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ON THE

NATURE AND PROPERTY

OF

SOILS:

THEIR CONNEXION WITH THE

GEOLOGICAL FORMATION ON WHICH THEY REST;

THE

BEST MEANS OF PERMANENTLY INCREASING

THEIR PRODUCTIVENESS,

AND ON

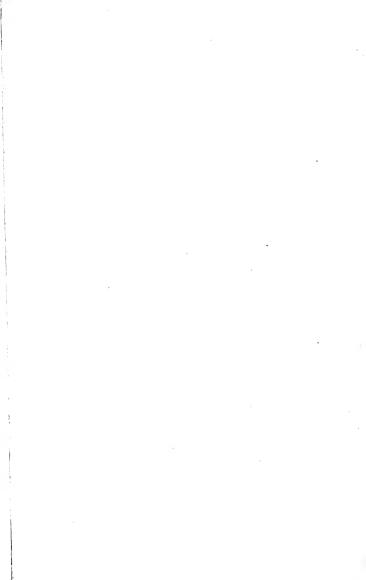
THE RENT AND PROFITS OF AGRICULTURE.

BY JOHN MORTON.

Second Edition.

JAMES RIDGWAY, PICCADILLY.

MDCCCNL.



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ON THE

NATURE AND PROPERTY OF SOILS.

1. Introduction.

THE surface of the earth partakes of the nature and colour of the subsoil or rock on which it rests.

The principal mineral in the soil of any district, is that of the geological formation under it; hence, we find argillaceous soil resting on the various clay formations—calcareous soil, over the chalk, and oolitic rocks, and silicious soils, over the various sandstones. On the chalk, the soil is white; on the red sand stone, it is red; and on the sands and clays, the surface has nearly the same shade of colour as the subsoil.

The lime, potash, and iron, existing in various proportions in the rock, are acted on by the atmosphere, and the rock is decomposed; some of it into fine impalpable matter, some into sand, and some into coarse gravel or rubble.

The surface is composed of the same materials

as the subsoil, with the addition of vegetable and animal matter, in every state of decay, intimately mixed with it; and we perceive a change in the external appearance of the surface, whenever there is a change in the subsoil below.

The similarity of the materials which compose each of the geological formations, with those which compose the soil resting on it, will be easily discerned; and their seeming difference may be owing to the vegetable, and colouring matter in the soil. Iron, on being exposed to the atmosphere, becomes oxidized, forming the oxid of iron, and gives a redder colour to the soil than that which is exhibited by the subsoil.

The connection which subsists between the soil and the subjacent rock or subsoil is, in our opinion, of great importance, as a knowledge of it would form the best foundation for a classification of soils; and would always convey some idea of the nature and quality of the materials of which the soil is composed.

2. We shall therefore give an outline of the main body of each of the geological formations in England, and their connection with the surface, without entering into a detail of all the ramifications and outlaying or detached portions of each; and beginning with the Tertiary formation, and descending in succession across the whole range of the geological formation in the kingdom, we shall take a short view of their internal structure—the nature of the materials, and the extent of each formation—the agricultural character—the nature and composition of the soil—the state of culture—and the means of improvement.

In doing this, we shall use the terms by which the different soils are known in the several localities where they occur.

3. There have been many attempts to form a classification of soils, but these have universally failed in conveying to the mind, either of the practical farmer, or the scientific agriculturist, any correct idea of their nature or properties.

If we can shew an identity of the materials which form the soil, with those of the subsoil upon which it rests, we shall obtain a key to a more correct and satisfactory classification of soils than at present exists; and their nature and properties, the kind of crops which they are best calculated to produce, and the materials necessary for their permanent improvement, will be more evident.

4. Earths of Transportation.

THESE are formed by extraordinary floods which tear up the soil and subsoil from the higher land, and deposit them on the land below. These torrents, when increased by continued rains, are so im-

petuous as to carry down with them every thing that impedes their passage. The lightest substances are carried the farthest, and the heaviest the shortest distance; consequently, we find on the side, and at the bottom of high hills, stones and large gravel; farther on, towards the lower part of the country, we find beds of gravel of a smaller kind, mixed with sand; and where the river becomes nearly level, we have sand, sandy loam, and frequently deep rich loam, with a considerable portion of clay minutely disseminated through the mass.

Whatever may have been the form of the surface of the earth before the universal deluge, that awful catastrophe must have been a powerful agent in forming its present surface.

The figure used by Moses in describing the intensity of the rain, "And the windows of heaven were opened," shows us that we have no idea of the quantity of rain fallen in a given time, nor of the effects which it produced; but if we suppose that the rains equalled only what is frequently seen in the tropics, and judge of its effects from the length of time which "the windows of heaven were open," we may easily conceive the effects were most terrific. Tearing up, and carrying away every thing before it, the surface would first give way—the vegetable mould would be carried down—and as the level of the sea arose, the lighter

parts would be deposited where the rapidity of the current was stopped by meeting the level surface of the water; and this would go on, till the water arose to the highest point.

5. ALLUVIAL SOIL consists in the accumulation of minute particles of soil and light vegetable matter washed away from the surface of higher ground by the water of rivers in the time of floods, where their motion is rapid; and which, when they become sluggish, they deposit on the level ground which they overflow.

The richest alluvial soils are to be found at the junction of large sluggish rivers with the sea, or where they meet in the valleys through which they pass; and the soil is most varied and heterogeneous in the composition of its parts, when these are in minute divisions and intimately blended together. The finest natural soils are thus formed of numberless thin layers of mud by the overflowing of rivers, and left to dry till the next overflow brings a fresh supply.

The artificial mode adopted in Lincoln and York shires of warping land is precisely the same as the natural way in which alluvial soils are formed, and may be seen in full operation every summer. The motion of the tide disturbs the sediment deposited in the beds of the rivers, and carries it either back into the rivers, or forward towards the sea; and

such is the quantity of minute particles of earthy matter in the water, that a depth of eighteen inches of the water of those rivers which run into the Humber, will deposit one inch of mud in the course of a day. Advantage is taken of this deposit, and the low worthless land within the reach of the tide is, during one summer, covered to the depth of from twelve to eighteen inches, and in some hollow places, to the thickness of three or four feet. The land to be warped is surrounded by a bank sufficiently high to hold all the water that is allowed to come in during each tide, which is admitted and drawn off by sluices, as the tide falls. During the period it remains, a deposition of the sediment takes place; and this operation goes on twice every twenty-four hours. It is found that the warping in dry summers produces a greater thickness of deposit than when the season is wet.

The greatest extent of alluvial formation in England is along the east coast, commencing east off Lynn in the county of Norfolk, and continuing northwards by Wisbeach, Holbeach, Spalding, Boston, Wainfleet, Saltfleet, Grimsby, and Barton, in Lincolnshire; from thence to where the Don, the Aire, the Wharfe, and the Ouse, join and form the Humber; and from the north side of that river along the Yorkshire coast, to the neighbourhood of Bridlington.

This extent varies in breadth from a mile to four

or five; and, following the course of most of the rivers for a very considerable way, it decreases in width as the rivers recede from the sea.

On both sides of the Thames, there is a considerable extent of Alluvial Soil, which is of a clayey nature, and forms rich pasture land. In the neighbourhood of Sandwich, there is alluvial or marshy land of considerable extent, which separates the Isle of Thanet from the county of Kent. Romney Marsh in the same county extends from Hythe to Rye, is several miles in width, and consists mostly of alluvial sand and marshy soil. On both sides of the Bristol Channel, there are also considerable alluvial formations, but particularly from Bridgewater through Axbridge to Weston-super-Mare, in Somersetshire. The soil there is generally of great richness, and extends up the rivers Parret and Yeo, Axe and Brue, for many miles. The same soil is also found in Gloucestershire from the mouth of the Avon to Frampton-on-Severn; and in Lancashire along the coast from Liverpool to Lancaster. These are the principal localities; but there are many other portions to be found along most of the rivers, as the meadows on the Trent, in Nottingham and Derby shires; on the Thames, in Berks and Oxford shire; on the Severn, in Gloucester and Worcester shires; on the Dee and Mersey, in Cheshire and Lancashire; on the Tees, in Yorkshire; and in Scotland, the

alluvial soil is of great extent on the banks of the rivers Forth and Tay.

But though the banks of all these rivers consist of alluvial soil, yet as the materials of which it is composed depend entirely on the geological formations through which the rivers flow; of course, the nature and properties of the alluvium in one river or one country, may differ entirely from that of another.

Wherever this formation appears, it forms a low level district; and most frequently little or nothing elevated above the level of the river which passes through it, or of the adjoining ocean at high water. Indeed, it is found necessary to protect many large and fertile tracts of this formation by embankments; otherwise, they would be continually overflowed by the rivers during floods; or by the sea, when the spring-tides occur at the full and change of the moon.

Agricultural Character and Nature of the Soil.

At the mouth of the Ouse, the alluvium is a rich marshy land, formed of marine silt on a basis of clay; and when these are mixed, they form rich grazing land. Along both sides of the river, the soil is a deep hollow putrid sandy loam, full of vegetable matter in a state of decay, sufficiently adhesive to resist drought, and porous enough to strain off

superfluous moisture. Generally speaking, this is also the nature of the soil along those parts of the coast of Norfolk, Lincoln, and Yorkshire, where the Great Ouse, the Nen, the Glen, and the Witham, are emptied into the sea; and where the Trent, the Don, the Aire, the Wharfe, and the Ouse, join the Humber. At Gainsborough on the Trent, and in the Isle of Axholme, it is called a rich warp loam; at Saltfleet, it forms a dark brown loam of admirable texture, varying to a black and brown sandy loam, soapy and tenacious from warping; a friable sandy loam; a clayey loam, not adhesive; and a marine clay loam. At Boston, it is a rich loam upon clay and silt, and varies from three to six feet in depth. The soil is best where every variety of substance brought down by the river, is intimately mixed with those marine or clay substances brought up by the tide. This is almost the constant character of soils formed by natural, as well as artificial warping; and is by Geologists called Alluvium.

It is always fertile, free in its nature, and easily cultivated; is fitted for the production of every variety of crop, which it brings to the highest perfection, and produces in the greatest abundance.

This formation is perfectly dry, and the only attention required from the cultivator is to keep the banks good; so as to prevent the sea or the rivers

from overflowing the land, particularly that which is arable.

About one-half of all the alluvial accumulations may be in tillage, and the remaining half in meadow and pasture land. We consider that this soil produces a greater quantity of grain, and more luxuriant and nutritious herbage for feeding stock per acre, than the soil on any of the other geological divisions in England.

6. DILUVIUM.

Geologists have given this name to accumulations of sand, gravel, and other materials, which are found covering in masses some of the older and continuous geological formations to a greater or less extent.

There is generally a connection between these diluvial tracts, and the formations under or near them; yet this is not universally the case, for we find in that which rests on the new red sand-stone, not only rolled fragments of that stratum, but also of most of the primitive rocks. These are principally in the shape of boulder stones or large gravel, and the sand and earthy parts are mostly from the red sand-stone. This accumulation in the neighbourhood of Nottingham and Mansfield is, in many places, upwards of one hundred feet in depth.

The diluvium resting on the chalk and tertiary formations, is composed of rolled flints and reddish clay. This appears to have been produced by the breaking up, or disintegration, of a portion of the upper chalk and plastic clay strata, at a period after all the formations had taken place, on which the diluvium rests. In some places, there is little else but flints; and when these are of a dead white colour, the soil is of little or no value. In other places, as in Dorsetshire, the diluvium is a sandy flinty gravel, naturally producing heath and furze. In many districts, as in Kent, Surrey, Sussex, Hants, Berks, &c. it is mostly composed of red tenacious clay with rolled flints, varying in some instances to a loamy clay, or to sand and gravel. We are of opinion that much of the earthy matter in this diluvial district, is of the same nature as some of the beds of the plastic clay.

The general aspect of the surface of this formation is uneven, and presents rounded insulated hills of moderate elevation.

That in Dorsetshire is the most extensive, and the most worthless. There is seldom much water in the diluvium, unless where it is a sandy gravel; for the rain, which percolates through it, is thrown out where it rests on the London or plastic clay; and when it rests on the chalk it disappears, from being quickly absorbed by that stratum.

Agricultural Character.

The nature of the soil on this diluvium, which rests on the chalk and tertiary formation, is of the same character as that of the diluvium on which it rests. When clayey, or when mixed with sand and flinty gravel, as at Hatford, in Bedfordshire, the rolled flints are sometimes equal to one-half of the soil; and at Highclere, in Hants, even more than two-thirds of the soil are flints. At some places, a greater portion is of clay or sand; and the clay, which is mostly of the colour and nature as already described, is exceedingly adhesive, and sticks like birdlime when wet. In other parts, the flints are mixed with loam.

State of Culture.

Most of this soil is in arable culture, and produces turnips, barley, oats, wheat, clover; and, when under proper management, it becomes a useful soil. The tenacious clayey gravel is expensive in the cultivation, as it is most difficult to work, except between wet and dry. The greatest improvement which has been made in this soil, is by the application of chalk; for, with a good coating of this calcareous substance, it becomes sufficiently productive; and if this be repeated, with the addition of sand and good tillage, it produces good crops of

wheat, oats, barley, turnips, and clover. Even the soil at Highelere, which is composed of at least two-thirds of flints, produces, with a proper coating of chalk, good crops of wheat, turnips, and clover.

The diluvium on the new red sand is furrowed into vales with hills of small elevation. It is found in detached portions over the new red sand, and even over the coal formation to a considerable extent. From Nottingham through Mansfield, Welbuck, and Worksop, it consists of a sandy gravel, which gives a ready passage for the moisture to descend to the clay or marl of the new red sand below, which throws out the water in springs at the bottom of the hills.

Agricultural Character.

The nature, as well as the composition, of the soil of this diluvial district is very various, depending entirely on the predominance of clay or sand with gravel; and its colour changes from white to grey, yellow, brown, and red.

State of Cultivation.

The most part of this soil is under arable culture, and produces, if well managed, good crops of wheat, barley, oats, turnips, and clover. When it is of a clayey nature, it is generally under fallow once in five or six years; for, being of a close and tenacious

nature, it requires great care and attention, and, of course, is expensive in management. Drainage, when wanted, and deep ploughing, produce wonderful effects on this soil. There are other diluvial deposits resting on several of the other formations, but these are of limited extent. From Huntingdon to Farringdon in Berks, along the lower edge of the gault or oak-tree clay, where it joins the choral rag or the Fen or Oxford clay, are deposits of a small flinty gravel, the greater part of which is of an angular form, and not larger than the size of beans.

There is a deposit of calcareous gravel on the lower edge of the Fen or Oxford clay, which we have traced through Lincolnshire and Northamptonshire, into Gloucestershire and Wilts. This sometimes rests on the edge of the shelly oolite, but mostly on the clay. At the bottom of the oolite hills, resting on the blue lias, and the lower edge of the lower oolite, there are other deposits of calcareous gravel, evidently formed from the washing out of the valleys in the north-west of these hills. These are always found at the mouths of the deep valleys which intersect the oolite hills. All these deposits are very limited and detached portions, and filling up hollows in the surface, never assume the form of hills. The surface takes the general sweep of that of the formation on which they rest: when, therefore, they rest on an impervious subsoil, they form reservoirs for water; but these are very easily drained by tapping them at the lowest level. The nature of the soil on them varies materially, being either of a calcareous or silicious gravelly character, according as the diluvium has been brought from a calcareous or silicious formation.

The greater part of Norfolk and Suffolk has a sandy surface on the chalk or marl; to this sand geologists have given the name of diluvium.

They suppose it to be the remains of the degraded portion of the tertiary formation; we are, however, rather inclined to view this as one of the sandy members of the plastic clay.

The sand is silicious, and is found in various spots of considerable thickness; in some places, there are small rounded flints amongst it; in others fragments of chalk in a rolled state; whilst in some spots, the soil consists of strong clay, and in others of a deep rich loam.

The surface may be described as an extended plain, as there are no hills on it, but merely slight depressions in the districts through which the rivers take their course. The extent is considerable, stretching from Sudbury to Bungay in Suffolk; from thence, through Norwich to Cromer; with a breadth from Thetford to Southwold, and from Swaffham to Yarmouth. This extent, however, is not continuous, as the chalk and chalk-marl pierce

through it in many places, in portions of considerable size. Indeed, it is a question whether this district ought not to be called the plastic clay or chalk formation, rather than a diluvium. Water is near the surface of the soil, where it rests on the chalk-marl, and the ditches are kept deep, in order to draw it off.

The nature of this sand is silicious, and when unmixed with chalk-marl, it is frequently so light as to be blown in heaps by the wind; in other places, where mixed with flints, it produces heath and furze. The lightest sand in this formation is from Woodbridge to Beccles.

Agricultural Character.

The whole district may be termed a sandy loam, varying from a good rich loam to the lightest sand. There is a considerable portion of it in poor sheep walks, which present a desolate and dreary aspect. This is the best cultivated district in the kingdom; being level, it is easily worked at comparatively little expense, and is perhaps the most profitable to the cultivator. The subsoil being chalk, chalk-marl, or plastic clay, the means of permanently improving it are to be found under the soil at various depths, and this may be done at little expense; for 100 cubic yards per acre of chalk, or chalk and clay, dug in the corner of the field, may be wheeled over the

surface and spread on the land, at the expense of 50s. per acre.

Most of this district has been improved from a rabbit warren of little or no value, and made to produce from 30 to 40 bushels of wheat, and from 40 to 60 bushels of barley per acre; and the rental has been increased from 1s. to 20s. per acre. When the chalk-marl or clay lies near the surface, it is wet; but when drained, it is very productive in wheat, beans, turnips, barley, and clover.

7. Peat, Moss, or Bog,

Is composed of an accumulation of vegetable matter in a half decayed state, which has undergone, and is undergoing changes, different from the ordinary decay of vegetable substance. It consists of a soft, light, spungy substance, holding water in excess by capillary attraction: but when dry, it is inflammable, burns with little or no flame, and changes its colour on being exposed to the atmosphere, from a brown or yellow to a blackish colour. It is formed by the growth and partial decay of aquatic plants in a cold wet soil, or in stagnant water in hollow or shallow basins, either on low or on high land; in many instances, it is semifluid, and so soft, that neither man nor beast can pass over it. The water is antiseptic from the tannin

principle of the plants of which it is composed; and as the tannin principle of moss has the power of preserving animal and other substances for a great length of time, their decay is gradual and very slow.

In the transactions of the Royal Society there is an account of the body of a woman found six feet deep in a moss in Lincolnshire, in June, 1747; her hair and nails were unaltered, her skin tanned, soft, strong, and pliable; and, from the antique sandals on her feet, she appeared to have been a Roman lady.

The nature of the materials which compose peaty soil is a vegetable substance in a partial state of decay, containing the tannin principle in a considerable degree, and also oxid of iron dispersed through the whole mass. The subsoil of peat must necessarily be close and retentive; it is generally clay.

The greatest extent of peat moss, or black fen land, under cultivation, is in the fens of Lincoln, Northampton, Huntingdon, Norfolk, and Cambridge shires, and extends from near Cambridge through Ely, March, Thorny, Crowland, Spalding, Donnington, and Tattershall, to Lincoln; in length being about 70 miles, and varying greatly in breadth, though the average may be about 10 miles. The greatest breadths are those from Ramsey to Down-

ham, from Peterborough to Wisbeach, from Bourn to Holbeach, and from Wainfleet, through Tattershall, to Merton. This line is perhaps equal to 25 miles; but this peat or black fen land is not continuous, being intercepted by alluvial soil deposited by the rivers which pass through it. The whole of this district rests on the Oxford clunch, or fen clay formation.

In Somersetshire, there is a considerable extent of peat, moss, or fen land between Bridgewater and Wells. Part of this is cultivated, but most of it is still too near the level of the water in the ditches, from the imperfect state of the drainage.

In Lancashire, there are extensive peat mosses or peaty land in the neighbourhood of Manchester and Liverpool. Trafford and Chats mosses are under improvement; and in time, when the drainage is perfected, and the surface covered with clay or marl, these will be productive of corn and vegetables.

The above are the most extensive deep mosses, or peaty lands in England; besides these, however, there are, in most of the middle and northern counties, portions of low peaty lands, of which some parts have been cultivated, and are at present most productive. There is another kind of moss or moor land, which, on the sides and tops of the high hills or mountains, in Lancashire, Westmoreland, Cumberland, Northumberland, and Yorkshire, is of great

extent, but of very little value, from its elevation; and the humidity of the atmosphere in so cold and spongy a soil, prevents the profitable culture of such, even although it was perfectly drained.

Agricultural Character.

When the low peat, moss, or fen land is perfectly drained, so as to carry off not only all the surface water, but also that which the spungy nature of the peat holds by capillary attraction, it naturally sinks down and becomes more firm; and when the surface is pared off and burned, and pulverized by the influence of the frost, it becomes a soft black soil, composed entirely of vegetable matter, with the oxid of iron, and the tannin principle intimately blended through the mass. It naturally produces a coarse grass not of much value, and abundance of straw, when under arable culture, but very little grain, and that of a weak light nature; when, however, it is brought under a proper system of culture, and when, by the application of clay, the nature of the soil is changed, it becomes a most productive soil, easily cultivated, and yields the most abundant crops of oats and wheat. So great has been the effect of this mode of culture, that even 14 quarters of oats, and 6 quarters of wheat, have been known to be produced upon an acre of land, which, not many years before, was of little or no value. As

the Oxford or clunch clay is found at various depths under the peat in Lincolnshire, it is lifted up and spread over the surface, and, when incorporated with the black or peat earth, it forms the most productive of all soils. This is done by making trenches three feet wide, at the distance of eleven yards from each other, quite across the field: the black mould or peat is taken out and thrown forwards, the clay is then lifted up to the depth of two feet, throwing one half on each side; then another portion of the peat is taken off in the line of the trench, and thrown into the place where the last portion of clay was taken out. This operation is extended over all the field. When all these trenches are deprived of clay to the depth of two feet, the clay is then regularly spread over all the surface, except where the trenches are; it is then ploughed when dry, and sown to oats, and when the system is continued once every six or eight years, the capability of the land is increased in a most wonderful manner.

8. LONDON CLAY.

This may be said to be the uppermost of the geological formations of any extent in England, for the upper marine and fresh water formations are very limited, and are only to be found in the Isle of Wight, and on a small portion of the east of Suffolk. This clay is a bluish or blackish colour when wet, and brown or grey, near the surface, when dry. The whole is very tough and tenacious, the upper stratum in dry weather opens into perpendicular cracks for a considerable depth, and at a certain depth below, there are horizontal layers of nodules of a ferruginous clay limestone, called septaria. These layers are repeated at intervals of several feet; this is the substance from which Parker's, or the Roman cement, is made.

The lower portion, in which the septaria are found, has fine grains of mica in it, and is more slaty than that which is nearest the surface. It seems indeed to be a clay more or less pure, having mica in the lower, and fine sand in the upper portion; and, in some places, it is found of a marly nature, effervescing with acids, with white specks on it of a calcareous kind.

