by hand, art, or skill; in other words, that which is not a natural product.

Artificial manure.—A manufactured manure, such as "superphosphate."

Beater.—The name given to that part of a threshing-machine which beats the grain out of the ear.

Bi-phosphate of Lime.—A name given to the soluble compound (of phosphoric acid and lime), formed when bones or any other substance containing insoluble phosphate of lime is dissolved in sulphate or muriatic acid. It was supposed that it contained twice as much phosphoric acid as phosphate of lime; hence the name bi-phosphate, from the Latin *bis*, twice. The term superphosphate is now substituted for bi-phosphate. (See superphosphate).

Broadshare.—The part of a plough commonly called a sock in this country, is the share. A broadshare is a double sock, generally made of cast-metal, and from its width called broadshare. The share or sock is the part which cuts the ground horizontally.

Calcareous. Calx is the Latin for lime. Calcareous means partaking of the nature of calx or lime. A calcareous soil contains a large quantity of lime. Lime is often called calcareous earth.

Carbon.—From *carbo*, the Latin for a coal, is the name given to one of the simple bodies which forms the substance of charcoal. It is a solid body which enters largely into the composition of plants and animals. The diamond is pure carbon crystallized. Blacklead is a carbon, with a trace of iron mixed with it.

Carbonic acid.—A compound of carbon and oxygen. Is a constant product of combustion and decay; the carbon of the fuel or substance undergoing decay, unites with the oxygen of the air, forming carbonic acid. It is also given off in the breath of animals; the carbonic acid thus evolved being the result of the union of the carbon of the blood with the oxygen of the air.

Carbonate of lime, or limestone, is composed of carbonic acid and lime. When by the force of heat in a limekiln, the chemical affinity between the carbonic acid and the lime is overcome, the limestone is decomposed, carbonic acid is evolved, and lime, called also lime-shells, remains behind.

Caustic.—A substance which burns or corrodes animal bodies. Nitrate of silver is called *lunar-caustic*. Potash is caustic, and so is quick-lime.

Cavings.—The name given in several localities to short straws produced in threshing.

Chlorine.—A gas of a greenish-yellow colour, and most disagreeable odour. Common salt is composed of chlorine and sodium, the metallic base of common soda. It is the active agent in common bleaching powder, and in chloride of lime, which is a powerful disinfectant.

Clay.—A term which commonly means earth. As applied to a particular class of soils, it means those which are unctuous and tenacious.

Cereals.—From Ceres, the goddess of agriculture; a name applied to wheat, oats, barley, rye, rice, maize, and other crops that produce bread-corn.

Combustible.—That which admits of being burnt.

Combustion.—The process of burning.

Cobs.—Unshelled corn; that is, what passes through the threshing machine without the grain being separated from the chaff.

Couch grass.—A troublesome weed which creeps or couches through the soil.

Crank.—In machinery, a contrivance for changing straight into circular motion, or the reverse; as the crank of a steam-engine.

Crofter.—The holder of a croft, which is the Anglo-Saxon name for a small piece of land.

Chaff-cutter.—A machine used for cutting or chopping hay and straw into short pieces, very generally called "chaff" by farmers.

Concentrated Manures—are those which contain in a small bulk the constituents required to increase the yield of crops. Guano and superphosphate are concentrated manures. Farmyard manure is not a concentrated manure.

Concave.—Hollow, without angles, as the inside of a drum. In a threshing-machine the concave is that within which the "drum" revolves. In the English threshing-machine the grain is rubbed out of the ear by friction between the beaters which rest on the drum and the concave.

Conferva.—Water-weeds, which are made up of jointed capillary tubes, and which grow by the addition of one tube to the end of another.

Constituents.—The parts which compose or make up a body are called its constituent parts.

Coprolites.—Fossils supposed to have been the dung of animals which no longer exist. They are rich in phosphate of lime, and used largely for the manufacture of superphosphate.

Cultivator.—A name given to a class of implements, not accurately defined, for cultivating the earth. Many farmers apply this term to the grubber.

Dead-weight.—The weight of the saleable meat of an ox, of a sheep, or of a pig; in other words, the weight of the carcase after it is dressed for sale by the butcher.

Deodorizer.—A substance which is capable of removing disagreeable effluvia. Charcoal is a deodorizer.