The external character of this formation may be termed a low, uneven, gentle-waving surface, with sufficient slope for drainage; having small risings, but no abrupt or great deviations. The most elevated land may be about 400 feet above the level of the sea, although in Essex there are several hills upwards of 600 feet high; yet the general character of the surface is that of low land, without any great or striking feature.

This formation extends, with little interruption,

from Orford in Suffolk to Manningtree in Essex; and, in a continued course, south of Colchester, through Maldon, Billericay, Rumford, and Barking, to London, Richmond, and Staines; then through Windsor Park to Oakingham in Berkshire; and from thence, to Strathfield Saye, to Rotherwick in Hampshire. Its greatest breadth is from Croydon through London to Barnet, a distance of about 20 miles; from the Thames, near Rochford, to Chelmsford, its breadth is about 15 miles; and from Guildford in Surrey to Windsor, its breadth is about the same.

There are some portions of the London clay on the coast of Kent, at the Isle of Shepey, High Alslow, and Reculver Cliff; but there are interruptions in its course. The rolled flinty gravel, before mentioned as the diluvium of the flint, chalk, and plastic clay, is formed between the river Boding and the New River, east of London, filling up a breadth of perhaps five or six miles; and at Bagshot and Purbright heaths, where it is said to be covered with the sand of the upper marine formation, it again appears. There is also a considerable extent of this formation, in what is called the Isle of Wight Basin, from Christ Church and Ringwood to Southampton in Hampshire; and this continues in a line through Titchfield, Portsmouth, to near Worthing in Sussex. The greatest breadth of this field is in the New Forest, from the sea side at Lymington to near

Romsey, where it is perhaps 16 miles in extent; but from Southampton to Worthing, it becomes a very narrow strip indeed, and is in some places not more than a mile in breadth.

It thus forms a considerable portion of the southeast of Suffolk, a large portion of Essex, and nearly the whole of Middlesex, as well as portions of Kent, Berkshire, and Hampshire.

There are no springs in this formation. It is so close and compact as to be completely impervious to water; it therefore prevents the water, which is in the plastic clay below, from coming up through it. The perpendicular rents made in it in dry weather, are filled and soaked with the water in time of rain; and this, with the natural tenacity of the clay, keeps it much longer wet than it would otherwise be.

Agricultural Character.

The soil on this formation is generally of a brownish colour; though in some places it is grey, pale, and yellowish. It is naturally a strong, heavy, wet, tenacious, clayey soil, on a brown or bluish subsoil. The dense and compact nature of this soil is owing to the minute and impalpable nature of the materials of which it is formed. It seems chiefly to be clay, and a very small portion of very fine, impalpable, micacious, and silicious sand, with

the oxid of iron. In some instances, the soil is slightly calcareous, adhering to the feet in wet weather, although not slippery; shrinking very much in dry weather, and cracking into perpendicular fissures to the depth of three or four feet. It sticks to the plough like pitch; and its cultivation is consequently difficult and expensive. If ploughed when wet, it rolls before the plough in a broken and muddy state, and chokes it.

In some places, there is a considerable portion of sand in this soil; this is the case near the rivers, where it forms rich, friable, fertile, sandy loam, composed of fine sand and vegetable matter with the clay. When this soil gets dry after heavy rains, it assumes a whitish appearance.

The tenacity of this soil is great, and a little rain makes it work like mortar.

Where it is allowed to remain in a natural state, the pasture is covered with ant hills. There is a very great portion of the land on this formation in pasture; that which is under arable culture is too strong for turnips and barley; but, under proper cultivation, it produces large crops of wheat, beans, and clover. The system pursued in its cultivation, is to summer-fallow it once, in four or five years.

The fissures made in this formation during the time of great drought, form cavities for holding water; and, although there are no springs in this

soil, yet, from this cause, it becomes necessarily a wet soil; it is, however, easily kept dry by having the ditches and the furrows always kept clear, so as to let the water drain off as it runs through these fissures into the furrows, and from thence to the ditches.

Almost the whole of the soil in this formation is enclosed, except some in the New Forest, and in Bagshot and Purbright heaths. These wastes are capable of great improvement, merely by draining off the surface water, and burning the heath or other natural productions on the surface. The whole of this clay is much improved by a well-regulated system of cultivation and manure; the sand of the plastic clay is to be found near to it, and is an excellent material for altering its texture, by giving it a greater degree of friability, and by forming it into a clay loam. With repeated dressings of London manure, it is converted into very rich dry meadow land, and produces large crops of excellent hay.

9. PLASTIC CLAY.

This formation occupies the space between the London clay and the upper chalk, and is composed of an indefinite number of beds of clay and sand of every variety of colour; white, black, blue, purple,

bright yellow, orange, and red. The sand alternates with partings of clay, both of which are sometimes as thin as pasteboard; although, in some places, the beds, both of the sand and of the clay, are several feet in thickness. The component parts of the formation are clay and silex, with iron as a colouring matter. The sand is formed of very minute particles of silicious matter; the clay is unctuous, tenacious, and, in some of the beds, particularly the white, is nearly pure, and is used for making tobacco pipes; but the other varieties are mixed with very fine sand, without any calcareous matter in the composition, either of the sand or clay. A bed of rounded or water-worn flints, with yellow sand, occasionally forms some of the members of this formation.

The surface of the plastic clay in some places is rather hilly, but not of great elevation; in others, it is a low level surface, as in Essex, Suffolk, and Norfolk.

It embraces the outline of the London clay, and presents a very irregular junction both with it and with the chalk. Its extent and direction may be traced along the middle of its course, from near Lavenham in Suffolk, by Halstead, Braintree, and Sawbridge, to Waltham Cross in Essex. This portion of it has a greater breadth than any other

part of it in England, averaging about 10 miles over the whole of this distance, the length of which may be about 50 miles. Its course then turns north to Hatfield, proceeds by St. Albans and Watford in Hertfordshire, to Redhill and Salthill in Buckinghamshire, and then to Maidenhead, Reading, and Hungerford in Berkshire.

In this circuitous line, its breadth is sometimes not more than a mile. From Reading through Newbury and Broxfield, beyond Hungerford in Wilts, along the Kennet, its course southward is through East Woodhay, Banghurst, and Odiham, in Hants, to Guildford, Leatherhead, and Croydon, in Surrey; where it is again of considerable width, and continues onward through Bromley as far as Dartford in Kent. There is another field of this formation, embracing the London clay of the Isle of Wight Basin, which may be traced from near Dorchester, through Poole and Wimborn in Dorsetshire, to Fordingbridge, Romsey, Chilworth, and Fareham, in Hampshire; and then through Chichester and Arundel, to Worthing in Sussex. The alternations of sand and clay when the beds are of considerable thickness, particularly when beds of gravel exist, form large reservoirs for water; and hence, water is to be found over the whole extent of this formation.

Agricultural Character.

The soil on this formation in Dorsetshire is a poor, barren, sandy, flinty, gravel, generally of a yellowish, though sometimes of a brown red, and blackish, colour; and, producing nothing but heath, is of very little value: from Ringwood, however, in the whole of its course eastward, it is a dark coloured gravelly loam, or sandy loam on clay, mixed with reddish brick earth and gravel, and forms a very rich loam, of an agricultural character, similar to that of the London clay, when the sand is absent. In Hampshire near Newbury, it is very wet and springy, forming sometimes a quicksand, and sometimes a strong brown or grey loam with a great deal of moisture in the soil, causing boggy places in the hollow, and under the peat is to be found a tough, sour, clayey gravel.

In Essex, the soil is a strong, heavy, wet, reddish, or brown loam, on a clay subsoil, which becomes, with rain, strongly adhesive and close; in other places, as at Chelmsford, it is a sandy loam, and a good turnip soil.

Indeed, every variety of soil may be met with, in a short distance, over the whole of this formation, which is owing to the rapid succession of sand and clay, and the other materials of which it consists.

After rain, this land, when in fallow, has a whitish

appearance, from the minute particles of white sand left on the surface, after the clayey parts have been washed out; in some places, there is a rich, pale, reddish, sandy loam, which is deep, moist, and friable; adhesive without tenacity, friable without looseness, and which produces large crops of wheat, turnips, and carrots.

The greatest portion of this soil is under arable culture; the remainder is in heaths, and extensive wastes, as in Dorsetshire, Hants, and Berks near Newbury. The clay soil in Essex and Herts is well cultivated: one crop of corn, and a fallow crop, is the system, and the corn is sown on two-bout ridges.

The light soil produces turnips, carrots, barley, and wheat.

The character of the soil on this formation being wet and springy, and producing peat in those hollows where the water is allowed to lie, the whole requires to be well drained, before any system of culture is adopted. From the nature of the subsoil, there seems to be considerable difficulty in effecting this; but by carefully attending to the nature of the stratum out of which the water comes, a complete drainage can be easily effected.

The only difficulty is, that the soil is easily carried off by the stream, which forms deep gullies when the water is in any quantity.

There are in the soil of the plastic clay formation

all the materials at hand for making a good friable loam, by simply mixing the sand and clay together, and pulverizing the soil well by the addition of manure.

In Norfolk and Suffolk, although the sandy soil, (which we believe to be the sand of the plastic clay), is of great extent, yet it is not of great depth; and being near the clay, or chalk, or chalk marl, there is the means at all times of increasing its tenacity by a covering of this clay or chalk marl.

So convinced are the farmers of Norfolk and Suffolk, of the value of the clay or chalk marl as an alterative to the sandy surface, that they generally chalk or clay their land once in eight years at least, and sometimes oftener; and, by allowing 100 cubic yards to an acre, incur an expense of 50s. per acre, for digging, wheeling, and spreading. It is solely by this process, that the Norfolk sandy soil, which naturally was of the most worthless kind, and produced nothing but heath and bent for a few starving sheep, is now converted into good sandy loam, which yields large crops of turnips, barley, and wheat.

When this soil rests on the chalk, as in Berkshire, &c. and is reddish and clayey, with yellow sand beds, nothing improves it so much as a good dressing of chalk. This is done in Hampshire and Berkshire, by allowing 9 baskets or 18 bushels to a perch, or 2880 bushels to the acre, at an expense of 42s.

This is frequently done by sinking pits down through the subsoil to the chalk, sometimes to the depth of 20 or 30 yards; but when the chalk is near, it is taken from a pit in the side of the field. The effects produced by the application of chalk or lime to the soil are most astonishing; so much so, that rich crops of wheat are obtained where nothing grew before, and sterile worthless land is converted into a productive district. Hounslow heath, a portion of this formation, used to produce nothing but heath; and now, it produces the most luxurious crops of every kind of grain.

10. THE CHALK FORMATION.

This formation is divided by geologists into the upper and lower chalk, and both these are formed of numerous beds of various thickness.

The upper chalk has beds of flint and dry open partings; the lower chalk has no flints in it; the beds are separated by open partings; and in both, are numerous perpendicular divisions, which give an open and pervious nature to the whole formation.

Chalk is a white earthy limestone, being a carbonate of lime more or less pure.

The constituent parts of it are lime and carbonic acid in nearly equal portions; though some varieties of it have a small portion of silica, alumina, and iron.

The chalk district is elevated, broken into many irregular parts, and intersected by numerous deep winding vallies. On the north-west side, it presents an abrupt elevated range of hills, which bound the valley of Pewsey in Wilts, the vale of the White Horse in Berkshire, and the low ground from Wallingford in Berkshire to the vale of Aylesbury, and which run eastward to Royston in Cambridgeshire. The lower chalk forms a range of low hills, in front of the elevated range of upper chalk. These hills are of considerable elevation, particularly in the counties of Dorset, Wilts, Hants, Berks, and Bedford, as well as in Yorkshire; but in Norfolk, Suffolk, and Cambridgeshire, the formation is nearly a level plain.

The features of the chalk hills are large, their sides are very steep, and frequently very abrupt; but being always smooth and rounded, they never present a rugged aspect; and the vallies adjoining are deep, and generally without water in summer.

This formation extends from Bridport in Dorsetshire, by Dorchester, Salisbury, Hungerford, Henley, High Wycombe, Beck Hempstead, Stevenage, Saffron-Walden, Newmarket, Thetford, and Swaffham, to Docking in Norfolk, along the north side of the London Basin, and crossing the Wash, it enters Lincolnshire at Burgh, and extends through South Binbrook to Barton; and after crossing the

Humber, it proceeds from Hull, through Beverly and Ganton, to Foxholes. That which forms the south side of the London Basin begins at Dover, and extends through Chilham, Stockbury, Chatham, Farmingham, Mertsham, Guildford, Farnham, and Winchester, to Salisbury. There is another branch which forms the north side of the Isle of Wight basin, beginning at Beachy Head, in Sussex, and extending through Shoreham, Arundel, north of Fareham, Bishops-Waltham, to Winchester; there is also a very small portion along the middle of the Isle of Wight. The greatest breadth of this formation is from Bishops-Waltham in Hampshire, through Winchester and Whitechurch, to Wantage, in Berkshire, being upwards of 40 miles; between St. Albans and Dunstable, its breadth is about 15 miles; between Dunmow and Royston, about 20 miles; and it may be said to extend over nearly the whole of Norfolk and Suffolk, from Woodbridge, through Stowmarket, Eye, Attlebury, Hingham, Dereham, and Fakenham, to Burnham, a distance of about 70 miles; and from Yarmouth to Stokeferry at right angles to this line, it is upwards of 50 miles in extent. The chalk, if not at the surface, is within a few feet of it.

In Lincolnshire, its greatest breadth, from Castor to Ludborough, is only about 15 miles; the broadest part of it in Yorkshire, from Bridlington to North

Malton, is about 25 miles; in Kent, the greatest breadth, from Folkestone to Canterbury, is about 15 miles.

The water, which comes from below the lower chalk, is pure and limpid, and delicious to drink. It contains carbonate of lime, and is of the best quality for water meadows; hence, the best water meadows are in the chalk valleys.

The openness of this formation keeps the whole of the surface very dry; indeed the whole of the chalk soil is dry, and there are no springs in it, except those that are thrown out by the clay below the lower chalk.

Many of the valleys, which in the winter have rivers flowing in them, are left perfectly dry in the summer, owing to the openness of this formation, which allows the rain to run through it to the clay below. These valleys are called bournes.

Agricultural Character.

The soil of this formation is made up of decomposed chalk, with or without flint; that in the upper chalk has a large portion of flints in the soil, and is composed of angular fragments of chalk, mixed with vegetable mould of a sandy nature. It is a dry, loose, chalky mould, a light hazel mould, dry and friable, with a small portion of sand in its com-

position; or a deep, dry, chalky loam, called white land.

All of these soils contain flints in more or less abundance, and naturally produce pasture of an excellent quality for sheep, although very short; and under proper arable cultivation they yield good crops of barley, turnips, wheat, and sain-foin. If the farmer can obtain a good crop of straw, he is sure of getting a good crop of corn of excellent quality.

The soil on the lower chalk is also called white land. It is without flints, and has fewer fragments of chalk in it than the soil on the upper chalk. This may be owing to a portion of clay or alumina in the lower chalk, on which the frost and the air have a great effect, and reduce it to a powder; or dissolve it into minute particles, so as to form, with vegetable matter, a chalky loam. This soil is a deep, strong, grey, loam, a chalk marl, or a calcareous loam of a white colour, from the quantity of chalk in its composition.

White marl, malm, or marme, are names which are given to it in different districts.

It is a most productive soil of the finest quality, and when it is blended with the green sand on which it rests, the mixture forms a rich, friable, deep, loam, fit for the production of every kind of crop.

This is a much richer and more productive soil

than that on the upper chalk, being stronger and more adhesive; it is better calculated also for the production of wheat, beans, and clover; but not so well fitted for turnips as the other: for although it produces great crops both of turnips and barley, the land is injured by the trampling of the sheep in consuming them on the ground.

When wet, this soil is tough and adhesive, ploughing up into a close tough furrow slice, which when dry becomes extremely hard and difficult to reduce, and is therefore expensive to cultivate; but if ploughed in proper seasons, when neither too wet, nor too dry, it is easily managed and reduced into a loose and friable tilth.

A considerable portion of Norfolk and Suffolk, and a portion of Lincolnshire, seem to be formed of rubbly or rolled chalk, as if it had undergone the wearing process of moving water. The soil on this partakes more of the nature of the lower chalk or chalk marl, being strong and adhesive, and without flints in it. A large portion of the upper chalk in the counties of Dorset, Wilts, and Berks, is in downs and sheep pasture, and most of the remainder is under the plough. Little of this district in these counties is inclosed, though almost the whole course of the lower chalk is under arable culture. The valleys, in which there is any water, are universally formed into rich water meadows.

There is a great portion of the upper chalk, which is covered either with a thin coating of sand, (the sand of the plastic clay, we think), or vegetable mould, in a state of nature, having been occupied as a sheep-walk for ages; and it has been kept in the same state, instead of being increased in value by the improved state of agriculture.

The climate of the chalk soil varies with its position. In the north and east, it is cold and much exposed to the east wind; in the middle and southwest, it is dry; and although much exposed from the absence of hedges and woods, it is earlier than could be expected from its high elevation above the ground on either side of it. The air is mild and healthy, although keen, on the hills, but warm in the valleys; and the white nature of the soil and roads considerably injures the eyes.

The surface, from being much undulated, from the low level of the east coast in Norfolk and Suffolk to the high hills of Hants, Wilts, and Dorsetshire, makes a considerable variation in the climate. In Norfolk and Suffolk, the harvest is much earlier than in Hants, Wilts, and Dorsetshire. The sides of the hills are skirted with woods and coppice, but these are of very limited extent.

The open and porous nature of the subsoil leaves the surface perfectly dry; indeed, so much so, that yearly expense is incurred by the farmers in making and repairing ponds for catching rain water for their stock; and wells have occasionally been dug through the chalk to a great depth for water. A great improvement would be made in the chalk district by inclosing the whole.

It is curious that the land on every other formation should be almost wholly enclosed, and that this should be almost entirely an open extensive plain; this is the case, whether you take Dorset, Wilts, Hants, and Berkshire, on the west; or Cambridgeshire, Norfolk, Suffolk, and Lincolnshire, on the east. Is this to be considered as the cause, or the effect of the sheep-fold, as a manure to fallows?

The soil on the downs is a very thin covering of a sandy vegetable mould, which is soft, weak, and full of fibres.

This extensive portion of land might be much improved, by the means which has produced so great a change on the Lincoln wolds; and in Norfolk and Suffolk, by an admixture of the surface with the subsoil. This would not only give depth to the soil, but the calcareous matter of the chalk would make the inert vegetable matter more active; and, with a well regulated cultivation, a succession of good crops of turnips and barley would be the result, and a much greater quantity of food would be produced for sheep, than is at present got from the short grass which it affords.

This would also have the effect of returning the manure produced from the crop, to the land which produced it: and the present robbing system of folding on fallow, at the expense of the down, would soon disappear.

The improvement effected on the sandy and chalk soil in Lincolnshire, by the application of bones, has been great.

11. GREEN SAND FORMATION.

THE green sand is found under the chalk, and takes the same direction, following it up the valleys, between the hills of the lower chalk formation. is composed of various beds; the upper beds, next to the chalk, are those that have the truest character, being green or greyish in colour, and having in their composition most of the green earth or chlorite, which is peculiar to this formation. The lower beds are frequently of much greater thickness; and are of every variety of colour, from yellow to a deep This formation is composed of silicious sand, intermixed in some places with scales of mica, and a large portion of a green earth or chlorite. form a soft species of sand-rock, but are so slightly united together that they are easily displaced with the finger or nail.

In the upper or true beds of the green sand, beds of schist, passing into coarse chalcedony, are sometimes found; and also beds of bluish limestone, as in Kent: the colour of these varies from white, light grey, green, yellow, orange, and brown, to dark red, and even black.

The surface of this formation has, in general, a low and level aspect; but in some places, as in Kent and Surrey, Dorset and Lincolnshire, it forms a continuous range of hills in front of the chalk.

The extent of this formation, though not of great breadth, may yet be said to follow the outer line of the lower chalk through all its windings; but, in some places, it is so very narrow as scarcely to be seen, or is covered by the malm or lower chalk. This being of a loose porous nature, the water easily passes through it; and it may, therefore, be said to be dry, and without water; but, in some places, where it joins the clay below, there are large springs forced up through it; and, when the surface of the clay on which it rests is nearly level, as in Wiltshire, between Devizes and Pewsey, the surface may be said to be wet.

Agricultural Character.

The soil of the green sand formation and that of the chalk, marl, or malm, are frequently so blended together as to render it difficult to perceive the line that separates them. This soil is composed of chalky matter, clay, and silicious sand, with the green earth.

The sand increases as we recedefrom the chalk, and the calcareous matter increases as we approach it. This soil is of a greenish mottled colour, of a friable crumbling nature, and rich and productive of every kind of crop, especially turnips, potatoes, wheat, and barley. Where the sand abounds, and is mixed with sufficient portions of calcareous matter, a deep loam is formed of a greenish colour, which, under good turnip husbandry, is most productive.

In Kent, every variety of the soil on this formation may be seen from Maidstone to Tunbridge; at Sandey and Biggleswade, in Bedfordshire, this soil, which is mostly sand, is under the highest degree of cultivation, and forms the best garden land, and is the most productive in the kingdom; but the productiveness of the soil in this place is more owing to the mode of culture employed than to the soil, for it is of a very weak, sandy nature. The black sand and white silvery sand are the worst soils, and naturally produce nothing but heath.

From Biggleswade, through the vale of Aylesbury, under the chalk hills, to Dorchester and Wantage, in Berkshire, there is a tract of sandy loam, which is soil of this formation.

It is of considerable width, and extends in Wiltshire from Pewsey, by Devizes, and Warminster, to

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Mere; and in Dorset and Devonshire, it is of considerable width in many places, and forms a rich tender loam of a brown colour, called *fox-land*, and is very fertile. In Dorset and Devonshire, there is a great portion of this soil in pasture, as well as in some parts of Wilts, and in the vale of Aylesbury; but, for the most part, it may be said to be under arable culture.

The means of permanently improving this land, after it is drained and inclosed, (if for pasture), are so immediately within the reach of the farmer, that he can at little comparative expense improve its texture, and permanently increase its productiveness by chalk or chalk marl on the one hand, and the oak-tree or clunch clay on the other; but even without the application of these substances, deep or double ploughing or trenching have the effect of deepening the soil, and increasing its capability. When mixed with the chalk marl above it, it has the power of receiving and transmitting moisture more freely, and is neither so easily injured by wet weather, nor by excessive droughts, as other soils are.

12. GAULT.

This clay has the same position on the north and west of the great range of chalk hills, as the weald clay has under the chalk hills, which form the south side of the London, and the north side of the Isle of Wight, basin, but has a very different appearance and texture. It is mostly of a bluish or grey aspect, although in some places it changes into a brown and even yellow colour; it appears likewise to be of a coarse nature, and has not the thin slaty appearance which the weald clay has, but is a solid compact mass of impervious clay. In many places it contains calcareous matter, but generally the subsoil does not effervesce with acid; and when brought to the surface, the clay gradually grows of a darker colour from the influence of the atmosphere.

The external character of this formation, like the weald clay, forms a wide valley along the foot of the chalk hills; and in Cambridge and Hunting-donshires, where it joins the Oxford or Fen clay, it takes the form of low hills and wide valleys.

As the geological position of this formation is in the centre of the green sand, that is, under the true green sand and above the lower members of it, which take such a variety of colours, it may be supposed to have as great an extent as that of the chalk; but this, like the green sand, is not found to be continuous; or, at least, it thins out so as to become imperceptible on the surface.

There are two great deposits of it; the one in Berkshire, in the vale of the White Horse, the other GAULT. 45

in Cambridge and Huntingdon shires; and these two are joined together by a continued line of less breadth.

In some places, where the green sand abounds, this formation is either wanting or covered with it; and where the green sand is wanting, it evidently bears the marks of the green sand in its structure, as it has a greenish colour, with a portion of the green earth in its composition. course is from South Marston, in Wilts, by Shillingford, north of Wantage, to Abingdon in Berkshire; it then proceeds by Thame, in Oxfordshire, and passing through the vale of Aylesbury, it continues through Bedfordshire to Caxton in Cambridgeshire, and St. Ives, in Huntingdonshire. Its greatest breadth is from Wallingford to Abingdon in Berkshire, on the west, and from south of Caxton to Huntingdon on the east. There is also a narrow strip in Norfolk, from Downham, east of Lynn, to Hunstanton; and another in Lincolnshire, from Bolingbroke, by Horncastle, Wragley, Market-Barsin, Caiston, and Brigg, to Barton; but this, in some places, is not a mile, while at others, it swells out into several miles in breadth.

This formation, like the weald clay, is so impervious that no water is retained within it, and of course there are no springs; but it is kept in a wet state by the surface water, which runs over it from

the green sand on the one side, and the coral rag, and Portland or Aylesbury stone, on the other.

Agricultural Character.

The soil on this formation varies much in its quality. In the vale of the White Horse, in Berkshire, this clay is overlaid with a thin covering of the malm and green sand, which, being mixed with the soil, form a rich friable clay, with a considerable portion of calcareous matter in it.

There is also a mixture of very small, rolled, and angular flints in the soil; which are whitish externally, and give to it a greenish grey colour, through Oxford, Berks, and Bedford.

In these counties, it is nearly of the same nature; although in some places, its colour changes from bluish to brown, and even to yellow. It is a mild clay, of a friable nature, and forms an excellent and very productive soil, with marl or calcareous matter abounding in it. In Cambridge and Huntingdon shires, however, this soil forms a thin cold clay, and when slightly wet it becomes as sticky as glue, while heavy rains wash away the furrows, and frost opens up the soil and makes it porous as a honeycomb.

The line which separates the lower chalk or green sand from the gault is not well defined; these pass into each other, and gradually assume the nature GAULT. 47

of argillaceous loam, with fragments of the green earth, even where the green sand formation is wanting. It has a greenish grey colour, and forms a friable clayey soil.

The coral rag, or Aylesbury stone, is wanting in Bedford, Huntingdon, and Cambridge shires, so that the soils being so much alike, the line of separation cannot be distinguished. From Caxton, in Cambridgeshire, through Huntingdon, to Stilton, the soil seems to be of the same nature; although from Huntingdon to Peterborough, it is called the Oxford or Fen-clay. There is a district around Arrington, in Cambridgeshire, and all the way to near Huntingdon, where this soil is of a grey or yellow colour, on a yellow subsoil. It is of the poorest quality, most difficult and expensive to cultivate as arable land, and naturally produces poor coarse pasture of little value.

The whole surface is covered with ant-hills, and this is the most worthless district, as the vale of the White Horse in Berkshire, is the most productive of the soil, on this formation.

There is a great extent of this soil, from near Shillingford in a line north of Wantage to Abingdon, in common field and in arable cultivation, which produces rich crops of wheat and beans; but the land lies so low, is so much divided, and so imperfectly drained, that it is difficult to keep the

ditches clean; indeed, in many places, it is completely drowned with the surface water, which comes from the green sand or malm that rests on it, as well as by the flood from the rivers or brooks.

Over the whole extent of this formation, there is a great portion of the land in common field under arable culture, and the course of cropping is summer fallow and two crops, consisting of wheat and beans or oats; but where the land is enclosed, it is in pasture, and produces very rich herbage, particularly in the vale of the White Horse.

The first step towards the improvement of the soil on this formation would be to enclose the common field, or divide the several allotments; so that each proprietor might have all his land together, and be enabled to use the best means of keeping off the surface water from his land, without being interrupted by that of his neighbour. The straightening of the river, particularly in the vale of the White Horse, would prevent the surface from being injured in the time of floods; and enclosing the cold land in Cambridgeshire, and laying it down to pasture, would much improve it. Furrow-draining, in order to draw off the water that falls on the surface, might encourage the growth of the better sort of grasses, and thus improve the herbage.

13. OAK TREE, OR WEALD CLAY.

THE clay of which the wealds of Kent, Surrey, and Sussex, are in part composed, has got these names.

It is a close compact substance, formed of various layers of a whitish, yellowish, fawn, or buff-coloured clay. These beds are sometimes of a thin slaty nature, and some of them have the appearance of tile or shale in their composition.

They are composed of very minute particles of clay and sand, in an impalpable state of division, but in close mechanical contact; so minute indeed are the parts, that no particle can be perceived by the touch, and there are neither stones, gravel, nor calcareous matter, in any of the beds of this formation.

The surface of this clay is very uniform, and there being few spots which are raised above the weald, it forms a low level valley between the green and the iron sand.

It extends in the form of a horse-shoe, from Bonnington, in Kent, by Tunbridge, Crawley, Haslemere, Pitworth, Clayton, and Huilsham, to Peversly-beach, in Sussex, with a breadth of perhaps four miles. This formation is of so close and impervious a nature, that no water can penetrate it, either up from below or downwards; yet, from its impervious nature, it throws out the water which passes through the green sand on the one side, and on the other, the water of

the iron-sand is forced up by it, and overflows it at its junction; and thus it is kept wet on both sides, although there are no springs within it.

Agricultural Character.

The soil is in every respect like the subsoil, although of a darker fawn or hazel colour, and has a pale, whitish yellow, sickly appearance in some places. When ploughed, it cuts like a piece of soap, and the furrow turns over unbroken.

It does not adhere much to the feet, but is unctuous and slippery, and close and adhesive to the particles of which it is composed.

They are of a very fine impalpable nature, more of a fine sand than clay, mixed with little or no vegetable matter; and so close and retentive is the soil, that when once it is soaked with wet, it requires a very long time before it becomes dry, as the atmosphere has little or no effect on it, from the whiteness of its colour and the closeness of its texture.

The peculiarity of this soil is the minuteness of the division of its parts; the siliceous matter being so very fine, and the clayey particles being equally minute, they form a close firm paste, which dries into a substance almost as hard as brick, and which the roots of vegetables are unable to penetrate. From the great expense in cultivating this soil, a considerable portion of it is in woods; some is in poor wet

pasture for young horses and oxen, and the remainder is under the plough.

There is a diluvial deposit on some parts of this soil, composed of a flinty iron-sand and gravel, but of very limited extent. A perfect surface drainage could be easily effected by forming this soil into narrow ridges and small inclosures, with deep ditches to carry off the surface water; but nothing would tend to improve it more than subsoil ploughing, after it has been perfectly furrow-drained, so as to take off all the water that soaks through the moved subsoil; this process, with chalk or lime added, would tend to ameliorate this close soil, open its texture, and make it plough up and become friable.

14. IRON-SAND, OR HASTINGS' SAND.

The formation to which geologists have given this name is composed of very fine grains of silicious matter, and very soft, white, yellow, or red sand with clay. The sand is sometimes indurated, and becomes a sand-stone. When this is the case, it appears in layers in successive repetitions; and in the Isle of Wight, it has the appearance of a loose grit-stone, of a dark brown or reddish colour.

The surface is undulated, and the hills in Sussex rise to the height of several hundred feet.

The greatest extent of this formation is in Sussex, extending from Hastings to the river Arun, being

about 50 miles in length, and about 10 or 12 miles in breadth. There is also a small portion in the Isle of Wight, and the sand in Bedfordshire has been called iron-sand, which, however, we believe to be the members of the green sand, and in every respect like those in Surrey and Kent. Many of the members of this formation being porous, the rain readily sinks to the bottom, or till it meets one of those beds of clay (which are so numerous in that part of Sussex), and is then thrown out by it; so that there is a large proportion of springs in this formation, which keeps the surface wet.

Agricultural Character.

The soil on the iron-sand in Sussex is of a very soft substance, being composed of fine silicious sand, mixed with clay, and a large portion of ochre of ferruginous matter, and thus forming a yellowish fawn-coloured or brown sandy-loam, which is very weak, and naturally produces heath, furze, broom, and other brush-wood. It yields good early crops, however, and when under proper cultivation, it is productive in turnips, barley, and clover. In the Isle of Wight, it is of a dark brown colour, more of a gritty nature, from having a greater quantity of iron in it, and forms a sandy loam of a harsh gritty quality.

There is a large portion of this soil under pasture in Sussex, which is greatly improved by the depasturing of sheep; and that which is under arable culture produces good crops of turnips, barley, oats, clover, and wheat.

Complete drainage, and deep ploughing, would greatly improve the soil on this formation; and as an alterative to improve its texture and increase its productiveness, chalk, lime, or clay, would have an excellent effect. Turnips, vetches, and clover, fed off with sheep, and the land laid down permanently to pasture, and grazed by sheep for the first three years, would at least greatly increase the productiveness of this soil.

15. CORAL RAG, CALCAREOUS GRIT, AYLESBURY AND PORTLAND STONE.

The coral rag formation is composed of several members, all of which are calcareous, and most of them silicious and gritty, at their partings. The true coral rag consists of a rough, irregular, calcareous mass, the irregularities of which are filled up with calcareous clay; but some of the other members are of a thin, shelly, calcareous, gritty, flagstone, from one to four inches in thickness; and these generally have a ferruginous, silicious, gritty appearance externally, and strike fire with steel. The partings are of silicious yellow iron-sand, while the upper members of the Aylesbury or Portland

stone have partings of calcareous sand. The coral rag has a gentle inclination to the south-east. All the members of this formation effervesce with acids, and have more or less of silicious matter in their composition.

The surface of this formation, although it appears level to an observer from the chalk hills, yet forms a range of low hills, in front of those of the chalk, when viewed from the Oxford clay. This formation begins on the west of Devizes, in Wilts, and passes by Calne and Highworth to Farringdon and Abingdon in Berks, and continuing to the south of Oxford, it stretches beyond Aylesbury, in Buckinghamshire, with an average breadth of about four miles. The flat thin beds of this rock, which are in a continued and unbroken line for a great extent, and the thin partings of clay, throw out water; and from the level nature of the surface, its broad shallow valleys or troughs, where the springs burst out, have universally a considerable portion of peat or bog-earth in them. This may be owing to the ferruginous nature of the water, which passes through the ironsand

Below the peat, there is a white substance which is locally denominated soft white earth; this is carbonate of lime under the appearance of a light, soft, white marl; and from the minute divisions of its parts, it forms a soft wet clay whenever it comes to

the surface. It is a most worthless soil, and produces nothing but very coarse carnation grass,

These bogs can easily be drained by cutting off the springs below. This marl, which when dry is so light that the wind carries it away, is of little or no value as a manure on this soil, which is already of too light a nature, and contains too much calcareous matter in its composition.

Agricultural Character.

The sandy partings of this rock give to the soil its peculiar character, and these, with the natural decay or broken portion of the rock, form the whole depth of the soil, which is therefore light, thin, and sandy; and the sand being both calcareous and silicious, the soil partakes of the same nature. In some places, there is a large portion of iron-sand or ferruginous matter in the soil, which from its thin and sandy nature is easily and early affected by continued droughts; but under good culture, it produces great crops of turnips, barley, clover, and wheat: and when the seasons are moderately damp, the crops are very large.

Almost the whole of the soil on this formation is in arable culture. This is probably owing not only to the little expense in cultivating it, but also to the poor, benty herbage, of little or no value, which it produces either in its natural state, or when it is laid down to pasture; it is, therefore, of much more value under arable culture than in pasture.

The best and most profitable mode that can be adopted with this thin soil, is to have large flocks of sheep to consume the produce on the land, and never to have more than half of it in corn. The four-field, or Norfolk system of husbandry, is best suited to it.

The wet and boggy troughs have, in many places, been drained by merely cutting through them into the rock below, where the water rises; and by this simple mode, they become dry, and consequently are much more valuable than they were before.

16. THE OXFORD, CLUNCH, OR FEN CLAY.

This formation is composed of a strong bluish clay, with septaria and beds of bituminous shale, some of them of considerable thickness; from which circumstance, inexperienced persons have been deceived into the idea that coal may be found there, and have been at considerable expense in searching for it. This clay is of a dark blue colour, but turns brown by exposure to the atmosphere, and becomes strong and adhesive. It forms the foundation of the hills which are capped by the coral rag; and, in some places, it rises into low round-headed knolls, at the foot of those of the coral rag. The extent

of this formation is considerable. From near Crewkerne, in Somersetshire, it passes east of Sherbourne, near Shaftsbury, to Mere; where it thins into a narrow strip in its course through Christian-Malford, Cricklade, Lechlade, Bampton, Oxford, Bicester, Fenny-Stratford, Newport-Pagnel, near Bedford, Kimbolton, to Sutton and Peterborough. It then disappears under the fen-land, but is found every where under the peat, at the distance of a few feet. At Bourn, it again comes to the surface, and continues its course to Folkingham, Heckington, Blankney, Lincoln, Market-Barsin, Carston, Brigg, and Barton, in Lincolnshire. Its greatest width is from Huntingdon to Thrapston, and from Lincoln to beyond Wragley. At these two places, it is not less than 15 miles wide; though the average width of the whole line may be from six to eight miles.

This formation is so close and impervious that no springs are found in it; yet the surface is wet, either from the rain or from the water that comes out of the coral rag above it, or from that which arises from the stone brash upon which it rests.

Agricultural Character.

The richest and most productive pastures are on the soil of this formation. It is a brownish clayey loam; the herbage is most luxuriant in Wilts, Gloucester, and Oxford shires, but in some places of Bedford, Huntingdon, and Northampton shires, and over portions of this formation, there is every shade of quality, from the rich pasture land of Christian-Malford and Dancy in Wilts, to a cold, stiff, wet, yellow clay—a thin, cold, hungry, clay soil, or soft vegetable mould—a tender, cold, loose clay, lying upon a wet yellow clay.

In Bedford and Northampton shires, it is a close, heavy, compact clay, and difficult to plough, except between wet and dry. The frost has a great effect on it, by reducing it to a fine powder; in wet weather, it is dirty; but extremely loose and dusty in spring, when dry. It is very deceptive in its appearance, and though it looks like a good loam, it is very thin and poor. The frost loosens the roots of the clover and wheat in spring, and the dry winds blow the plants out. The corn comes up luxurious, but looks yellow in May, if the season be wet. This land, under good culture, produces good crops of wheat, beans, oats, and clover.

This soil is not only difficult to work, but is perhaps the most expensive of all the clays to cultivate; particularly that portion of it which is found in Bedford, Huntingdon, and Northampton shires. It is sometimes covered with peat or black mould, as in the fens of Lincolnshire, where it forms a rich fund for improving the peat, which, by an admixture with this clay, becomes the most productive soil in the

kingdom. In the vale of North Wilts, the greater portion of this formation is in pasture; and produces the richest herbage for the extensive dairies in this district, where the rich North Wiltshire cheese is made. In Gloucester, Oxford, Buckingham, and the vale of Bedfordshire, this soil is chiefly in pasture; but in part of Bedford, Huntingdon, Northampton, and Lincoln shires, there is a considerable portion of it under the plough.

It produces, beans, wheat, oats, and clover. The poor pasture land on this clay is, in some places, so completely covered with ant-hills, that a person may walk across the whole field by stepping from one ant-hill to another.

On the surface, there are frequently beds of gravel formed of very small rounded gravel, sometimes agglutinated together with a calcareous cement; and where this is the case, the soil is more friable. The best means of improving this soil is to drain it perfectly, and then to deepen its surface by subsoil ploughing, to carry off the water from the surface to the furrow-drains, and to adopt the alternate system of cropping.

17. OOLITE FORMATION.

This formation is composed of various members; the shelly oolite, (which is sometimes called forest marble,) cornbrash, stonebrash, a bluish rubbly limestone, weatherstone or shelly limestone, and the great colite or Bath-stone. The nature of the materials of which these are formed, as well as the soil on the surface, is so nearly alike that we intend to take a view of the whole series under this head, from the Oxford clay, down to the lower colite. That portion of the series next to the Oxford clay is formed of various beds of a thin, colitic, shelly stone; frequently so thin, indeed, as to be used for covering houses and for paving stones. These beds are from one to three or four inches thick, very hard, and generally almost entirely composed of shells; they are of a brown colour externally, but when broken they appear internally of a dark colour.

Between these beds, there are partings of calcareous clay, sometimes of a much greater thickness than the beds themselves; but in other places, the partings are thin, and sometimes of a calcareous sand instead of calcareous clay. The members of the shelly oolite, next to the Bath-stone, are formed of beds of much greater thickness, being frequently two or three feet; and are excellent building stones, as they stand the weather: hence the name of weatherstone. Between this and the great oolite, there is a thick bed of clay in some places, as at Bath, in which the fuller's earth is found. The great oolite is formed of beds of considerable thick-

ness, with open partings between the beds, and also perpendicular partings, which generally pass through all the beds to the bottom of the formation. These openings are from an inch to a foot wide, and form a ready passage for the rain that falls on the surface; so that there are no springs in the great oolite, till it meets with a bed of clay.

This rock is composed of an oviform substance, like the roe of a fish, being a carbonate of lime. The shelly oolite has some clay and iron in its composition. Many of the members, particularly the great oolite, is much affected by the air, the rain, and frost, which tear it to pieces and reduce it to minute fragments.

The external aspect of the oolite district is a flat table land with a broken edge, presenting a high elevated terrace at its baset edge on the west. In some places, the shelly oolite is formed into small risings, and very shallow valleys, in which begin the rivulets that carry off the water to the clay valley.

From the baset edge of the great oolite, there is a gradual descent over the shelly oolite, to the valley formed by the Oxford clay.

This formation has a very extensive range from Crewkerne in Dorsetshire, to Bruton, Frome, and Bath, in Somersetshire; through Tetbury, and Cirencester, in Gloucestershire; Burford, and Woodstock, in Oxford; Buckingham, and Towcester, Olney, Thrapston, Arundle, and Stamford, in Northamptonshire; Corby, Sleaford, and Lincoln, where it thins out to a very narrow strip to the Humber, in Lincolnshire. It again appears at Pocklington in Yorkshire, and widens out from New Malton to Kerby, near to Stokesby, and from near Scarborough to Maugerpark, near Gisborough.

The width of this formation is about 10 miles from Sturminster to Yeovil in Dorsetshire; and over the whole course to Grantham, its breadth may average 14 miles, though in many places it is 20 miles broad; and in Yorkshire, from Kirby Moorside to Kerby near Stokesby, it is where widest 15 miles.

From the nature of the perpendicular and lateral open partings in the great oolite, there are no springs in it, except where the water is thrown out by the clay of the fuller's earth on the clay below; but from the numerous thin clay partings between the beds of the upper or shelly oolite, the surface is in many places wet, and, in some places, large springs appear, which form the beginnings of rivers, most of which flow to the east. The Thames takes its rise in this formation, near to Cirencester; and the Avon, near to Tetbury; which, after crossing the whole of the formation of the Oxford clay at Christian-Malford, returns across it in a deep opening of the formation at Bath.

Agricultural Character.

The nature of the soil on the solite formation varies with the nature of the rock. Where the cornbrash or forest marble exists, the soil partakes largely of clay, owing to the clay partings between the beds of rock. These clay partings give to the soil its nature and character; it is therefore a wet, tenacious, calcareous, argillaceous soil, with thin slaty fragments of the rock on which it rests intermixed with it. This soil is of a good quality when dry, not too strong for turnips, and in many places strong enough for beans; but there are instances where this clay abounds with loose petrified shells, and when this is the case, the soil is thin and of the most worthless kind, and forms a close, calcareous, adhesive clay, which, without any other mixture, produces nothing. On the great oolite or Bath stone, the soil is thin, loose, and dry; and formed of small fragments of the rock on which it rests. Part of it, being so decomposed as to form the earthy part of the soil; it is therefore stony and friable, and consists of calcareous matter, intermixed with a very little vegetable matter in a state of decomposition.

The soil is best when it is mixed largely with fragments of the formation; and when these do not occur in the soil, it is generally what the farmers call dead or sleepy sand, and forms a close, brownish soil, composed of very minute particles of a brown earth; which, when reduced to a fine powder, resists heavy rains, and forms a close impervious crust, agglutinated together by the rain, so that the water lies in the hollows or runs off without penetrating into the soil. The air is thus excluded, and vegetation ceases. The soil is of little or no value, although to look at, it has every appearance of a good quality, and of considerable depth, yet it is unproductive and worthless.

The soil over the whole series is chiefly arable, and produces wheat, barley, oats, turnips, and clover, and when stony, it is most productive of sainfoin. It is almost wholly enclosed with stone walls, and the fields are large.

The quantity of turnips, vetches, clover, and sainfoin, which is now produced on this soil, gives food to large flocks of sheep, which, by the enriching nature of their manure, have increased the productiveness of this district greatly beyond what it used to be, when few sheep were kept.

Where the clay of the fuller's earth is, and in other places in the upper members of this formation, the land is mostly in pasture. The soil on the shelly limestone or forest marble, when the beds are separated by partings of clay, is wet and adhesive, and difficult to drain; but, by cutting through many of these beds, we may cut off the source from which the

water arises. The water from this formation contains a large portion of carbonate of lime, and is excellent for water-meadows.

Inferior oolite, and calcareous ferruginous sand.

This is the lowest of the oolite formation, and rests on the blue lias. It presents a variety of external appearances, and varies much in the nature of the ingredients of which it is composed.

In the counties of Gloucester and Somerset, and in part of Dorsetshire, it is a brownish snuff-coloured sand, with mica, and forms the base of the hills topped by the great oolite; in other places, it forms a concrete of calcareous matter and petrified shells, with brownish earthy sand and mica. This substance is very soft when first quarried, but it hardens by exposure to the atmosphere. It it occasionally met with as a brownish or yellow rubbly oolite, composed of loose fragments of calcareous stone, with incrusted matter, surrounded by loose or gritty loam; it is also found as a reddish, loose, soft, calcareous sand, and sandstone highly ferruginous, with veins of iron, is irregularly disposed through it; and beds of soft ferruginous, micacious loam, alternate with indurated beds of sandstone, which is used for building.