Dishing.—The hollow or dish-like appearance given to wheels by inclining the spokes outwards to resist strains. (See page 107.)

Disinfect.—To purify from infection; to destroy those organic poisons on which the existence of infectious or contagious diseases depends. Chloride of lime and carbolic acid are powerful disinfecting agents, and should always be used to prevent the spread of contagious diseases.

Disintegrate.—To separate the particles of a body, as in the crushing of rocks.

Dunes.—Low hills of blown sand.

Drum.—In a threshing machine, is a revolving cylinder, on which are fixed the beaters. The drum revolves within the concave.

Fanners.—A name often given to a winnowing machine; and so called from the fanners or vanes, or flat discs, which revolve on an axis, and produce the current of air that winnows or separates the chaff from the grain.

Fat formers.—Those constituents of food which are capable of producing the fat of animals.

Ferruginous.—Containing iron; from ferrum, the Latin for iron.

Finger and Toe.—A very destructive disease of turnips, so called from the appearance of the roots.

Flesh formers.—The constituents of food which are capable of producing flesh or muscle.

Gear, gearing.—A series of wheels working into each other for driving machinery. Thus, the horse gear of a threshing machine consists of the wheels, &c., which communicate motion to the drum.

Gluten.—A viscid substance procured from wheat and other grains. It is one of the flesh-forming constituents of food.

Green manuring—consists in growing vegetables, and ploughing them into the land in a green state, a practice occasionally resorted to on land deficient in vegetable matter.

Gypsum.—Sulphate of lime. It is the substance of "plaster of Paris."

Hydrate of lime.—A compound of quicklime and water.

Hydrogen.—A gaseous element which, with oxygen, forms water. and which enters into the composition of all animal and vegetable substances.

Hoove.—A disease of cattle in which the stomach is swelled by gas.

Hummeller.—A machine used for the purpose of separating the awns of barley from the grain.

Humus.—Humic acid. The name humus is given to the dark brown vegetable matter of the soil and is the result of its imperfect decay. Humic acid is generally present in humus, and is formed when, as in the bottom of a heap of farmyard manure, vegetable matter is undergoing decay in the presence of too much water

Hydrometer.—An instrument for measuring the specific gravity of liquids.

Impalpable powder—Is that which is so fine that its particles are not sensible to the touch.

Inorganic.—That which is not produced by vital action or living organs.

Insoluble.—Not soluble. When not otherwise specified, the term is in the text applied to that which is not capable of being dissolved in water.

Kaolin.—Aluminous earth used in the manufacture of porcelain. It is a word of Chinese origin.

Lactometer.—A glass tube, graduated at the upper end, for measuring the percentage of cream in milk.

Magnesia.—A white, tasteless earthy substance, composed of the metal magnesium and oxygen. It is present in the ash of plants. and must, therefore, exist in all fertile soils.

Marl.—Calcareous earth; or it may be described as a mixture of carbonate of lime and clay.

Mineral.—A substance which neither has, nor has been, the seat of life. The mineral constituents of plants and animals are those which are derived solely from soil.

Neutral phosphate of lime.—Like all neutral salts, the lime is neutralized by the acid.

Nitrate of soda.—A compound of nitric acid and soda; called also cubic pitre.

Nitre, or nitrate of potash.—A compound of nitric acid and potash. called also saltpetre. Is used as a medicine, and for preserving meat and butter.

Nitrogen.—One of the simple or elementary bodies; a gas which forms four-fifths of the bulk of the atmosphere. It is invariably found as a constituent of flesh or muscle. All "flesh-forming" constituents of food must, therefore, contain nitrogen.

Nitrogenized matter.—Matter containing nitrogen.

Nomenclature.—A complete set of names or terms used in any branch of science or art.

Muriatic acid.—An acid commonly called spirit of salt. It is composed of hydrogen and chlorine, and is now more usually and correctly called hydrochloric acid.

Organic matter.—That which has been produced by organs which are, or once were, the seat of life.

Oxygen.—One of the simple or elementary bodies. It is a tasteless. colourless gas which enters into the composition of all animal and vegetable substances, as well as of water and soils. The word is derived from two Greek roots, which mean to generate sharpness. because it was formerly supposed to impart all their sharpness or bitterness to acids.

Oxidized.—When a simple body combines with o[illegible] ...mes