The lower beds in Oxfordshire are of a greenish-coloured sand. Calcareous, micacious, silicious,

and ferruginous substances in various proportions, compose this formation. Where this formation is broadest, as in the counties of Oxford, Northampton, Rutland, and the north of Gloucestershire, it forms a chain of rounded, conical-shaped hills, overlooking the valley of the lias, and the table-land of the great oolite; and these hills are surrounded by deep valleys, which open into the blue lias below. The hills about Daventry are of considerable elevation, and form pleasing aud picturesque scenery.

The whole of the surface of this formation is very uneven.

Some trace of it is to be found under the great oolite throughout the whole of its length. From Bridport to Yeovil in Dorsetshire, it has a considerable breadth; but from this place to Cheltenham, it is sometimes so narrow as not to exceed 100 yards in breadth, while at other places it widens out to perhaps a mile or two. The principal body is from Cheltenham to Stamford, where it again thins out to a narrow strip, which continues through Lincolnshire to the Humber. Its width in Dorsetshire is about 7 miles; in Gloucestershire, from Stow to Winchcombe, it is about 12 miles; and this is about the average of its width through Oxford, Northampton, and Rutland shires, to Arbury. Near Daventry is the highest ground in this part of the kingdom. The water from Hellidon goes to Leamington, and is conveyed by the Avon to the Bristol Channel; from Sudbury Hill, by the Nen to Peterborough, and the German Ocean; and from the hill north-west to Chawellton, by the Charwell to the Thames. All these springs arise within one mile of each other in this formation. This, however, like the great oolite, is a dry and porous substance, so that the water sinks through it, and is thrown out by the beds of clay, or by the blue lias below.

Agricultural Character.

The soil on this formation varies much in its nature. It is calcareous, ferruginous, and micacious, and forms a soft sandy soil of a deep brownish colour, of a good depth; friable, yet having tenacity sufficient to adapt it to the production of every kind of crop.

The soil is composed of loose fragments of the stone brought up by the plough. The soil on the rubbly calcareous subsoil is stronger, and of a better quality than that which is on the soft micacious sand or gritstone; it is dry and healthy, and strong enough for beans and wheat. The red land contains most sand, and is best for turnips and barley.

The general good quality of the soil may be owing to its depth, as well as to the loose, open, porous nature both of the soil and subsoil, which

readily admits the roots of plants in search of moisture and nourishment, and drains off all superfluous water. The red soil, when combined with calcareous earth, is sufficiently retentive of moisture, and is fertile. The grey or black soil is more tenacious, less sandy, more calcareous, and produces better and more nutritious pasture than the red land. Most of this district is enclosed, and a great part of it, from Cheltenham to Stamford, is under arable culture; but there is a considerable portion of it in pasture on the side of the oolitic hills, and particularly when it is of a clayey nature.

18. BLUE LIAS.

This formation is composed of a blue clay of great thickness, having thin beds of argillaceous limestone, which bear this name. These beds alternate with beds of clay and marl, and are often so thin as not to be more than an inch in thickness; and the beds of lias limestone are seldom more than four or five inches thick.

At a distance, these alternate beds give a ribbandlike appearance to the strata, where they are exposed. The clay is of a strong stubborn nature, and sometimes calcareous; its colour is generally blue, but in some places, it is yellow or brown; it is very tenacious, and principally composed of clay and some calcareous matter.

This lias forms the valley at the bottom of the lower oolite; and, although it is sometimes found a considerable way up the side of the hills, topped by the lower oolite, yet it may be said to take the form of a low valley, the surface of which is undulated, but not hilly.

The extent of this formation is equal to that of the oolite, and is found at the bottom of the oolitic hills, in the whole of their course from Lynn Regis in Dorsetshire, to Whitby in Yorkshire.

Between Chard and Taunton, Somerton and Shipton Wallet in Somersetshire, there is a considerable extent of this blue lias; from thence it passes between Bath and Bristol to Wotton-under-Edge, in connected patches of greater or less breadth; from this place, it proceeds to Gloucester, Tewkesbury, Evesham, Shipston, Kineton, Southam, and Rugby in Warwickshire; to Lutterworth, Melton Mowbray, and Barrowby, in Leicestershire; to the east of Newark and Gainsborough, to Burton in Lincolnshire. On the other side of the Humber, it appears at Market Wighton, and continues its course to Porkington, Thirsk, Black Inn, Stokesley, Gisborough, and, after reaching the coast, comes round by Whitby to Robin Hood's bay.

The breadth of this formation over the whole of

its extent is various, as it follows up all the valleys in the lower oolite; its greatest breadth is the district extending from Shipston in Warwickshire to Melton Mowbray in Leicester, the average of which may be 14 or 16 miles.

This clay is an impervious body of several hundred feet in thickness; and, where the lias limestone is formed, the beds are thin and parallel, and closely joined together with thin close beds of clay between them. Although this may be said to be a damp wet soil, yet there are no springs found in it; the water is, therefore, only surface water, which from the level nature of the surface, does not run quickly off, as the water from the lower oolite runs over it, and keeps it wet for a considerable distance.

Agricultural Character.

The nature of the soil in the blue lias is mostly of a calcareous clay, intermixed with some minute particles of sand. It is very various; in some places, it is a poor cold tenacious clay soil; cold, sour, and unproductive strong wet clay; harsh, unproductive land, and difficult to convert into good permanent grass; but in other parts, where it has been long under good management, either as arable or pasture land, it bears the character of a strong clayey marl, of a retentive nature, but at the same time suffi-

ciently productive. On limestone, it becomes a rich clay loam, and affords very rich herbage in old pasture; it is very tenacious, and holds the rain as it falls. When the soil is of a good depth, it is friable and porous, and very fertile. At Melton Mowbray, it is a rich heavy loam. The whole of it is naturally adhesive, impervious, and damp; difficult to cultivate as arable land; and, as pasture, it is more or less productive, according to the quantity of dead or decaying vegetable matter which it contains. In some places, where it has been long pastured, and where a considerable portion of vegetable matter is mixed with the soil, it produces rich and nutritious pasture; and where it is under the plough, and properly cultivated, it produces great crops of wheat, beans, clover, and oats.

From the great expense which attends the culture of this soil as arable land, the greater portion of it is in pasture, and forms the dairy districts in Somerset, Gloucester, Warwick, and Leicester shires, where the finest cheese is made, and where great numbers of cattle and sheep are fattened.

The greatest improvement that can be effected in this soil, is to keep the surface perfectly dry, by carrying off the water as fast as it falls; and where the ridges are high, which is almost universally the case in this district, to have under ground drains in each furrow to let the water sink into the subsoil, artificially made porous, and be carried off under ground to the ditches.

19. NEW RED SANDSTONE, OR RED SAND.

This is a reddish sandstone, or clay marl, tolerably compact, but more frequently of a friable texture, or a conglomerate. The sandstone is silicious, and is frequently so indurated as to be fit for building, as at Wellington in Somersetshire, Warwick, Coventry, Nottingham, and many other places; but it is sometimes a loose red or yellow sandstone, too friable and soft to be of any use as a building stone.

The clay beds of this formation are generally marly, or clay of a red colour intermixed with blue, white, and green spots or stripes. These are frequently hardened into stone, and form a calcareous stone or limestone.

The chief varieties which this clay exhibits are a red argillaceous marl, a rocky loam or slaty marl, a reddish rock, and clay with spots or stripes of a whitish and greenish coloured matter, highly calcareous.

In Sherwood Forest, there are large masses of red and yellow sand belonging to this formation. The conglomerate is composed of beds of silicious pebbles, agglutinated with calcareous matter, and beds of rounded limestone pebbles, called popple-stones in Somersetshire, which are agglutinated by calcareous matter, and are frequently burned as lime. These beds are sometimes in successive repetitions: in other places, beds of silicious pebbles only exist; when this is the case, these rest on the indurated sandstone. The salt mines in Cheshire and Worcestershire are in this formation; and the water, in many places, is saltish.

This formation is composed of red clay, red marl, red sand, and silicious pebbles. The red clay and marl have a glossy appearance, and the latter has a soapy feel, which is peculiar to it.

The surface, which is much furrowed into hill and dale, forms a low uneven valley with a continued course of small risings, and exhibits a variety of beautiful undulations, consisting of little flats and gentle swells.

This is the most extensive formation to be found in England. It begins at Torbay in Devonshire, and passes through Exeter, Honiton, Collumpton, Wellington, Taunton, to Watchet and Bridgewater, in Somersetshire; then, in detached portions, to Gloucester, where it again widens out in its direction to Worcester, Birmingham, Nottingham, York, and Darlington, to the mouth of the Tees; it branches off from Birmingham to Stafford, Nantwich, Liverpool, Preston, Lancaster; and, narrowing round the coast to Allonby, where it is of con-

siderable extent, and forms a triangle with Longtown and Appleby. Its greatest breadth is from Loughborough in Leicestershire to Shrewsbury, a distance of about 80 miles; from Chester to Macclesfield, it is 35 miles wide; from Bridgenorth to beyond Coventry, it is 45 miles; from Weatherby through York, near Porkington, it is upwards of 30 miles; from Brampton, through Carlisle, to beyond Wigton, it is 20 miles; and the average of its breadth in Devon and Somerset shires may be about 10 or 12 miles.

Wherever this formation is sandy or friable, and porous, the rain water descends till it meets some of the clay, and is then thrown out. This district, although it may be said to be dry, has many springs in it, and in the centre of the kingdom, the Severn, Trent, Mersey, and their tributaries, rise in this formation.

Agricultural Character.

In Devon and Somerset shires, this is an unctuous friable clay or red marly soil, of the first quality. It is friable enough for turnips, yet sufficiently tenacious for beans and wheat, and produces the richest and most luxuriant crops of any soil in the kingdom; and the only manure that seems necessary is the application of lime, with which it produces increased

crops on every repetition. The effects of lime on the red marl, are much greater in Somerset and Devonshire, than in any other portion of the soil on this formation.

Whenever the red marl clay comes to the surface, it forms a rich red friable loam, highly fertile both as arable and meadow land; but on the porous red sandstone or loose sandy gravel, the soil is a light sandy gravel, or good sandy loam, productive of turnips and barley, but too light for beans. In other places, it is a soft light sand, and forms large sandy tracts in Nottingham and York shires, which are poor and barren, and produce scarcely any thing but heath and furze; there is, however, little of this poor soil, when compared with the great extent of rich productive soil on this formation.

The general character of the soil is a red rich friable clay; a marly loam, or a sandy loam, and these are found in every variety of colour and of texture, from a loose sandy soil to a strong red clay. The nature of the soil is clay, sand, calcareous matter, or marl, slippery and greasy when wet, and of a soapy feel when dry: if ploughed wet, it cuts up like soap, and does not push before the plough like the calcareous clay of the oolite formation. A large proportion of the soil on this formation is in arable cultivation, and is sufficiently productive under tolerable management. The meadows are rich, and

produce abundant crops of nutritious herbage; and the arable land is productive of every kind of crop that is adapted to the soil. There is over the main body of this formation, in detached portions, a considerable extent of the diluvial gravel before mentioned. This gravel is formed of rounded portions of the same rock with gravel and boulder stones, belonging to most of the primitive rocks. Whenever this soil is wet, the drainage of it is easily accomplished; and deep ploughing with a good dressing of lime, and, where it is of a strong clay, a summer fallow to get the land perfectly clean, may be necessary.

Sand, or soft loose vegetable matter, as a manure, is of use to keep it open; and when it is loose sand, clay marl would have the effect of making it more tenacious and firm.

20. MAGNESIAN LIMESTONE.

The magnesian limestone is found under the new red sandstone, and is believed to rest on the coal measures. It is a strong solid crystalline rock, of a grey, or buff colour, and of which large blocks of almost any dimensions may be raised. It is easily cut into ornamental architecture, and extensively used in building.

The beds are of various thickness, and generally

form a firm, solid, building stone; though not unfrequently it breaks into small pieces, and is used for making roads. Some of the beds are of a gritty silicious sandstone, intermixed with beds of silicious sand and small gravel.

The materials which compose this rock are, lime or calcareous matter, magnesia, silex or silicious sand, and gravel, with perhaps a portion of clay and iron. In Northumberland, some of the beds have an oolite form, with grains as large as sparrow eggs, sometimes much larger, and grouped together like chain-shot. It is also found cellular and crystalline. The aspect of this formation is rather plain and level; for although there are some risings and some valleys in it, yet there are no hills nor elevated ground of any magnitude. The extent of this is much less than any of the formations we have mentioned; it begins near Nottingham, and extends through Mansfield, Doncaster, Ferrybridge, Weatherby, Boroughbridge, Bedal, and Darlington, to Sunderland. average breadth of this range may be about 5 miles. The porous nature of the rock, and of the new red sandstone which rests on it, allows the water to descend till it meets with some beds of clay, or impervious matter, which throws it out in fine springs; but most of the soil on this formation is dry, except some in the most northern part of the district, where the rock is covered with a yellowish clay formed from the decomposed rock.

Agricultural Character.

From statements, which have been repeatedly copied, that magnesian lime is pernicious to the growth of vegetables, we would naturally expect the soil of this formation, if it partakes in the smallest degree of the nature of the substance of the rock, to be sterile and barren; this, however, is not the case, for although the soil is in general very thin on the magnesian lime, yet it is a good light soil for arable culture, and with manure produces good crops.

From Nottingham to Boroughbridge, the soil is profitably cultivated as arable land, and produces good turnips, potatoes, barley, and wheat; and when a good supply of manure can be had, abundant crops of these are obtained in moderately moist seasons. The soil is thin and generally dry, and the pasture, in general, is short, poor, sheep grass.

From near Sunderland to Sedgefield, the soil which covers the magnesian limestone is ocherous clay, producing poor crops of grass: but from Standrop to Darlington the soil is fertile, and may be considered the best and richest grazing land in the north.

The soil has fragments of the rock in it, has rather a reddish fawn colour, although the rock under it is whitish, and has very much the appearance of the soil on some of the soilte. The most of this soil is cultivated as arable land, and produces good crops of turnips and barley.

21. COAL FORMATION.

The strata forming the coal measures, are sandstone, millstone grit, micacious sand, and every variety of shale and argillaceous matter. These are in beds of various thickness, resting on, and alternating with, each other in every variety of succession; sometimes they are level, but more frequently they form a basin, which dips towards the centre: thus, the edges of all these strata have a tendency upwards, and as all kinds of shale, whether argillaceous, bituminous, or in the form of limestone, when exposed to the air, rain, and frost, are perishable; so when these strata come to the surface, they fall down and are converted into different kinds of clay or loam.

The surface of the coal formation, although uneven, is very seldom hilly; the ground has an undulated and smooth rounded aspect.

The coal fields are in separate and detached portions. There is the Northumberland, the Durham, the York, and Derbyshire coal fields in the north; the Lancashire, in the west; the Stafford, Leicester, and Warwickshire, in the centre; the Gloucester, the Somersetshire, and the Welsh coal fields, in the

south, including the counties of Monmouth, Glamorgan, Carmarthen, and Pembroke. The Northumberland, Durham, York, Derby, and South Wales coal fields, occupy a surface of nearly equal dimensions, averaging about 60 miles in length, by 15 miles in breadth, for each; the other fields are much smaller, and are also in several detached portions. The varied nature and the inclination of the strata, which form the coal measures, naturally tend to throw the superabundant moisture to the surface; which is thus kept in a moist or wet state, and it sends forth more springs than any other formation we have mentioned.

Agricultural Character.

The perishable nature of the strata of the coal formation, gives to the soil its matter and character. The soil inclines much to clay, owing to the perishable nature of the shale and argillaceous bind, when these members abound; but where the members are micacious or silicious sandstone, these produce a loose, soft, and wet sandy soil. In some places, where it is wet, it is of a clayey nature, although it seems sandy in its nature when dry; but the coal formation is almost universally covered with clay, and the soil is generally of a yellowish colour; and being wet, poor, and cold, it produces naturally a very bad herbage, principally composed of heath

and carnation grass. It is more fit for arable culture, than for pasture. Lime has a great effect on these soils, and when well cultivated, by its aid they produce good crops of oats, wheat, and clover. The clayey nature of the soil on the coal formation, as has already been observed, is owing to the perishable nature of the strata; the argillaceous beds of bind, clunch, shale, black or bituminous shale, decompose or fall down into clay, or strong loam; and when dry, these, with good culture, form a good productive soil; but when the clay is wet, with micacious or silicious sand in high situations, as in the north, the soil being soaked with water forms peat on the surface, becomes a moor, and produces heath.

In some places, however, the coal measure is covered with a reddish sandy clay, formed from the reddish sandstone or Pennanent stone, as in the Somerset and Gloucestershire coal field, which produces a good friable soil with fragments of the rock in it. In Durham, the soil is weak and wet, being a moist, soft loam, on yellow ocherous clay, and is called water shaken. The soil is very thin, the water is near the surface, and when the yellow clay, which is mostly composed of fine minute silicious clay, is turned up, nothing will grow.

On the central coal field, there is a strong clay loam, which is sufficiently productive; a white sandy

clay on bastard iron-stone, which forms a poor and barren soil; a white and yellow clay soil, on a yellow clay subsoil, which is poor and worthless. When the soil is friable and dry, it is mostly under arable culture; but there is a great part of it in poor pasture land, used as stock farms for rearing young beasts; if this soil, however, were well drained, it would greatly increase its value.

22. MILLSTONE GRIT.

The millstone grit is the lowest member of the coal formation. In the northern coal fields, it is sometimes found in thin beds in the form of a sandstone, fine in texture; that is, the grains of silex are small, with minute plates of mica; in other cases, the stone is of a coarse texture, made up of large grains of silicious sand of the size of mustard seed and even larger, agglutinated so closely together with an argillaceous cement as to resist the effects of the atmosphere, and to form one of the strongest and most durable stones for building.

The beds are from a few inches to several feet in thickness, and they are generally separated with partings or thin beds of bind or shale.

The constituent parts of this rock is silicious sand, cemented together with clay. Sometimes the cement easily gives way, and then it forms loose sand; but this is seldom the case; most of the beds are so solidly agglutinated together, and so exceedingly difficult to work, as to destroy the edge of the tools employed in quarrying, or in boring holes to split the rock with gunpowder.

The surface of this formation is hilly, and generally rises into high mountainous districts, which frequently present a precipitous front.

It is of great extent, and follows the course of the coal, and the mountain lime. From Alnwick, there is a narrow strip about three or four miles wide through Northumberland, to the west of Wolsingham in Durham; it then widens out to perhaps twenty miles, and continues its course to Bernard Castle, Scaleknowle, Middleham, Middlesmore, Paitly Bridge, Otley, Keighley, Halifax, and Holme; it then branches off on the west side of Panistone to Ughill, and west of Chesterfield, to Ashover; and from Holme on the west, to Kettles Hulme; and on the east of Macclesfield and Congleton, it approaches to near Cheadle.

There is another large portion of it in Lancashire, which begins at Pendleton hill near Clithero, and after taking its course down the river Ribble to Preston, it then proceeds through Bolland Forest to Ingleton. Its average breadth, from its commencement to its termination, may be equal to about ten miles.

The numerous beds of this formation, from their being frequently separated with bind or shale, have a wet surface, and send forth numerous springs.

Agricultural Character.

The high elevation of the whole of this formation, the wet state of the surface, and the sandy gravelly nature of the decomposing rock, give life and vigour to the aquatic plants, which are so productive of peat moss by their decay; hence, over the whole of this formation, there is a much greater extent of moss, either in large flats or on the tops and sides of the mountains, than is to be found on any other formation in England.

Almost through the whole of the length and breadth of this formation, peat moss is to be found; although in some places, where it has been drained and cultivated, it produces scanty crops of corn. It is a hungry, sandy, gravelly, or clayey soil; and where it is covered with peat moss, it has a natural tendency to produce heath.

The most of the soil in this district is in a state of nature, and forms extensive tracts of waste or heath. Some of them are called Forest, without having a single tree to entitle them to the name; there are, however, some portions near the towns and villages, which were originally in pasture, but are now under cultivation.

From the great elevation of the whole range, which forms a mountainous district, the climate is cold and bleak, and the harvest in general very late. When the peat is completely drained, it subsides, and in process of time the vegetable mould gradually decays, and the subsoil is very clayey or gritty. When this is mixed with the soil and well limed, it will, when laid down to grass, produce herbage for young oxen or horses, but the climate is too cold and elevated for arable culture.

23. Carboniferous, or Mountain Limestone.

This is a solid compact rock, formed of thick beds of limestone, inclined more or less to the horizon, and on which the millstone grit of the coal formation rests. There are seldom any partings of clay between these beds; they are generally open, although sometimes they are filled with rubble and calcareous spar.

There are also perpendicular rents or openings in the rock, which frequently forms caverns in its centre, and sometimes even subterraneous rivers and lakes of great extent. Between this rock and the millstone grit, there is frequently interposed the bituminous shale, which is a member of this formation. It is a black clayey substance, easily decomposed, and forms a blackish calcareous clay.

This formation contains petrified organic remains. It is frequently so close and solid in its texture, as to be used as a marble.

It effervesces with acids, and burns into quicklime. Its constituent parts are lime and carbonic acid; but some varieties have also silica, iron, and alumina. It is not so liable to be decomposed by the effects of the atmosphere as the other limestones we have mentioned, although the limestone shale is easily decomposed.

The surface of this formation extends to a considerable elevation, and presents, in many places, a craggy and rocky aspect, forming precipices, rocky valleys, and hills or mountains, which are generally studded with large blocks of stone on the surface; hence it has obtained the name of the mountain limestone.

This formation is of great extent. There is a narrow strip about thirty miles long and about a mile wide, from near Alnwick in Northumberland to Brigfield, where it extends to a great width, and continues through Durham to Brough in Westmoreland, a distance of about thirty-five miles in length, with an average breadth of about twenty-five miles.

From Brough, it continues by Stephen-Kirby to Sedbergh in Yorkshire, and by Norton, Settle, and Skipton, to Clitheroe in Lancashire, a distance of forty-five miles, with an average breadth of fifteen;

but across from Middleham in Yorkshire, to the Bay of Morcambe in Lancashire, it is forty miles broad at least. From Brough, there is a branch extending through Clifton in Westmoreland, by Heskett, Uldale, and Cockermouth, in Cumberland, to Middle-Town, on the coast, a distance of sixty miles; but the breadth of this range averages perhaps about five miles only. There is another large portion of this formation, which begins at Midhope in Yorkshire, and extends by Darwell, Chapel-in-le-Frith, Tideswell, Bakewell, Matlock, and Winksworth, to Ashbourne, in Derbyshire. The width of this portion, from Lech to Bakewell, is about twenty miles. There is another smaller field in North Wales, from Wrexham in Denbighshire, through Mold, and Holywell, to Llanasa, in Flintshire.

Besides these, there are several smaller fields in Gloucester, Somerset, Monmouth, Glamorgan, Brecon, and Carmarthen shires; but these, although of great length, are of little breadth, scarcely averaging two or three miles, except on the Mendip Hills in Somersetshire.

The cavernous nature of this rock, with its numerous fissures, and the porousness of its bcds, gives to the rain that falls on it a ready passage, till it meets the bituminous shale or clay, which throws it out at the bottom of the limestone hills, where the springs are larger than in any other formation.

Agricultural Character.

The soil on the mountain limestone formation is generally very thin, of a brownish or dark appearance, and composed of small angular fragments of the rock, with mould from decayed vegetables, and the detrition of the rock itself; it is, therefore, a dry, loose, friable, rubbly soil and very thin, from the nature of the rock, which resists the effects of the weather. There are extensive portions of this rock without any vegetable mould on its surface, and these present nothing but the bare rock, without the least vegetation. Other parts have a thin covering of mould, and produce naturally sweet, short pasture; but where the limestone shale is of considerable extent, as in Derbyshire, it decomposes so readily as to form a strong, deep, blackish, cold, wet, clay soil; which, however, when drained, well limed, and properly cultivated, produces good crops. The contrast between the pasture on this, and on the sandstone, is so great, as to be perceived at a considerable distance.

Most of the soil on this formation is in pasture; but in some places, as in Somerset, Gloucester, Derby, and Cumberland, where the soil is of a considerable depth, it is productive of good crops of wheat, barley, turnips, and grass. The high elevation and rocky nature of the carboniferous lime-

stone, give to this district a cold and bleak appearance; and, if it were not for the dry and porous nature of the rock, the harvest on it would be late, but this is not the case; indeed, when we take into account its elevation above the level of the sea, the harvest is earlier than we could expect.

24. THE OLD RED SANDSTONE.

This formation occupies the place under the mountain limestone, and above the grey wacke. Its internal structure is very like some of the members of the millstone grit. In Hereford and Monmouthshires, it is a sandstone composed of very minute particles of silicious sand and mica, of a reddish colour, and forms thin beds with partings of a reddish clay. Some of the beds are of a considerable thickness, and make good building stones; and being a micacious sandstone slate, are not only used for flags, but are also fit for millstones. Some are found agglutinated together by calcareous matter, but most of them are separated by partings of clay. The surface is uneven, and forms numerous risings of no great height; although, in some cases, it rises on the grey wacke to a very considerable elevation.

The greatest extent of it in England is in Here-

ford, Monmouth, Glamorgan, and Carmarthen shires, where it forms a sort of triangular figure.

Its length from Wenlock in Shropshire, through Tenbury, Leominster, Hereford, Old Castle, Crickhowell, nearly to Mishye Sydwill, is about sixty miles; and its greatest breadth from Newport, Abergavenny, Crickhowell, Brecon, nearly to Builth, is about forty-five miles; and across from the Malvern hills, through Broomyard and Leominster, to Pembridge, its breadth is twenty miles. This formation is of little extent in any other part of England, unless some of the millstone grit in the north be of this formation, and we do not think it is; but it is of great extent in Scotland, both in the south and north. When there are partings of clay between the beds of micacious sandstone, the water, that percolates through the sand above, is thrown out in the form of springs at the bottom of the hill; but generally speaking, this formation cannot be called wet, as there is a great portion of soft sandy subsoil, which allows the water to sink through to the formation below.

Agricultural Character.

Many of the members of this formation seem to fall rapidly into decay, and to form a loose, red, sandy soil; and when mixed with the clayey partings, it has a glossy, greasy, appearance, and is slippery when wet. Those parts, which are composed of coarse pebble stone, form, on decomposition, a sandy gravel full of small pebbles. The soft crumbling red stone, or dunstone, easily falls to pieces by exposure to the air and frost, and forms a good light red sandy soil; when mixed with the red marl or clay, it is of great fertility, from having such a portion of calcareous matter in it. The dunstone soil is excellent for the growth of hops, but the red clayey soil produces the heaviest crops of wheat.

Where the beds of the rock are thin, with partings of clay, the soil is of a clayey nature, red, sometimes grey in colour; and when resting on a broken or rubbly subsoil, it forms rather a strongish clay soil; which, under good culture, is capable of producing large crops of wheat, beans, oats and clover. The soil formed by the detrition of the puddingstone or gritty dunstone with sand, is of a loose gravelly nature; and, when there is a mixture of some of the partings of clay marl, it forms an excellent light soil for turnips and barley.

The open and loose nature of the subsoil affords an easy passage for the roots of trees; it is therefore perhaps the best fitted for the production of fruit trees, and hence the whole of the county of Hereford, and portions of the adjoining counties, are full of orchards of apple and pear trees, and these produce the finest cider and perry. The barley

and wheat, which this red soil produces, are of the finest quality. This soil meets the new red sand in Gloucester and Worcester shires, and is in many places very like it, not only in external appearance, but also in the nature of the materials of which it is composed.

There is a great portion of the soil on this formation in arable culture, and it yields large crops of barley, wheat, turnips, and clover; the pasture too forms an excellent herbage for stock, and the Hereford breed of oxen have a high character for feeding. Hops are also cultivated to a considerable extent in Hereford and Worcester shires on the red sand.

The warm and dry nature of the sandy soil on this formation, hastens the harvest even where the hills are of considerable elevation; and the Welsh mountains, which are near, and have a considerable effect in cooling the atmosphere around them, would retard the harvest; but as most of this formation is rather low and of a sandy nature, it may be said to have a good, dry, and early climate. Almost the whole of this formation is enclosed with hedges and ditches.

The principal means of improving the soil on this formation is complete drainage, and deepening the soil by deep or subsoil ploughing. This mode, with a dressing of lime, greatly increases its fertile

power, and makes it produce large crops of every kind of corn.

25. GREY WACKE AND CLAY SLATE.

As these two formations are so nearly alike in the materials of which they are composed, and also in the soil which rests on them, we have associated them under one head.

The internal structure of the grey wacke has a slaty texture generally, and much resembles the appearance of the clay slate, lying at every angle with the horizon, from level to perpendicular; and, although it appears to be closely joined together, yet water easily descends between the joints, and it is easily quarried, from the facility with which the rock is split in the direction of the lamina.

Clay slate is of a fine grained slaty structure, and composed of clay and iron.

Some varieties have carbon in their composition; that which passes into mica slate; or grey wacke slate, has mica in very thin plates.

The mica slate has small grains of quartz or felspar in its composition, besides the clay and mica. The grey wacke is composed of angular portions of quartz, felspar, mica, earthy angite, earthy felspar, and clay slate, cemented together by a base which partakes of the nature of clay slate. When the

embedded portions are very small, the rock is of a slaty structure, and gradually passes into mica slate or clay slate: but when the embedded portions are larger, the mass of rock or beds are thicker, and form good building stones. In some instances, it passes into a kind of pudding-stone or conglomerate, composed of angular portions of granite, clay stone, or prophyry, embedded in a base of clay stone. Both the clay slate and wacke are of a greenish, grey, bluish, reddish, or brownish colour, and some varieties are white.

The external aspect of both formations is much alike. They present an elevated series of hills grouped around, with lofty ridges, the summits of which are sometimes covered with broken craggy rocks; but they have generally smooth and rounded sides, with conical tops, and rise abruptly from deep valleys below. In many instances, in Somerset and Devon, these conical hills are so near each other, that the spaces between them exhibit deep chasms or gullies, which have obtained the local name of coombes.

The greatest extent of this formation is in Wales, which commences at Abergavenny in Monmouthshire, and terminates at St. David's head in Pembrokeshire; with a breadth from Ludlow in Shropshire to Aberystwith, and thus including two-thirds of the principality. In Somerset, Cornwall, and

Devon, it is of great extent, commencing near Bridgewater in Somersetshire, and continuing its course through Devon to Landsend in Cornwall, with very little or no interruption. There is also a small portion to be found in Westmoreland and Cumberland, which extends from near Penrith to Morcambe bay in length, and in breadth from Kirby-Lonsdale to Broughton.

The porous nature of the rock, the high elevation of the hills and mountains, and the deep ravines or valleys between them, give out a large quantity of water, which is formed into lakes of considerable extent, or carried away by numerous brooks and rivers.

Agricultural Character.

The soil on these formations is almost universally of a thin shelloty nature, and formed of loose fragments lying between the solid rock and the soil, which are every where embedded in a reddish or grey shivery kind of substance formed by the decomposition of these fragments, which composes the basis of the soil. The upper soil is only a further decomposition of these parts, with the decaying vegetable matter that has grown in it; the soil is therefore a loose, free, tender loam, formed of the small fragments of the rock.

When the lamina of the clay slate is nearly pa-

rallel with the horizon, the surface is more retentive of moisture: but when it is much inclined, the rain carries with it all the manure into the open rock, from which circumstance, it is then called a greedy or hungry soil. In the valleys or gullies, however, the decomposition seems to be more complete; and perhaps this is owing to the fragments being always kept in a damp state. It is formed into a brownish, whitish, or reddish clay; and the soil, which is the result of this decomposition, is cold and wet, and of little value. The moors have frequently this clay on the surface of the rock, and are of great extent in Wales; and in Somerset, Devon, Cornwall, Westmoreland, and Cumberland, they are also very extensive, but of little value. The high elevation and mountainous nature of this formation prevent its being brought into arable culture; it is therefore mostly in pasture.

In Somerset, Devon, and in some parts of Wales, however, it has been cultivated; and when the wet parts are drained, the surface pared, burned, and well limed, great crops of turnips and oats have been the result; and if enclosed, after being well pulverized and burned a second time, it were laid to permanent pasture, where the climate is good and the elevation not too high, it would pay a good interest for the expense incurred, and afford good pasture for sheep and young beasts.

26. Granitic Formation.

Granite is of a close, compact, crystalline structure, and said to be without beds or partings of any foreign substance; there are, however, numerous veins in it of quartz, felspar, and porphyry, but these are so intimately connected with it as to make along with it one solid substance; and this is said to be the case even for a great extent. The component parts of rocks of this class are felspar, quartz, and mica; in sienite, the mica is replaced by hornblende.

These several substances are always found in distinct, and in separate crystals intimately joined together without any agglutinating substance; and in the combination they vary greatly in proportional quantity, for sometimes the one and sometimes the other abounds.

The surface of this formation rises into high mountains, and is therefore mountainous and uneven.

They are not of great extent in England; in Wales, they take a high elevation; in Devonshire and Cornwall, however, they do not take so clevated a station, and are therefore brought more immediately under our observation, as being, perhaps, the only locality of this formation, the surface of which is cultivated.

At the bottom of the high hills, springs are to be found, but these are not of great magnitude.

Agricultural Character.

The soil of this formation is evidently of the decomposed rock. It is composed of gravel from the granite, and is called a light brown mould, a loose tender gravel, a light peaty earth on granite, or a granite gravel.

Some varieties of the granite are indestructible, whilst others, as in Cornwall, are speedily decomposed into gravel or sand. The felspar in Cornwall, from the potash which it contains, is decomposed by the influence of the atmosphere on the potash, into a white clay; and when it is mixed with the quartz of the granite, it forms a good soil, which when properly cultivated, and well manured with calcareous matter, sea shells, or lime, becomes most productive of wheat and barley.

The most productive, is that which has a large . portion of clay from the decomposition of felspar. On the granite rock in Devonshire and Cornwall, peat is found resting on a basis of granite gravel and clay; but this is of little value, and difficult to improve.

The soil of Dartmoor forest is of this character.

The elevated nature of this formation, where the humidity of the atmosphere is great, together with the thinness of the soil, will for ever prevent it from being ameliorated otherwise than by planting, which is the only way of turning it into a profitable property.

It would, however, tend much to improve the district around it, if these high mountains were covered with larch, a hardy tree and well suited for such an elevation.

27. BASALTIC ROCKS.

The internal structure of these rocks, being of igneous origin, is much alike, except those which take the columnar form. They have been forced from below through the old red sandstone principally, although some are found through the coal formation also. Basalt is unstratified, being a granular aggregate rock of angite and felspar, which varies from a coarse granular, to a compact, ferruginous, and amygdaloidal character. On the whole, it presents an irregular mass, unstratified and closely joined together, but having numerous, irregular, close joints, which continue in the same direction only for a few feet, where they terminate in the solid mass, and where others are found to begin, and to proceed in different directions.

These joints or backs seem to have no connection with each other, and the rock may therefore be said to be of a solid compact nature.

The materials of which these rocks are composed,

are at least the elements of quartz, hornblende, felspar, and angite. The clinkstone, trap, and greenstone, are of a greenish, blue, or black colour; and small grained, hard, and brittle. These are not so readily decomposed as the other varieties. The amygdaloid and claystone porphyry are easily decomposed, particularly the latter, which seems to be wholly felspar crystals embedded in a base of decomposing felspar. The amygdaloid is sometimes formed of a hard porous substance, like honeycomb, the base of which is angite and felspar intimately blended; and the cells or round cavities are sometimes empty, and sometimes filled with pebbles, agates, hornblende, zeolite, chalcedony, quartz, jasper, onyx, or calcareous spar.

When the matrix is easily decomposed, which is often the case, the pebbles fall out, and are found in the soil.

The surface of this formation takes the form of round topped hills of considerable elevation.

They are found over a great part of Scotland, but their extent is very limited in England; and only found in a few places in the counties of Cumberland, Northumberland, Derby, Caernarvon, Pembroke, Hereford, Gloucester, Devon, Cornwall, &c.

This formation having many joints in the mass, gives a ready passage to the rain water, but there are not many instances where the springs are of any

magnitude; although, where the surface is covered by the clay of their decomposition, the soil is frequently damp at the bottom of the hills where the springs arise.

Agricultural Character.

Most of the varieties of basalt are easily decomposed, from the iron and potash which they contain. The basaltic soil is composed of the elements of the variety of the rock upon which it rests; it is therefore either of a reddish, brownish, or greyish coloured cast, with fragments of the rock, Scotch pebbles, topaz, agate, and chalcedony mixed in it. It is friable, and, if well drained, may be easily kept, by manure and good culture, in a state, which would gradually increase its productiveness. It is, indeed, of considerable fertility, and under proper management, becomes a soil of great fruitfulness.

The greater part of this soil in Scotland is under arable culture, and produces, in Lothian and Fifeshire, the richest and most abundant crops. It is, however, of an extent so limited in England, that there is little of it cultivated, and, except in Northumberland, Derby, and Cornwall, the most of it is in hill pasture.

28. CLASSIFICATION OF SOILS.

It will be seen from the foregoing statements, how far we have succeeded in establishing an intimate connection between the soil and subsoil; how far the matter which composes the soil is identified with that which composes the subsoil, or geological formation on which it rests; and how far this connection may be useful in forming a classification which will be advantageous to the agriculturist.

A classification and arrangement of soils, which will identify their peculiar properties, shew the kind of crops they are best fitted to produce, and the mode of culture best calculated for each, is what we think will be most satisfactory and most advantageous to the agriculturist.

The advantage of such a classification will enable us at once to see what materials are superabundant, and what are deficient or altogether wanting, in a soil. This will direct us to the kind of materials, which, when applied, will produce the alteration of texture which, we think, will permanently improve the soil, and will also prevent us from employing those materials which would be injurious, by their tendency to increase the substances with which the soil already abounds; and we think it may also have the effect of directing the agriculturist to a more minute study of the nature and properties of the soil

he cultivates, and tend to prevent the error, which he may have fallen into, in adopting one system of culture for all kinds of soil.

We shall, therefore, associate together the soils on those formations, the nature and properties of whose materials are nearly alike; although they may differ in the proportion of the materials of which they are composed.

It will be seen that the materials of which the several formations are composed, namely, clay, lime, and silex, may with propriety be used as the distinguishing feature in any association of soils; and making use of these peculiarities, we shall associate the soils of those formations together, whose predominant minerals have a close alliance to any of these substances.

When we consider the nature of the materials of which the soils of the several associations are composed, we shall be led to adopt a mode of culture suited to each association—with due regard to every circumstance which may be peculiar to the soil and the situation. Thus, a mode of culture could be marked out for each association, and the means of permanently increasing the productiveness of each would also be shown.

29. Aluminous Soils.

The soils resting on the following formations may be associated together, whose superabounding mineral is clay or alumina, and the silicious matter in them, as well as the clay, is in an impalpable state.

- 1. The London clay, No. 8.
- 2. The plastic clay, No. 9.
- 3. The weald clay, No. 13.
- 4. The clay of the coal formation, No. 21.

There is little or no calcareous matter in the soils resting on these formations.

- 5. The blue lias, No. 18.
- 6. The gault, No. 12.

There is a considerable portion of calcareous matter in the soil of these, but less silicious matter than in the others.

The principal feature of the soils resting on these formations, is the minute division of the minerals that compose them, from which is formed a close, adhesive, and retentive soil.

When these soils are rich and well cultivated, they will produce large crops of wheat, beans, oats, and clover, and the richest and most feeding hay or pasture when in natural grass: but they are too close and retentive for the growth and consumption of turnips on the soil by stock, and are not, there-

fore, fit for turnip husbandry. When these soils are poor or badly cultivated, the produce is naturally very poor coarse grass; or when in tillage, oats is the only crop that will pay for cultivation, until the subsoil is perfectly drained, and their texture altered by the application of lime, sand, gravel, or burned clay, with long or unfermented farm-yard manure, to open up the soil and keep it porous.

30. CALCAREOUS SOILS.

In the soils of the following formations, lime is in excess; and there is in some of them a considerable portion of clay, but little or no silicious matter.

- 1. The lower chalk-marl, No. 10.
- 2. Some of the gault, No. 13.
- 3. The clay of the oolite, No. 17.

The soils resting on these formations are formed of impalpable matter.

- 4. The diluvium on the Oxford clay, No. 6.
- 5. The diluvium on the blue lias, No. 6.

These are calcareous gravelly soils.

- 6. The upper chalk, No. 10.
- 7. Some of the lower chalk, No. 10.
- 8. The shelly oolite, No. 17.
- 9. The great oolite, No. 17.

The soils on these formations are composed of

fragments of calcareous rock, with little or no silicious matter in their composition.

- 10. The coral rag, No. 15.
- 11. The lower oolite, No. 17.
- 12. The magnesian lime, No. 20.
- 13. The carboniferous lime, No. 23.

The soils on these formations are composed of fragments, and have a considerable portion of silicious matter in their composition.

The nature of the materials which compose these soils being calcareous, they bind closely together when ploughed wet, or if trampled upon in that state; particularly those of the lower chalk, the gault, and the clay of the oolite. These are unfit for the production of turnips to be consumed on the ground by stock, as the trampling greatly injures them when wet. All the other soils of this association are well calculated for the turnip system of husbandry, which greatly improves them; they are also well fitted for the growth of wheat, barley, oats, turnips, vetches, potatoes, clover, and sainfoin; and some of them that have a considerable depth of soil will, when well cultivated, produce good crops of beans. All these soils, except the shelly oolite, are easily drained, and if deep or subsoil-ploughed will be greatly improved.

31. Silicious Soils.

The superabounding mineral in the soil of the following formations is silex: in some of them, it is fine sand; in others, it appears as gravel. Clay is the other prevailing mineral, although in some, lime is also present.

- 1. The sand of the plastic clay, No. 9.
- 2. The iron sand, No. 14.
- 3. The sand of the coal formation, No. 21.
- 4. The millstone grit, No. 22.
- 5. The old red sand, No. 24.
- 6. The granite formation, No. 29.

The soils on these formations are composed of very friable, loose, dry sand, with very little aluminous, and no calcareous matter in their composition.

- 7. The diluvium on the plastic clay, No. 9.
- 8. The diluvium on the gault, No. 13.
- 9. The diluvium on the new red sand, No. 19.
- 10. The diluvium on the coal formation, No. 21.

These form gravelly strong soils, with a considerable portion of clay in their composition.

- 11. The grey wacke and clay slate, No. 25.
- 12. Some of the basalt, No. 27.

These soils are composed of fragments.

13. The alluvial, No. 5.

- 14. The green sand, No. 11.
- 15. The new red sand, No. 19.
- 16. The old red sand, or red marl of Hereford, No. 24.
- 17. Some of the basalt, No. 27.

All these soils have calcareous matter, with silex and clay in their composition, and are of the first quality.

The nature of the soils on the first six formations mentioned in this association is a silicious sand, dry and porous, without any lime in its composition. They are greatly improved by the application of lime, which not only gives a degree of tenacity to the soil, but also acts powerfully on the irony matter; rotten manure too is highly beneficial.

These soils, under proper culture, produce good crops of turnips, barley, vetches, and clover, and are well calculated for sheep consuming the produce on the ground.

32. All the soils on the diluvial formations, which are found resting on the plastic clay, gault, and clunch clay, the new red sand, the coal formation, and the old red sand, are composed of gravel of every size, from fine sand to large boulder stones, mixed with silicious clay. They are therefore strong tenacious soils, which bind together if ploughed or trampled on by cattle when in a wet state; and some of them are too strong for turnip husbandry,

but under good culture are productive of wheat, oats, and clover, and are permanently improved by the application of lime and loose vegetable matter.

- 33. The soil of the grey wacke and clay slate is of a tender nature, being composed entirely of fragments of the rock on which it rests. It is much improved by lime, which adds calcareous matter to the soil of which it is deficient. From the elevation of this formation, its soil is only fit for oats, barley, turnips, and grass.
- 34. The soil on the basaltic formation is of a rubbly nature, from the decomposition of the rock on which it rests, and lime has a powerful and beneficial effect on it. Under good culture, it produces large crops of wheat, barley, oats, turnips, vetches, and clover. Furrow draining and deep ploughing are necessary to keep this soil dry, and increase its productiveness more than any other expedient.
- 35. The soils on the alluvial, the green sand, the new red sand or red marl, the old red sand or red marl of Hereford, Gloucester, and Glamorgan shires, and on some of the basaltic formations, have a mixture of clay, silex, and lime, in every proportion. These form soils of the finest quality. They all have a somewhat gritty or rubbly texture, except the first two, sufficiently porous to let the water fall through them, and sufficiently adhesive to give a proper de-

gree of firmness for the production of every kind of crop in the greatest luxuriance. They are not too strong and adhesive for barley, turnips, and potatoes; nor too loose and friable for the production of wheat and beans. Lime acts powerfully on the soil of the new and old red sand; and on the basalt, it is believed to act on the iron contained in the soil, and produces increased crops on every application.

36. The Principles of Vegetable Life.

It is most desirable to trace the rudiments of the science of vegetable physiology, to explore the first source, and determine the principles of vegetable life.

Nature is universally simple and uniform in all her operations; there is no complexity in any of the causes which produce so wonderful effects.

We find, from analysis, that vegetable bodies are composed of the various substances of carbon, hydrogen, oxygen, &c.; and their growth and increase may be traced to the influence of rain-water, air, and the heat of the sun, which they decompose and appropriate by a secret operation, which is as yet but little known to man. When the rays of the sun fall on the leaves of plants, oxygen is given out, and hydrogen is absorbed, forming within the plant the carbonaceous matter of which plants are com-

posed. The materials of which the soil is composed only seem to afford the plant a proper supply of moisture to the roots for its nourishment. The matter of which each plant is composed is not to be attributed to the peculiarities of the soil in which it grows, but to that peculiar property which nature has given to each plant to produce its kind, in whatever sort of soil it may be planted; and so varied are the nature and colours of plants grown in the same soil, that we may see the yellow primrose, the blue violet, the white snow-drop, and the red rose, produced on the same soil where the carrot, the onion, the potatoe, the apple, the cherry, the wheat, the bean, and the oak and fir trees, are growing in the greatest perfection.

Vegetation cannot proceed without water, air, heat, and light; two of these without the other will not produce it in a healthy state. Water and heat, without light, may in some plants, in some stages of their growth, produce an unnatural kind of vegetation, but it is never brought to perfection without the presence also of light and air. Water, however, without heat, will not produce it, neither will heat without water, although, in both cases, air and light should be in abundance. In the absence, therefore, of any one of these agents, vegetation fails, so that, whatever may be the food of plants, these must be the principal ingredients. Accord-

ingly, a full and plentiful supply of them produces the most luxuriant growth of all plants, and, with a limited supply, a limited growth takes place. Thus, vegetation is most rapid in summer, when the earth is moist, or in warm weather after rain, and it is almost entirely at a stop during the winter season. With all the plants which the farmer cultivates abundance of any one of these principles without the others causes poverty and death. A superabundant supply of water, when it becomes stagnant, causes the death of all vegetables that are not aquatic, though there should be abundance of light, heat, and air.

The circulation of air and water through the soil and subsoil gives life and energy to the growth of plants. A porous subsoil draws off the redundant water from the soil as it falls on it, thus, not only displacing the stagnant air existing in the soil and subsoil, but drawing fresh air after it, as it passes through it.

Humboldt informs us that dry earth, when moistened, has the property of decomposing atmospheric air, and of conveying its oxygen to the roots of plants, which vegetate therein.

May we not therefore infer that the water, the air, and the influence of the sun, have much more to do in producing these effects, than the mineral matter which composes the soil in which they grow? We would not say that a plant takes up so much

flint from the soil, because the earth of flint or silex is one of the component parts of such a plant, no: it may be supplied from the water, or the air, which, with the influence of the sun, is carrying on a process which is only known from its effects. Plants breathe, says Ellis, that is, they give out oxygen, when the light of the sun is on them, retaining the hydrogen, and forming carbon for the increase of the plant; but when the light is absent, they receive oxygen, and hydrogen is given out. The leaves are so necessary to the healthy growth of plants, that, if they are injured or destroyed in the early part of their growth, the plant dies; and the free access of light to the leaves is also necessary, that they may, by the influence of the atmosphere, prepare the sap and return it through the whole of the plant to the root. In the leaves, the sap is combined with new principles, and prepared for increasing the organs of the plant. On the lower side of the leaf, the moisture and elements of the atmosphere necessary to vegetation are absorbed.

This flow of sap from the root to the leaves, and from the leaves through the whole plant, goes on till the plant is perfected, or till the winter checks its progress. In sunshine, carbon is received by growing plants from the air, and oxygen is given out, and this process is performed by the leaves; but in the dark, carbonic acid gas is thrown out

into the atmosphere, and oxygen is absorbed. The decomposition of water and carbonic acid gas is perpetually going on during vegetable life, and forming the organs and the materials of plants.

The sap, which flows from the roots to the leaves of plants, consists of various ingredients chemically combined with water. All matter that enters into the composition of plants, when in a state of growth, must have been volatilized or chemically combined with water or air, so as to be taken up from the soil or atmosphere. Vegetables growing in the sunshine decompose the carbonic acid of the atmosphere, which they absorb and form into part of their organized matter.

The sun, air, and moisture, give life, health, and vigour to vegetables; and electricity is also a powerfully aiding cause in promoting their vigorous growth.

No manure can be taken up by the roots of plants in its gross state. Animal and vegetable matter deposited in the soil is decomposed, and furnishes the elements of vegetable life; and the water in the soil as it were digests it, and forms a solution, which it conveys to the plant.

The sap taken up by the roots of all plants is a perfectly transparent liquid. We think, therefore, that water, air, light, and heat, are the original elements; the universal principles of vegetable life.

37. THE EFFECTS PRODUCED BY THE SUN AND AIR ON VEGETABLES.

THE progress of vegetation necessarily depends much on the state of the atmosphere. The heat and coldness, the dryness and humidity of the air, have certain effects on every soil, and on every plant, and either encourage or retard the progress of vegetation.

Heat, or the influence of the sun, is the principal agent of fermentation; and the best soil, even with the addition of animal and vegetable matter, would be unproductive without the vivifying rays of the sun, to produce fermentation amongst its parts. A rapid supply of fresh air or oxygen from the atmosphere is necessary for the continuance of fermentation, either in the earth, or in any other body. Black loam, ferruginous sand, and gravelly soils containing much carbonaceous and soft vegetable matter, are easily heated by the rays of the sun; and those that contain the greatest portion of vegetable and animal matter, if dry, retain the heat the longest. Chalks, being of a white colour, are, comparatively speaking, little affected by the rays of the sun; but, from being uniformly dry, they retain the heat much longer than a damp soil.

The sun makes very little impression on clays or damp retentive soils, because the heat is soon carried off by the evaporation of their moisture.

38. WATER.

WATER is composed of two elastic gases; namely, inflammable gas or hydrogen, and vital gas or oxygen, in the proportion of two volumes of hydrogen to one of oxygen. Water is the only vehicle by means of which plants receive nourishment from their roots; and every substance mixed with the soil as a manure must be dissolved, and form a chemical combination with water, before the organs of the roots can receive it.

It is therefore of the greatest importance to have at all times a proper supply of it, adhering by capillary attraction to the earthy materials which compose the soil; for that portion of water which is chemically combined with the soil, or which the soil has a stronger affinity for, cannot be taken up by the roots; and it is that portion only, which is adhering to it by cohesive attraction, which the roots receive, and which produce luxuriant and healthy vegetation: but water in too great abundance in the soil gets stagnant, checks vegetation, and destroys the roots of plants.

Water forms the principal part of the sap of

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plants; but its elements, being altered by principles received from the atmosphere through the leaves, constitute in combination with these, the materials of which the plant is composed.

39. AIR.

During the natural decay and decomposition of vegetable matter, the whole of its substance passes into a liquid or aerial state, and resumes its original elements, which are those of air and water.

Water, carbonic acid, oxygen, and azote or nitrogen, are the principal elements which compose the atmosphere. The air readily gives up its carbon to the leaves of plants, or to the soil, which has the greatest affinity for it.

The water existing in the atmosphere, as vapours, varies with the temperature, and its quantity is greatest when the weather is hottest; at 50 degrees, it constitutes about one-fiftieth of its volume, and almost one-seventyfifth of its weight; at 100 degrees, it constitutes about one-fourteenth of its volume, and one-twentyfirst of its weight.

The condensation of vapour, by a diminution of the temperature, is the cause of the formation of clouds, dew, mist, rain, snow, and hail.

40. VEGETABLES.

The analysis of organized vegetable matter gives mucilage, starch, sugar, albumen, gluten, and a small portion of various other substances. All these substances are composed of carbon, oxygen, and hydrogen, and some have azote in addition; and when these are reduced to their primitive elements, they are found to be the same, which compose water and air.

Vegetable and animal bodies, in a state of decomposition, give out carbon and hydrogen in great abundance.

41. NATURE AND PROPERTIES OF THE MINERALS WHICH COMPOSE DIFFERENT SOILS.

The cultivated part of the earth's surface is called soil, and is formed by the combination of two or more of the primitive earths, united with organic matter in a state of decay. The three principal primitive earths are silex or sand, alumina or clay, and lime. These are frequently in a state of minute division, forming impalpable matter; and they occur also in the form of sand, gravel and rubble. Some of these materials are capable of retaining moisture, and of preserving organic mat-

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ter from decay; while others hasten the decay of vegetable and animal matter, but possess little power to absorb and retain moisture.

42. SILEX.

WHEN silex is the principal ingredient of a soil, it is in the form of fine or coarse sand or gravel, with some of it reduced to an impalpable powder. The particles of silex, being hard and flinty, have no cohesion or attraction towards each other, but are rather of a repulsive character. The nature of this soil is porous and friable, and incapable of retaining moisture. Water, when poured on this soil, passes through it like a sieve to the subsoil; it also readily gives it up to the atmosphere by evaporation. It powerfully promotes the decomposition of vegetable and animal substances. Silex is generally combined with oxid of iron and clay, and forms a sandy or gravelly soil. Silicious sand, unmixed with clay or lime, is barren; and a sandy soil is that which contains at least seven-eighths of silicious matter. (Sir H. Davy.) When a sandy soil effervesces with acid, the sand is calcareous, which is better able to withstand the injurious effect of great droughts than a silicious sand.

The friable nature of sandy soils make them easily cultivated; and where they are mixed with

clay, lime, and vegetable matter, they are called loam. An excess of sand, is much less injurious than an excess of clay, in any soil.

43. ALUMINA.

CLAY is a tenacious, compact, adhesive substance; its particles are in minute divisions, and have a strong attraction for each other. It attracts moisture, combines with it, and retains it with the greatest obstinacy; and it retards the progress of decomposition in vegetable and animal matter.

Clay unmixed with silex, is barren and unfruitful. Silex, in an impalpable state, is generally combined with clay; and forms an unctuous, clammy, and adhesive clayey soil, of a white, yellow, gray, brown, or reddish colour.

Clay retains moisture, when poured on it, more obstinately than other earths.

A clayey soil is that which contains at least onesixth part of impalpable clayey matter. (Sir H. Davy.) When it is saturated with water it forms a plastic clay; the water combines chemically with it to a certain degree, and it gives up the remainder very slowly; and its parts are left in close contact, like a well tempered brick dried for the kiln.

44. LIME.

CALCAREOUS matter, forming a soil, is generally a carbonate of lime. It attracts moisture, and chemically combines with it. When burnt lime is slacked, it takes up one-fourth part of its weight of water, and is as dry and powdery as the finest flour; and when it is exposed to the atmosphere in this state, it soon absorbs the carbon which was expelled from it by burning, and becomes of the same nature as it was before it was burned,—namely, a carbonate of lime, but only finely divided. In its caustic state, it is a powerful decomposer of animal and vegetable matter; but when a carbonate, it preserves these substances from decay much longer than sands.

When the surface is of this substance, it is either in a fine impalpable state, as clay marl or chalk marl, forming a close calcareous clay; or in a hard rocky or rubbly shape, forming a dry, porous, friable, chalky gravel, or rubbly calcareous soil.

Soil that is formed of pure carbonate of lime is, like pure clay and silex, barren and unfruitful; but when mixed with sand and a little clay, it forms a calcareous loam. Soils, which have the most calcareous matter in them, are said to have the greatest affinity for carbon; we may infer, therefore, that such a soil will retain the carbonaceous matter it

receives from manures, longer than either sand or clay.

45. LOAM.

LOAM is a mixture of clay and sand, and sometimes lime, with vegetable and animal matter. This, formed by nature, is compounded of an infinite variety of proportions, giving all the diversity of texture found in soil.

Mould is that which contains the remains of putrified organic matter, which has grown and decayed on the surface. The richness of soils is in proportion to the quantity of the mould they contain, if in an actual state of decomposition, and in a properly constituted soil. The remains of this matter, after its dissolution, is a soft, light, black substance; the abundance of which is the cause of blackness in garden mould, which has been long in cultivation: the French have given to this substance the name of Humic acid.

46. The Properties and Use of Soil and Subsoil.

ALTHOUGH it has been shewn that there is an intimate connexion between the nature and properties of the soil, and those of the subsoil upon which it rests; yet we would wish it to be under-

stood, that the nature and quality of the materials of which the soil is composed, have not so much to do with its productiveness, as the mere mechanical mixture of its parts, by which it is brought into such a state of friability, as to enable it to retain moisture in dry seasons, and give off, by filtration, its redundant moisture during a continuance of wet weather. The soil only affords support to the roots of plants while they are growing, it does not in any way give nourishment to them. The most important elements of vegetation being water, air, light and heat, man without these, may spend his strength for nought; it is, therefore, necessary to get the soil in the best state for receiving, retaining, and transmitting just such a portion of them to the growing plants as, under the peculiar circumstances of soil and climate in which they grow, is best fitted for the kind of plants cultivated. The soil being, therefore, merely the reservoir of water, air, and heat, and of decomposing organic matter, it may be rendered either fertile or sterile by giving it the power of storing up and retaining these elements for use in a much greater quantity than before, or by abstracting from it, or depriving it of the power of receiving, retaining, and transmitting these to plants. Every operation which tends to give or to facilitate the free ingress and egress of water, air, light and heat to plants, and to the soil in which they grow, will facilitate

their growth. Organic matter in the soil should always be kept in an active state of decomposition, for it is only when in this state that it can do any good to growing vegetables. This is generally effected by frequently moving or cultivating the soil, and by keeping the land perfectly dry and porous, for if it be kept wet the vegetable matter will become antiseptic, and capable like peat of preserving vegetable and animal matter from putrifying.

47. SILICIOUS SANDY SOILS soon decompose the manure bestowed upon them, which is carried off by water and evaporation.

These are called hungry soils.

Soils on a dry porous subsoil, are more easily dried by evaporation, than when the subsoil is clay or marl.

A dry, light, sandy soil on a clay subsoil, is more productive than on a sandy, gravelly subsoil; and it also supplies the means of its permanent improvement, by mixing some of the subsoil with the soil.

48.—"The best constituted soil is that in which the earthy materials, the moisture, and manure are properly associated; and on which the decomposable vegetable or animal matter does not exceed one-fourth of the weight of the earthy constituents."

Putrefaction goes on very slowly in strong adhe-

sive clays; while in sand and gravel, the process is very rapid. In quick lime, it is more so than in sand; but carbonate of lime, or effete lime, retards the process of putrefaction more than sand or clay. All earths have an affinity for, or the power of, retaining the gas or effluvia from the fermentation of animal and vegetable matter, which takes place on or near their surface.

None of the primitive earths, when pure or unmixed with others, are capable of supporting vegetable life; they are neither convertible into the elements of plants, nor into any new substance, by any process naturally taking place in the soil. When they are component parts of the soil, they merely act as mechanical agents for the support of the plant, and prepare a bed in which the roots sink and extend themselves for the purpose of fixing their position; thus forming a natural laboratory, in which the decomposition of organic matter is carried on, and where it is reduced to its original elements for the reproducing of plants.

A soil that is formed of nearly equal parts of the three primitive earths, namely, sand, clay, and lime, with a mixture of decomposing vegetable and animal matter, imbibes moisture from, and gives it out to, the atmosphere, and has all the principles of fertility which give life and vigour to the plants that grow in it.

The properties of a good soil should be so friable and porous as to permit the roots of plants to strike freely in every direction in search of nourishment, and to allow the superfluous water readily to pass off through the subsoil, but to be sufficiently tenacious to retain moisture for the support of plants when in full vigour.

Fertile soils must be composed of silicious sand, clay, and calcareous matter. "The proportion," Kirwan says, "where rain to the depth of twenty-six inches falls per annum, is fifty-six per cent. of sand, fourteen of clay, and thirty of calcareous matter." But these proportions depend entirely on the climate, the situation, the nature of the subsoil, and other local circumstances. More silicious sand, is required in proportion as these circumstances tend to make the soil wet; and more clay, if they tend to make it dry.

The constituent parts of a fertile soil should bear a certain relative proportion to each other: but if any of these prevail or fall short to a certain degree, the soil becomes less productive.

The proper proportion of the primitive earths, to form a productive soil under these circumstances, may vary, from 50 to 70 per cent. of silicious matter; from 20 to 40 of clay or aluminous matter, and from 10 to 20 of calcareous matter.

According as the climate is moist, the soil should

be friable and porous; according as it is dry, the soil should be adhesive and retentive.

The most productive soil is that which is so constituted as to maintain such a degree of moisture in very dry, and in very wet seasons, as only to give a healthy supply of it to the plants. Such a soil gives to plants the means of fixing their roots sufficiently deep to support them during the period of their growth; and allows them to ramify in every direction in search of nourishment, where they may easily abstract the elements of vegetable life without being injured by a redundant or a deficient supply of moisture, during any period of their growth. A constant supply of air and water is necessary to make, and keep the soil, permanently productive; when the soil is easily made and kept friable, it will also have the power of absorbing, retaining, and decomposing the water, the air, and the organic matter, which may be in its composition, by insensible fermentation; and give up a constant supply of the results of this decomposition for the growth of plants, either at seed time, when they are merely vegetating,-in summer, when they are growing with the greatest luxuriance,-or in autumn, when they are ripening their seed for harvest.

49. The productive powers of nature.

The powers of nature to create vegetable produc-

tions appear never to diminish; the process goes on year after year with increasing energy, and brings forth an increase of vegetable matter, to be again decomposed and returned to the soil. This is the natural process, by which the decomposing vegetable matter, which we find in the soil, is formed; and there has been a continual succession of production, decay, and reproduction of vegetable matter going on, ever since nature first sprung into existence, producing vegetables which, when dead, are decomposed into the elements of which they were originally formed.

No loss is sustained by the decomposition of vegetable or animal matter in the soil; all is reduced to the first elements of plants, which give fresh energy to vegetation, by again entering into vegetable composition.

Thus, the process of the growth and decay of vegetable matter goes on in a continual succession, and the decay of one crop becomes the nourishment of the next.

When nature is left to herself, the accumulation of decomposing vegetable matter on the surface becomes great; and if the soil is not possessed of the property of hastening their decay, the vegetable matter is merely increased on the soil, without adding to its productive powers.

On a careful examination, we think, it will be

found that the production of vegetables never exhausts any soil: the yearly growth of grass with its decay, adds yearly to its productiveness, and even a plentiful crop of weeds, when allowed to decay on the land which produced them, has the same effect: and thus it is, that land, which has been worn out by cross cropping, is by slovenly farmers left for nature to improve.

It is believed by observers of nature, that plants do no injury to the soil while they are producing their stems and leaves, but that it is only when the blossom and the seed require nourishment that the plants exhaust the soil.

They do little or no injury to the soil unless they produce their seed, and they may be kept for years in a growing state, if they are not allowed to blossom. Experiments have shown us that the nourishment required for the perfecting of the seed is most injurious to the soil.

When the natural pasture is consumed by stock, it is converted into animal food for man: and the excrement of the stock being left on the soil forms a rich decomposing animal manure, which gives to the soil increased energy to reproduce an increase of vegetable food, for an additional quantity of stock.

Pasture land is full of vegetable fibre, from the surface down as low as the roots of plants descend. Some are the recent roots of grasses, others are those of every stage of decomposition. In arable land, scarcely any vegetable fibre is to be found: this circumstance should teach us, that to form a good pasture, we should fill the soil with vegetable fibre as a manure, where we convert arable into pasture land.

The very small proportion of vegetable matter, which is contained in the most productive arable soils, would almost seem to indicate, that their richness does not depend on the decomposing vegetable matter, but on something else; for if all the straw or refuse of the crops which the soil produced, was returned to it after it had passed through the stomach of some animal, this would scarcely be equal to one-third of the whole produce.

A judicious succession of crops, and a profitable consumption of the produce by sheep on the ground, return to the soil such a quantity of manure, as to give an additional means of increasing its productiveness.

"Water is necessary to the growth of plants. It is essential to the juices or extract of vegetable matter which they contain, and unless the soil, by means of commutation, be fitted to retain the quantity of water requisite to produce those juices, the addition of manure will be useless. Manure is ineffectual towards vegetation, until it becomes soluble in water; and it would even remain useless in a state of solution if it so absorbed the water as en-

tirely to exclude the air: for in that case the fibres or mouths of the plants would be unable to perform their functions, and they would soon drop off by decay." 179, Steward.

It is necessary that the animal and vegetable matter in the soil should have this decomposing disposition, and the soil have it in proportion to the proper admixture of the materials of which it is composed.

A certain degree of heat, the influence of the atmosphere, and water, are necessary to carry on the decomposition of animal and vegetable matter in the soil. The best constituted soil, therefore, has the power of imbibing, retaining, and giving up to plants, a proper degree of heat, air, and moisture. When the atmosphere is warm, moist, and sultry, vegetable life is in the greatest vigour; which would indicate these to be necessary to vegetable life, if not the very principles on which it depends.

Soil should not only have an affinity for the moisture of the amosphere, but it should also have the property of readily transmitting it to the vegetables which grow in it.

The soil, therefore, which is best adapted for retaining and transmitting, in all circumstances of wet and dry weather, the necessary quantity of moisture to growing plants, may be reckoned the best and most productive.

If we impart to any soil that which induces vegetation, we improve it and increase its productiveness; but if we in any way withdraw from it that which tends to produce vegetation, we injure it, and may make it sterile. Barrenness in soil is produced when the component parts of it are so firmly united, that air, water, and the influence of the sun, cannot enter into combination with it. When a soil is pure clay, it is sterile and worthless; and so is that which is pure sand. The former, resists effectually the enriching influence of the rains and dews, which merely fall on its surface, and either run off or lie there, without penetrating into it. The sun and wind also may beat on it and blow over it, but they can never penetrate its mass to awaken up the dormant energy that lies within; they only have the effect by their repeated attacks to dry and harden the surface, crack it into irregular portions, and more firmly to lock up any languid and dormant principles of vegetable life that may be within the The latter, is so porous and loose in its texture, that the rain and dews no sooner fall on it, than they pass through it rapidly like water through a sieve; the rays of the sun and the wind evaporate and dry up the last particles that remain, producing only a transitory effect on vegetation; and because they have no regular supply of moisture the plants soon wither and decay.

The energies of the soil are frequently held in bondage by some pernicious quality inherent in it, or imparted to it, which if neutralized or extracted, the soil would become productive.

When light, sandy, and vegetable soils are artificially made lighter, they possess little of the principles of vegetation. The mechanical disposition of a clayey soil is also deranged by improper treatment, such as trampling or ploughing it in wet weather; and although the soil has a full supply of animal and vegetable manure in it, yet the mechanical derangement so totally locks up all its energies, that the necessary fermentation is altogether stopped, and complete barrenness is the result.

This we have frequently observed to occur, from land being trampled by sheep in eating off turnips from strong clay soil during wet weather, in the early part of spring.

They convert the surface into a complete puddle, and when it becomes dry, the parts composing the soil are so thickly united together, that it is like bricks dried for the kiln, and is entirely unfit for the production of plants. It is evident that the causes of sterility in these soils are opposed to each other; each, therefore, will require a mode of treatment peculiar to its case. The light, sandy, and vegetable soils, that are too friable, must be artificially rendered more firm; and the too tenacious clay soils

must be made artificially friable and kept so, and be pulverized and mechanically altered before we can expect them to become productive. It is evident, if these two soils could be mixed together, the mixture, with a proper quantity of vegetable and animal manure, would make a good productive soil.

50. On the Means of Increasing the Fertility of Land.

The productiveness of any soil, we think, depends entirely on its natural or artificial capability of retaining or transmitting its moisture, the vehicle at least by which nourishment is conveyed to plants. This productive power may therefore not only be continued in its greatest vigour, but greatly increased by proper management. When we by any means give to the soil a permanently increased vegetative power, we also increase the yearly produce which it yields.

Some soils produce large crops often repeated without manure; five crops of corn and a fallow are the conditions entered in some leases in the neighbourhood of Wisbeach in Lincolnshire, while other land will produce nothing without great expense of culture and manure, nor will an excess of manure make such land permanently productive; but if we change its constituent parts by the addition of those

earthy materials of which it is deficient, so as to bring it nearer to the nature of those soils which we know to be fertile, then we shall permanently increase its productive powers.

Water being the vehicle by which nourishment is conveyed to plants, the soil, whose constituent parts are best adapted for retaining a sufficient supply and transmitting a proper portion in very dry weather to the plants growing in it, without holding it in injurious quantities in the time of very wet weather, is possessed of the principle of vegetation, and will be found to be of the most productive nature. Such a soil will give not only firmness to support the plants, but will facilitate the growth of their roots in search of moisture and nourishment to the greatest depth.

There is not an individual who cultivates a garden, and who exercises his judgment in its culture, but knows that the addition of clay gives cohesion to sandy or gravelly soils, and that sand and gravel when mixed with a clayey soil diminishes its tenacious property; and that these changes, thus effected, permanently increase the productive powers of both.

In our endeavour to improve barren soils, we should examine them in connection with fertile soils in their neighbourhood, on the same geological formation; and the difference of their constituent

parts may lead us to the means of their improvement. If the cause of sterility be owing to some defects in their composition, these defects should be supplied. An excess of silicious sand is improved by the application of clay, peat earth, or calcareous matter, cold well rotten manure, and rolling or trampling with sheep or other stock, to consolidate its texture.

When clay is in excess, it is remedied by the application of sand, chalk marl, or burned clay, light unfermented manures, and perfect pulverization, to make the soil friable. An excess of vegetable matter in a dormant state, as in peaty soils, is corrected by burning, by the application of clay, sand, calcareous matter, gravel, rubble, or any thing heavy, to give firmness to the soil. Lime not only destroys the injurious effects produced by sulphate of iron, which abounds in some soils, particularly in those of a peaty and silicious gravelly nature, but is said to convert the sulphate of iron into a manure. None of these applications, however, will have the desired effect, unless there be first a perfect subsoil drainage of all superfluous moisture, conjoined with a perfect tillage.

Stagnant water, in any soil, melts down the particles of matter which composes it, and joins them together in close contact; it prevents the air and water from circulating amongst the roots of the plants, and they therefore die. When a clayey soil has been thus closed together by stagnant water, it requires to be perfectly drained, and it can only be recovered by repeated ploughings and harrowings, together with the pulverizing influence of frost to bring it into a fit state for vegetation, and if it has been long under water, it acquires a pernicious quality, which can only be got quit of with great difficulty,—fallowing, and the application of lime, has a great effect in reviving it.

The first principles of agriculture, which are shewn by the best practice, are few; they may be stated to be these: - make and keep the land perfectly dry, and clean, or free from weeds; make and keep the soil, which is too adhesive or too loose, of such a friable nature, as will make it receive, retain, and transmit moisture, and thus fit it to produce the most luxuriant state of vegetation; restore to the soil, as a manure, in a state of decay, the greater part, if not the whole, of the produce after it has been consumed by sheep or other stock. Never manure any land till every weed is exterminated, for weeds grow most luxuriantly in the soil to which they are natural: if any of them are left, they will outgrow the plant you intend to cultivate, and take up the greatest quantity of the manure laid on the land.

The properties of the mineral matter of which

soils are composed, are very various, this variety depending on the nature of the subsoil, as we have elsewhere shewn; but as it is only where soils have the mineral ingredients in a certain proportion, that they are capable of imbibing moisture from the atmosphere, of holding the rain which falls on it, and transmitting it to plants as they require it. Of imbibing and retaining heat, and of readily decomposing vegetable matter, which makes up the most valuable soil. A knowledge of these particulars is of the greatest moment to the agriculturist; by it he will be able to improve the texture of the soil, by adding to it the mineral substance of which it is deficient, so as permanently to improve it.

To alter the nature and properties of the constituents of any soil, may be more expensive than to manure it; but the effect of the former will be lasting, while that of the latter is transitory; the one permanently improves the nature and quality of the soil, the other only imparts a temporary excitement to force a crop for a year or two.

The materials necessary for the permanent improvement of the soil are seldom far off, and the expense, though in some instances considerable, is soon repaid by the permanency of its increased fertility; the manure applied afterwards has a much greater effect, the expense of cultivation is greatly diminished, and the capital laid out is soon restored

by its yearly increased produce. By these alterations, we store the earth with hidden and inexhaustible treasures, which, invisible to the eye, put forth their strength, and give us the evidence of their presence by the effects produced on vegetation.

In the process of vegetation, nature supplies soil, water, light, and heat; but the matter composing the soil may not be in such a state as to receive, and transmit these in such quantities, as will produce a healthy vegetation.

Man may regulate the supply by cultivation, and by altering the texture of the soil.

When the materials of which the soil is composed are in proper proportion, the soil is most productive; when any one of the ingredients is in too great a proportion, the soil is unproductive.

Pure clay, silex, or lime, when alone, we have before stated, is barren; but if they are mixed together, having a due portion of water, the influence of the sun, and a proper admission of air, (which are the prime movers in vegetable life), a fermentation amongst the materials is created; and if vegetable and animal manure in a state of decomposition be combined with these, the soil, which was sterile when separate, will become productive when combined, and this mixture of materials and mechanical alteration will change the texture, and improve the quality of the soil.

Neither the clay, the silex, nor the lime is decomposed by this process; but the soil, composed of these materials in proper proportion, has the power of combining with, and decomposing the vegetable and animal matter, the water, and air which it contains, and produces results which afford the necessary food for the growth of plants.

When the particles of earth which compose the soil are separate from each other, or well pulverized, it holds the greatest quantity of free or available moisture, and readily transmits it to the plants which are growing in it; but when the particles of the earth are closely packed together, like new made bricks, it neither can receive moisture, nor will it give out that which it already possesses.

Good soils are naturally possessed of certain powers, with which, by the aid of husbandry, we can produce certain effects; on poor sterile soils, these powers may be conferred by artificially altering their texture.

When the fluid in the soil is so connected with the fluid in the plant, and gives out to it a constant and healthy supply, then we say the soil is in good condition.

Manure applied to the soil increases its vegetative powers, but the way in which it acts is not well understood. The processes of the small rootlets are so very minute, that no crude substance can pass through them; it can therefore only be taken up by them in the form of water or gas, and be absorbed by the leaves.

Well rotten manure gives an unctuous or cohesive property; but, when in a loose or strawy state, it gives a porousness or looseness to the soil.

All mineral manures, as lime, chalk, marl, sand, gravel, ditch mould, road scrapings, and other earthy matter, act on the soil merely as an alterative, by changing the constituents of the soil and improving its texture; and by giving it an increased power of imbibing and decomposing water, air, and organic matter.

The most abundant ingredients in soil are sand and clay, and as a mixture of the one with the other tends to improve both, nature has so ordered it that these are generally found in great abundance, near to each other.

In the plastic clay formation, extensive tracts of sandy soil are found lying upon the brick clay; the soil of which is greatly improved by lifting up the clay, and spreading it over the sand, at the rate of 100 cubic yards to the acre.

There is also a considerable extent of this formation covered with flinty gravel, mixed with clay and sand, with a thin covering of black mould or peat earth for its surface, which produces heath and furze. This lies near the clay, and the whole of this district may be greatly improved by trenching, or otherwise mixing the sand and gravel with the clay below. The most of this is near the chalk, and would be greatly improved by an admixture of 80 or 100 cubic yards of it per acre. Chalk or lime destroys the pernicious effects of the sulphate of iron in the gravelly soil, and makes the soil which was worthless so productive as to pay the whole of the expense in a year or two.

Soil that is chiefly composed of finely divided or impalpable matter, is greatly improved by the application of small stones, gravel, or coarse sand; as this prevents the soil from collapsing or consolidating during continual rain.

All alteratives should be put on the land in small quantities at a time, or if in large quantities, it should be when the land is in fallow; and these should be well mixed by repeated ploughings, or by Finlayson's harrow, which is an excellent implement for loosening and breaking the furrow slice. The best way of putting on small quantities of materials for altering the texture of the soil, is to make a mixture of them, with the manure you intend to apply to the field; and these ought to be well mixed by laying them loose together, turning them several times, and fermenting them in the mass. When this is properly done, it should be carted and spread on the soil when

in fallow, and be ploughed in and well mixed, so as to be completely incorporated with the soil.

51. Perfect Subsoil Drainage, and deep Ploughing.

EVERY variety of good soil has a naturally dry porous subsoil, being either a deep, friable, porous earth, sand, or gravel, or open rock; so that rain water will not rest on its surface, but readily pass through the stratum below.

The greatest injury which the land receives is from stagnant water on the surface, or between the soil and the subsoil.

Bad and worthless clay soil is generally that, which is saturated by stagnant water.

If water be allowed to remain on good land, it will soon convert it into bad or worthless soil; a retentive subsoil has generally a soft or clayey surface, and is universally a bad and unproductive soil.

When the subsoil is retentive, the rain finds its way through the cultivated portion of the surface to the subsoil, and passes on slips between them to the furrows, keeping the cultivated portions of the soil wet and unfit for vegetation; but if the subsoil be porous, either naturally or artificially, it then goes directly through the subsoil or porous passage to the drains that are formed to draw off the redundant water.

It is the constant practice of the most scientific gardeners, when about to pot any plants, to put some broken tiles or gravel in the bottom of the pots to drain off the superfluous moisture from the plants to the hole in the bottom of the flower pots; and when they use a strongish or clay soil, instead of passing the soil through a sieve as formerly was the custom, they now chop it into small pieces, and thus give to strongish clay soils an artificial porousness which they naturally do not possess.

On examining the roots of plants growing in pots with soil thus prepared, we find the crevices between the broken pieces of earth full of roots, because they have not only a more easy passage where the soil is friable, in consequence of the lumps keeping the earth loose and porous between them, but here the drainage is most rapid and complete.

Land is not perfectly drained which, during the wettest weather, has any spots on it which the water rests upon, and gets stagnant for a short period; the rain should have a free course to sink down through the subsoil below the roots of plants, and then run off by the furrow-drains to the open ditches.

Complete subsoil drainage of the retentive soils can only be effected by having a drain in every furrow, or about one or at most two perches apart; and then by subsoil ploughing across the drains, and making an artificial porous stratum under the cultivated surface, to within an inch or two of the stones in the drains, that the rain-water may fall through the surface and run in the subsoil to the drains. The effect produced on the crops of close retentive soils, after they have been perfectly drained and subsoil ploughed, is most astonishing.

The produce is so much increased that it will, in many instances, pay the expenses in a year or two; and wet soils, which seemed to be strong clay when wet, become friable and even light when completely subsoil-drained, are easily cultivated, and light enough for producing turnips to be fed off with sheep.

Perfect drainage and deep ploughing is the true principle of giving to the soil an increased fertility; by this means, the plants are enabled readily to push their roots farther and deeper in search of food, which they obtain of a more healthy kind, than when the soil is imperfectly drained and ploughed shallow. All tenacious clay soils should be trenched or subsoil-ploughed once in every course of crops, or when they are in fallow; this practice not only gives to the roots of plants a greater scope to go in search of food in dry weather, but also furnishes a depth of porous substratum under the soil to draw off the superabundant moisture during continued wet weather, and transmits moisture to the roots of plants in continual drought.

The utility of trenching or subsoil-ploughing these soils, particularly such as have retentive subsoils, must be evident; for if the soil on such a subsoil be well pulverized merely to the depth of the furrow slice, in continued wet weather it soon gets into a state unfit for vegetation; the water becomes stagnant, and all the soluble matter in the soil is either washed out, or locked up in the soil, from being so thoroughly soaked as to exclude the air; and when it again becomes dry, it is as hard and solid a mass as bricks ready for the kiln.

In either of these states, it is impossible for any plants to vegetate; the soil being at one time as soft and smooth as well tempered mortar, and at another, almost as dry and hard as a stone.

But when the soil is artificially deepened by deep ploughing, and the subsoil is also made porous to a much greater depth by the subsoilplough, the rain gradually sinks down to the whole depth of the porous substratum, and from thence to the furrow drains; and in time of great drought, the deep moved ground will hold, by capillary attraction, a much greater supply of moisture for the nourishment of plants; thus draining off the abundant water during heavy rains, and supplying the means for healthy vegetation at all times.

Complete or perfect drainage is the foundation of

all improvements in husbandry; it should therefore be the first step which we take in attempting to improve or ameliorate the soil.

Land wet from springs should be drained by deep drains, so as to tap the porous stratum which contains the water at the lowest level if possible. But much the greatest part of what is called wet land, is so from its retentive subsoil, and the retentive adhesive nature of the soil, which so obstinately retains the rain that falls on it; so that the drying process is effected very slowly, when compared with soil whose subsoil is either naturally or artificially porous. The working of such land is kept back, and is frequently not effected in proper time. Nature furnishes us with the principles which should direct all our operations in permanently improving soil, or in cultivating it.

As we have seen that the richest and most productive soil has always a subsoil pervious to water, which carries it off as it falls, by imbibing it or filtering it to a considerable depth below the active soil; so we ought artificially to make as complete a drainage of subsoils to produce the same effect, by having drains from one to two perches apart, and by deep or subsoil ploughing across these drains to draw off the water to them which falls on the surface, so that the whole of the active soil may be always kept so dry as to be fit for the purposes of vegetation.

These drains must be sufficiently near each other, to allow the redundant moisture to be speedily and effectually carried off, by the artificial passage made at the bottom of the moved subsoil.

The distance of these drains must be regulated by the nature of the subsoil; if this be very close and impervious, they should be only about one perch, but if it be to a certain degree pervious, they may be two perches apart.

Before we attempt perfectly to drain any land, we must first understand the principles of the system thoroughly; or we may only adopt certain general rules, without considering that the various kinds of subsoil will require particular modes to effect our object.

Mr. Smith of Deaneston first gave publicity to the mode of perfect drainage, and subsoil ploughing; he says, "The principle of the system is the providing of frequent opportunities for the water rising from below, or falling on the surface, to pass freely and completely off, and therefore the more appropriate appellation for it, seems to be, 'The frequent drain system.'"

The most perfect and permanent mode of underground draining is the following; make parallel drains from the highest to the lowest end of the field, the distance between each being regulated by the nature of the soil and subsoil, and, at the bottom of the field, at the distance of about $16\frac{1}{2}$ feet from

the ditch, there should be an underground main drain into which the parallel drains empty themselves. This main drain should be large enough to take all the water from the drains, even though the field be 20 acres in size, and convey it to the ditch, with which it is connected at its lower end. The principal reasons for having all the underground parallel drains to empty themselves into the main, and through that into the ditch, instead of each emptying itself into the ditch, are, that while in the latter case a hundred mouths would require to be kept open and clear of rubbish, in the former only one has to be attended to, and also, that during the summer months some of the parallel drains would become dry and allow the entrance of moles and rats which would soon stop them up, but that the quantity of water which always issues from a main drain would forbid their entrance, and, thus hinder them from injuring it or the others.

The best time to drain surface or rain water from land is from September to April. The mode of proceeding should be first to lay out the directions of all the drains, and mark out the position of the whole, both the parallel and the main drains. The digging of the main drain should then be commenced at the lowest end of the field, and it should be finished before any of the parallel drains are touched. When the uppermost end of the main is

at length arrived at, the lower end of the furthest of the parallel drains should be commenced, and the others should be completed one after another. The direction of the parallel drains should be from the top to the bottom of the field, and if there be high ridges they should be in the furrow; they may be from one to one and a half or two perches apart, varying according to the nature of the subsoil. The fall should be as uniform as possible, it may vary from one in six to one in thirty, and it should be greatest just where it joins the main drain. The depth of the parallel drains should be three feet, never less than 30 inches. Their width at top should be about 15 inches, but at bottom it must be regulated by the size of the soles for the draining tiles, and may vary from four to five inches. Their length may be from 250 to 300 yards, but if they cross springs of water it should never exceed 200. The mode which we have adopted is to begin by putting in the tiles at the top of the highest parallel drains, and the order in which each drain is completed is exactly the reverse of that in which they were commenced, only the main drain is finishing as the others are completing, (i. e.) after the first parallel is completed, the main is commenced to, and completed as far as the second, which being finished, the main is carried on to the third, and so on till the whole is finished. A sole is put in for

each tile, or rather the soles should be put close together and the draining tiles should rest on one-half of two soles, the middle of each tile being over the junction of two soles. The width of the soles should be about one inch greater than that of the tiles, so that it may project half an inch on either side. The bottom sole of the parallel drain, at its junction with the main, should rest upon the top of the main draining tile, and care should therefore be taken to make it sufficiently high for that purpose; a distance of an inch between the tiles of the main drain should be left at that place, so that the water from the parallel drains may fall into the main, and as each tile rests on two soles, this opening would be covered by the projection of the last tile in the parallel drain, and no entrance would thus be allowed to earth which would otherwise fall in.

The position of the main should be at the lowest part of the field to be drained, its dimensions will be regulated by the size of the field, and the amount of water it is expected to discharge. A fall of one in 200 is the least that can be advised, one in 140 or one in 100 would keep the bottom clear of sediment. A main drain for a field of 10 acres should have tiles of at least four by six inches in size, or if two tiles side by side be employed, they may each be about three inches by four. The soles for the former should be seven inches in width, and for the

latter five. The main drains should have double the capability of carrying off water that it is expected to require. The depth of the main should be greater than that of the parallel drains by the height of the tiles used in it, so that, as was before stated, the soles of the latter may run over those of the former, and allow the water they convey to drop through an opening made for the purpose. Two tiles and two soles abreast are more preferable for the main drain than a large one of each.

The parallel drains should be covered by cinders or turf, or by the best soil. When the last of these is used nothing but the very best vegetable mould should be employed; clay or tile ought never to be used for the purpose. Tiles are rather dearer than stones, but they are better when the land has a very slight declivity. If however the field has a considerable descent stones are preferable and more durable. They should be broken till they can be passed through a two inch ring, and should then be filled in to the depth of 12 inches. The course of the main drain should be directed to where it would be most convenient for watering the stock so as to supply two or four adjoining fields. A large cistern ought to be used for the purpose, as if the stock get access to the mouth of the drains they would soon stop them up by trampling on them.

52. On the best Means of Permanently Improving the Class of Clay Soils.

CLAY soils are distinguished by their adhesiveness. They stick to the feet when damp, they imbibe moisture slowly, but do not transmit it freely for the use of plants; and when strong clay soils are brought quickly from a wet to a dry state, they approach to the state of bricks previous to their being burned. Clay soils are tilled with difficulty when too dry, and when too wet this operation has the same effect as the tempering of clay has, in the art of brick-making.

The tillage of such land in a proper state is therefore of the greatest importance, and this is best performed when it is neither too wet nor too dry.

Poor thin clays upon a retentive subsoil are the most unprofitable; the expense of their cultivation, under the present system is great, being frequently equal to the value of the produce, and sometimes far above it. Their natural produce is coarse grass of very little value, fit only for young beasts.

Clay soils are best calculated for the production of plants that have fibrous roots, particularly wheat, beans, oats, vetches, clover, cabbage, grass, &c.

While the light sandy soils have been greatly im-

proved by the adoption of a new system of culture, the poor clays remain in the same state they were in a century ago, without any increase to their productiveness; indeed, they are rather in a worse state than formerly. It is therefore supposed by some agriculturists, that, as there have been no improvements in the clay soils, while there has been so great an increase in the productiveness of sandy soils, the clays are not susceptible of improvement with the least chance of a proper return.

There is no doubt but a better system could be adopted for the cultivation of strong clay soils, than that which is pursued in the common fields, and on the clays of Bedford, Huntingdon, and Cambridge; and in other counties, on the malm, gault, oak-tree, clunch, Oxford, and blue lias clays.

The course of cropping adopted in the common fields and on thin clay, is summer fallow if dunged, wheat, and then beans; or without dung, barley, then oats, then fallow again; and this is the same as it was 100 years ago.

The chief cause of thus neglecting the clay soils is the difficulty and expense of cultivating them, and of converting them into pasture, after having been long kept under this system of arable cultivation. It is difficult to convert such land into good pasture, but it has been overcome, and the best and most profitable results have followed.

There is a much greater difficulty in getting a poor, cold, clay farm let, than one consisting of a poor sandy soil. The capital and ability required for the former being not only much greater, and of a higher order; but the risk is also much more in cultivating the clay, than the sand; as the mode of improving the land and securing good crops on sandy soils by claying, is easy and certain, and the turnip and sheep husbandry cannot be adopted on clays.

Besides, the system of cultivating light sand or loamy soils has been so long established, and the Norfolk or four-field system has now become so much the beaten track, that it would be difficult for the farmers who have been brought up to it, to leave it off, although a better one were shown them.

The turnip, and sheep system, however, cannot be adopted on clay soils, till they are completely drained and subsoil-ploughed, and till sand or light and porous matter be added to alter their texture.

Some new impulse must be given to agricultural speculations, before the cold wet clay soils will ever attain that degree of improvement which they are capable of, and which has been effected in the sandy and peaty soils.

The landlords should encourage tenants with

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capital and talent, by letting farms at low rents under improving leases, similar to the building leases granted in great towns; and binding them, by certain covenants, to improve the land by complete subsoil drainage and the application of alteratives; and by a proper mode of culture, to convert a certain portion of the arable land into pasture, under a particular mode found to be the best and surest for effecting its amelioration. The best and most profitable mode for permanently improving land, is to intrust it to the care of an intelligent and industrious farmer, under the security of an improving lease.

Perhaps Lord Kames's mode of letting land for this object is the best, with additional covenants binding the tenant to improve, by altering the texture of such soils as would be improved by it. It ought ever to be kept in mind, that the only true and systematic stimulus to improvement of any kind, is the certainty of profit in the outlay of capital. This is the main spring to all our exertions; without the certainty of occupying his improvements for such a length of time as will enable him to reap the advantage of his outlay, we may be assured that no man will either invest his own capital, or be inclined to borrow money, to be laid out in the improvement of another man's estate.

There is no doubt, however, but thin clay soils

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could be easily improved, and, perhaps, in a much greater degree than the sandy soils have been, during the last 40 years; and their surface may yet be seen clothed with a rich herbage, which shall vie with that of the other soils in producing the best cheese, beef, and mutton.

Clay soils will produce pasture, just in proportion to the quantity of decaying active vegetable matter in their composition. If this be abundant, the crop will be rich and luxuriant; and the decaying fibrous roots will form a dry, porous soil, giving a sufficient depth for the rain to sink through the subsoil, where it will run off by the furrow drains. If there be little vegetable matter in the soil, the moisture will make the earthy matter in it collapse and adhere together; and it will form a cold, wet, sterile clay, producing only carnation grass or nothing else of any value.

Pasture on clay soils should never be converted into arable culture, unless the application of skill and capital will not only repay the additional expense of the culture, but also tend to increase the permanent productiveness of the soil. Without a proper application of skill, capital, and industry on such land, the converting of it into arable culture will only tend to diminish the produce, if the free produce under the artificial culture fall short of that which nature itself afforded.

Much may be learned from the practice of market gardeners, in the neighbourhood of London and elsewhere. They have two methods of trenching their land. When the soil and subsoil are good to a great depth, they turn the surface under, and fetch up a fresh spit from below, to constitute the surface for so many years; but when the subsoil is poor or strong clay, they bastard-trench it, as they call it; that is, they throw the surface spit forward, always keeping it uppermost, and dig the subsoil by turning it over in the trench, without moving it from its place.

Their object in thus trenching their clay soils is to get depth for the rain water to descend, to give a greater depth of moisture to the roots of plants in dry weather, and for the superabundant moisture in wet weather to descend below the roots of plants, and run off to the drain.

If we perfectly drain thin clay soil by furrow draining, and deepen the subsoil by trenching with the spade or the subsoil plough, making it pervious to the moisture which falls on it, that it may immediately sink to a depth below the reach of the roots of the plants, the cultivated surface will be dry; and if we reduce the tenacity of the soil by applying to it those light or sandy substances, which, when well incorporated with it, will make and keep the soil permanently porous and friable, then the land

which before produced only a poor crop of carnation grass, or if arable, of oats, will now produce an abundant crop of wheat, beans, oats, clover, and even turnips; and if properly laid down, and full of manure, will form a rich pasturage for any kind of stock.

When clay soils have dry pervious subsoils, they become darker in colour from the repeated application of manures, and under a proper system of cultivation they lose their adhesiveness, and become a loamy soil, producing the most fruitful crops of wheat, beans, clover, vetches, cabbage, and the best and richest herbage for dairy cows. The milk from cows fed on such pasture produces more cheese and butter than the milk from cows fed on a sandy soil, and is also of a better quality.

Any thing which will produce permanent friability in clay soils, such as sand, lime, burnt clay, loose light vegetable matter, or long unfermented manure, will alter its texture and improve its quality.

When tenacious soils are completely subsoildrained, and a system of deep or subsoil-ploughing is adopted every time when the land is in summer fallow, if the soil be deepened and the subsoil made more porous, and if never ploughed when too wet, and a full portion of vegetable manure be given to the soil, and well mixed with it, a mechanical effect will be produced, which will change the nature and texture of the soil, and give to it that friability

which is so essential in all productive soils. The rain that falls on it will now percolate through it to the depth of the new formed subsoil, and thence to the furrow drains.

The soil now receives the circulation of the air, which is carried on by the rains filling up the interstices which the air previously occupied, and the complete drainage draws off all the superabundant water as it falls. By this operation, the earth again receives a fresh supply of air from the atmosphere, which promotes a chemical as well as mechanical action in the soil, and hastens the decomposition of the air and water, as well as the vegetable and animal manure it contains, and thus a liberal supply of the nourishment necessary for the growth of plants is obtained.

Soil that is principally composed of calcareous matter, in minute divisions, becomes a most tenacious stubborn soil; and, under certain circumstances, as sterile as the most worthless clay. Calcareous matter, therefore, although reckoned a valuable constituent in a soil, becomes an evil when it composes the greater part of it.

Calcareous clay when thoroughly dried, falls to pieces like burnt lime, whenever it is again wetted. Every poor clay soil may be much improved by paring and burning the surface, after it has been completely drained.

This is the first step that ought to be taken

towards ameliorating such a soil, and the more clayey the soil is, the deeper ought the soil to be burnt. When the burnt surface is mixed with the soil to the depth of the furrow, it acts as a coarse sand, and makes it more friable and porous, by converting the matter, which was before damp and adhesive, into a dry, friable, warm soil, permanently improved, and capable of producing luxuriant crops of every kind.

If we can get depth and friability to the subsoil of strong adhesive clay, we thereby prevent stagnant water from injuring the roots, and give to the plants the liberty of sending these roots to a greater depth in search of nourishment.

In all rich soils, there is vegetable matter in every state of decay, and the greater this portion of decaying vegetable matter is in strong clay soils, the greater is its productive powers. Besides this, decomposing vegetable matter will tend to keep strong clay land loose, friable, and porous.

53. Improvement of the Class of Silicious or Sandy Soils.

Sandy and gravelly soils are distinguished by the hardness of their parts, however minutely they may be divided, and by their friability, and the want of adhesion, which is a characteristic of all sandy soils.

They do not stick to the feet even in wet weather. Gravelly soils may be termed coarse sand. All sandy and gravelly soils are termed hungry soils; that is, manure is decomposed and gone much sooner in them than in tenacious soils; and rain readily sinks through a sandy or gravelly soil, and soon leaves it parched and thirsty as before; but plants grow most luxuriantly in such soils in the time of wet warm weather, although they are soon burnt up in the time of continued drought. Deep sandy or silty soils, however, when there is water in the subsoil within two or three feet of the surface, are less affected by long drought than strong clays in the like situation.

This is owing to the capillary attraction of the minute parts of the silt or sand which compose the subsoil. Sandy soils are best fitted for garden ground and spade culture; hence, such a soil is generally chosen for this purpose, although at a distance from the place where the produce is to be consumed. At Sandy near Biggleswade in Bedfordshire, and at Evesham in Worcestershire, there is a large extent of ground under garden culture to raise vegetables for the London and Birmingham markets. They are much earlier and better fitted for the growth of garden vegetables, peas, carrots, turnips, potatoes, barley, and rye, than clays; and although a deep sandy loam is not the most productive, yet

it is generally the most profitable, as the crops never fail on it, and the expense of its culture is much less than that of the clays. It is also more accessible to rains, and the vegetable and other manures applied to it are much sooner decomposed, and the effects produced are much more evident than on adhesive clays. The greatest improvement that can be made in a sandy soil is by the application of clay, calcareous matter, or cold tenacious manures. These tend to alter its texture and improve its quality, by giving to it a greater degree of tenacity, which enables it to retain moisture longer for the use of plants.

The sandy soils of Norfolk and Suffolk have been greatly improved by the application of clay, chalk, or clay marl, which is found under the surface. From 50 to 80 loads of 36 cubic feet per acre, but generally 100 cubic yards per acre, are wheeled regularly over the ground from a spot in or near the field, at the expense of sixpence per cubic yard or fifty shillings per acre.

In Hampshire and Berks, the sandy and reddish gravelly soil of the plastic clay is greatly improved by the application of chalk, which is got by sinking through the gravel to it, and lifting it up by a windlass. 2880 bushels per acre are applied with great advantage at the expense of 42s.

Deep ploughing, moving the subsoil so as to mix

with it some of the soil, and tenacious matter put on the surface to alter its texture, have a most wonderful effect of retaining the moisture, and of making the soil much more productive. Even deep ploughing the poorest sand is greatly beneficial, without the addition of any tenacious matter.

When a sandy soil is ploughed, or is otherwise pulverized, it should soon afterwards be either rolled, or trampled by sheep, &c. to render it firm, and to give it, by mechanical means, that degree of closeness which is necessary, when we cannot give it a due degree of adhesiveness by the addition of clay.

54. IMPROVEMENT OF PEAT OR FEN SOILS.

PEATY soil is composed of an excess of vegetable matter in a sponge-like state, holding an excess of water, which is the chief cause of its growth. It is therefore incapable of improvement, till it is deprived by thorough draining of the water it thus holds like a sponge.

There is a large portion of iron and tannin in its composition, which must also be got rid of: it is generally, however, but of little value for arable culture, till the texture of it be altered by the application of clay, silt, gravel, lime, or any other heavy tenacious substance, which gives a firmness and a body to it.

Black peaty soil is never profitably employed as pasture, as sheep do not thrive well on it. The milk of cows pastured thereon is thin and watery; hence, a good dairy cannot be found on this soil. In breeding them, there is great risk; and stock brought from other soils do not feed well; it is therefore much better adapted for arable culture.

The continual ploughing and fallowing too of this black mould or fen land produces a minute division of the roots of couch, which so abounds in the soil, that the land is stocked with plants for the next course, unless the season be so dry that they can be all picked out of the ground; but this is a very difficult task, for, from the softness of the soil, the horses' feet send down, below the reach of the plough, a portion of the couch at every footstep; so that fen land, in its natural state, without being hardened by the application of clay, defies the utmost exertion of the most industrious farmer to get quit of the weeds. Nothing will enable the farmer to destroy the weeds, the couch, the hariff and the chickweed, and many others, so well as a constant system of claying, once in six or eight years at farthest.

In the extensive fens in Lincolnshire, the black mould lies on clay or silt; and, in some instances, within one or two feet of it.

As an alterative, this clay is lifted up and spread

over the soil; and, when well incorporated with the black peat earth, it forms a most productive soil, and yields the most luxuriant crops of oats, wheat, cole, and turnips. The best and most profitable mode of cultivating black peaty or fen land, is first, by a fallow, to get it perfectly clear for cole or turnips. This crop ought to be consumed on the ground by sheep, in the early part of the winter; and in January or February at farthest, the surface should have a covering of clay.

When this is dry enough, it should be ploughed and sown with oats; then, with wheat as a crop for the following year; with clover for the fourth crop, which may be made to hay or cut green for horses, and after being well dunged and sown to wheat for the fifth crop, then fallow for cole or turnips succeeds and then clayed as before. Thus, by claying once in every course, it is calculated to produce one, if not two quarters of corn more, per annum, than without it. The average produce, under this mode of culture, is equal to eight quarters of oats, and four and a half of wheat.

Mr. Wingate's plan is perhaps more profitable than the above. He fallows for cole or turnips after the land has been well cleaned and dunged, and this crop is eat off with sheep on the ground.

It is then clayed and sown to oats, after which is a crop of wheat for the third year, the whole of the straw is consumed by oxen, with a portion of oil cake along with it, which gives a great degree of richness to the manure. The land is clayed every second course, or once in six years. The crops on this part of the east fen are equal, on an average, to 70 bushels of oats, and 40 of wheat. This system has been used for many years; the soil has lost its blackness, is now of a greyish colour, and has become a fine, friable, deep loam.

55. Improvement by Paring and Burning the Surface.

It is said that the plan of paring and burning the surface injures land which is not calcareous, and that it increases the fertility of calcareous soils. We have not seen any injury arising from this practice, but on the contrary have witnessed great advantages from it in every kind of soil.

It destroys all the roots and seeds of noxious plants, and kills the slugs and all other insects, with their eggs, that are amongst the turf.

It is said, however, that burning disengages the carbon in the soil, and that it flies off into the atmosphere; but we think from its heavy nature, that it is more likely to fall to the earth, and again incorporate with the new soil.

The ashes of burnt soil are said to be best, when

they are blackest; black ashes are produced by slow combustion; and red ashes, by a strong fire. The burnt surface, when mixed with the soil, makes it work more easily, renders it more friable, and less tenacious; and tends to make strong, thin, sterile, clay soils less tenacious, and more productive. The vegetable matter, which was burned, is quickly converted into an enriching property, which in some soils may lie dormant for ages. Wherever there is an excess of inert vegetable matter, the destruction of it by fire is most beneficial; the ashes, being mixed with the soil, produce large crops on land which before was unproductive; burning, therefore, destroys the inert vegetable matter, and converts it into a valuable manure. It is a good practice to give newly burnt land a dressing of lime when there is no calcareous matter in the soil, as the farmers do in Somerset and Devon, when they convert waste land into tillage; they plow the lime in with the ashes, and sow the land to turnips.

"An analysis of 200 grains of ashes, by Sir H. Davy from a calcareous soil in Kent, produced the following result.

e			per acre in lbs.
Carbonate of lime	80	•	. 69160
Sulphate of lime	11		. 9509.5
Charcoal	9		. 7780.5
Saline matter say			
Sulphate of potash	3		2593.5
Oxid of iron	15		. 12967.5
The remainder wa	as finel	ly divided	
Alumina and silica	82	•	. 70889
	200	-	172900 lbs.

or 79 tons 8 cwt. and 44 lbs. per acre." (Boys)

56. Improvement of Worn-out Land.

The cheapest and most efficacious mode of restoring and improving land that is worn out by any mode of culture, under which it has been for any length of time, is that of pasturing it for several years with sheep.

If the sheep be folded over the ground with no more food at a time than they can consume in one day, they will, by a daily change to a new portion of pasture, be of the utmost benefit to the land. Thus, a regular system of consuming the pasture by sheep as well as by manuring, continued for several years, cannot fail to improve any soil, and it is applicable to every soil that does not rot sheep. This is also the most profitable and economical way of consuming the grass on every kind of land.

57. THE USE OF FALLOWING.

Sir H. Davy says, "that summer fallow, by repeated exposure of the soil to the air without a crop injures the soil." It is evident that if land were always kept in a proper state of culture, it would never require to be fallowed to clean it. Against weeds of every kind, there should be a constant warfare; none should be allowed in the field to come the length of blossoming, not even in the hedge rows or by the road sides should this be permitted. If cut before they blossom and put into a stagnant pool, they would furnish a rich fund for manure.

The object of summer fallowing land may be, either to clean it from annual and perennial weeds, to give it rest when it has been worn out by over cropping, and to expose its parts repeatedly to the influence of the sun and air; or, to alter the nature of its constituent parts, by the addition of matter of which it may be deficient.

The process of fallowing is merely a mechanical operation by which the soil is repeatedly exposed to the influence of the air and sun, and reduced by the repeated application of the plough, drag, roller, and harrow, till it is sufficiently pulverized. When rain falls on land that is well pulverized, it displaces the air that is mechanically held either between or in the body of the clods; and when the moisture is all

drained off or evaporated, the soil then receives a supply of fresh air from the atmosphere.

The process of fallowing therefore gives to land a supply of fresh air and water, thereby increasing its power of absorbing and retaining moisture and air from the atmosphere, and of decomposing the materials it holds in solution.

As the object of fallowing is not only to clean the land from all roots and annual weeds, but to pulverize stubborn and clayey soils, it ought to have the first ploughing in October or November, that it may receive the influence of the frost to pulverize the furrow slice. The second ploughing ought to be given, if possible, before the root-weeds begin to vegetate in the spring, and always when the land is so dry as not to be injured by the trampling of the horses.

If the soil be retentive of moisture, it should be ploughed in the direction of the ridges; and the furrows should be cleaned out, so as to allow any water to run off, if there should be wet weather in the spring.

By this plan, there will be less chance of dividing the roots of couch into a number of plants, than there will be by ploughing the land for the first time, when it is dry in May or June, and after the weeds have taken fast hold of the ground. It is then not only a most laborious business, but it is almost impossible either to reduce the soil, or to take out the root-weeds; as all the labour only tends to cut the roots of the weeds in pieces, and leave them in the ground as plants for next year. When the land is well pulverized in the winter by frost, and early reduced by the plough in the spring, the root-weeds are easily drawn out by the drag and harrow. The land should never be ploughed in a wet state, nor should the weeds be ever allowed to put forth their leaves above ground in the spring; but a series of operations ought to be adopted, to get all the weeds out of the soil as soon as possible. This will be best accomplished by early pulverizing the soil, by dragging out and picking up all the roots, carrying them off the ground, and burning them.

The object of fallow is, therefore, to break down and pulverize strong, clayey, and stubborn soils; not only for the purpose of getting rid of all the weeds, but to give a new and friable texture to the soil by a mixture of horse dung, or some other soft, loose, and porous matter, which will permanently alter its constitution by giving it a greater degree of friability, and consequently increase its productiveness.

58. On Manures, their Nature and Application.

WE give the name of manure to all substances which are applied to land for the purpose of increasing the crops we intend to cultivate, and we are satis-

fied that, by the application of manures to our land, greater crops are produced, until the strength of the manure be exhausted; and then we apply another quantity to keep up its productiveness, without even inquiring into the nature of the manure which we apply, or the way in which it produces these effects on the soil.

The importance of manure to the farmer is such, that his success, in the production of the crops he cultivates, will mainly depend on its quantity, and the application of it to the crops he raises as food for sheep and other stock; as those crops which are consumed on the farm, are much more productive of an additional quantity of manure than the crops of grain, a great part of which is carried off the land.

Vegetable and animal matter in a state of decay or manure, is composed of carbon, oxygen, and hydrogen, as we have before stated, the elements of which are the elements of growing vegetables. "By the laws of chemical attraction, vegetable and animal manure is changed by the action of air and water, and made fluid or æriform." (Davy.) Vegetable and animal manure, when well mixed in the soil, gives to it the power of absorbing and transmitting moisture for the use of plants that grow in it; therefore, improvement in some soils, and increased energy in others, will be given by the application of manure.—

The effects produced will continue much longer in

some soils than in others; in some, it will be of long duration; in others, it will be transitory. The dung of animals, kept on the farm with litter, is the principal manure on which the farmer should depend, as he has it in his power either to increase or diminish it.— Other manure he can have recourse to, when an additional quantity is wanted. As straw and green crops are the foundation of manure, the increase of these raw materials is, therefore, of great importance with a view to future crops. When straw is left in the field as stubble, we are deprived of one-fourth at least of the means of producing manures; we therefore see the propriety of collecting all the straw which our crops produce, for the purpose of converting it into manure.

In the experiment we have made to ascertain the weight of a crop of straw, we find that the quantity of wheat straw will average double the weight of the wheat produced; so that if all the straw be converted into manure, by part of it being consumed by some animal as food, and the remainder as litter, it would, with proper care, produce manure sufficient to keep up, and with good culture increase, the productiveness of the soil.

Well fed cattle or sheep, whether in the field or stall or yard, produce an abundant supply of the best and most valuable manure, which will again produce an abundant crop of green food for stock. We hold it to be an axiom in agriculture, that all the manure which can be produced, should be applied to the production of green food, such as turnips, mangel wurtzel, potatoes, cabbage, vetches, or clover, for stock. By the application of all our manure to the production of food for stock, a very large quantity of food can thus be obtained on a small quantity of land, when compared with the old system of applying all our manure for the production of corn for the market. The produce of food for the feeding of stock ought to be our first object—that of corn for sale the second: if we secure the first, the second will follow of course.

A proper and unremitting attention to the accumulation of the dung-hill ought to be one of the first objects of the farmer; he ought to add to its contents by every means in his power, and adopt every plan for increasing its magnitude by the kind of crops he cultivates, and not only to add to its bulk, but also to its richness. The dung of beasts fed on straw only is of little value when compared with the dung of those fed on turnips: but the dung of those beasts fed on corn is better than either; and the dung of those fed on oil-cake is the most valuable of all the others.

An acre of clover is said to keep three 3-year old beasts for six months, from April to November; and an acre of turnips will keep three 3-year old beasts from 1st November to the 1st of May: the quantity of manure which these three beasts will produce, while

being thus fed in the house or yard for twelve months, will be about thirty tons.

If we have a cistern or a pool into which the urine and all the water from the dung-hill runs, and if we regularly return it to the dung-hill by pumping it upon it, or if we mix the liquid with earth, or if we cart it out in water-carts and spread it over our arable or pasture land, none of the richness of the dung will go to waste; but if this water runs to waste, this liquid, being the essence of the manure, it must necessarily be of less value; the whole of the dung-hill will run away in a liquid state, if allowed to remain long enough.—We have seen this to be the case in numberless instances; indeed, there are very few farmers who pay a proper attention to this circumstance; all let their liquid manure run away to the to make an estimate of the loss which the farmers in general sustain in this way, I would say that he loses at the very least one-fourth part, and in some instances, much more of the means he has of procuring a good crop of turnips. An ox or a cow fed in the house throughout the year, will produce as much dung as will be sufficient for half an acre of turnips.

The manufacture of manure or the art of preparing it for every kind of land, ought to be more attended to than it is, and if farmers saw the advantage which they would derive from having their manure prepared for their particular kind of soil, they would pay more attention to it than they do at present: this is one of the most necessary branches of the agricultural business,—not only the preparation of it, but the means of increasing its quantity, and preserving its quality.

Then, again, there ought to be more consideration paid to the application of manure to particular land: large quantities are frequently put on land, and the result is the production of an overabundance of straw and less corn. Dung, we think, should never be put on land but for the production of green crops. If the effects produced on these crops are so great, that the consumption of the whole will tend to make the next crop over luxuriant, then part of the crop should be taken from the land, and consumed in the yard.

When dung is mixed with the soil, it produces a certain degree of fermentation in the vegetable matter which the earth contains, separating its parts, dividing and pulverizing it, making it friable and porous, and in a certain degree performing what is done by tillage. This putrid fermentation of vegetable and animal matter in the soil has a great effect on the portions of earth which it comes in contact with; the putrid matter is disseminated through it, altering the nature and texture and colour of the soil, and making it friable, clammy, and of a dark colour.

The production of turnips, vetches, and clover, by a large proportion of the farm, and the consumption of these by sheep and oxen, will, under almost every circumstance, produce a sufficient quantity of manure to keep the land in a highly productive state; and, if sufficient attention be paid to this part of agricultural business, a much greater quantity of corn will result from it, even when a less breadth of land is sown to corn, and a greater proportion to turnips, vetches, and clover.

As manure is of such vital importance to the farmer, every attention should be paid to the collection of the materials necessary to form it; every vegetable substance, together with the waste earth of ditches, road sides, sides of the fields, yards, &c. will add to the compost heap, not only in quantity, but also in quality, if proper care in the mixture be attended to.

Weeds of every kind will be available before they come to seed, or rather before they blossom, as the seeds of many of them are perfected before the blossom drops off; and it should be kept in mind, that no fermentation in the dunghill will destroy the vegetative power of a single seed.

When vegetable matter is fermenting in a dunghill, it should be mixed and covered with earth, which will imbibe the volatile or gaseous matter that is thrown off during its fermentation; and if there be a large portion of animal manure in the compost, it should have a bed of earth to imbibe all the carbonaceous matter that runs from it: and on every turning over which we think it right to give the mass, we should add an additional quantity of earth to cover it with.

Much earth should be used in all dunghills, as the earth that is thus impregnated is nearly, if not altogether, as valuable as the dung itself, in altering and improving the soil to which it is applied.

But in these composts, regard should be had to the nature of the soil, to which we intend to apply them; for we should regard manure more as an alterative, than as food, for plants. A compost for a light soil should be formed of cold manure, the dung of animals which chew the cud, of clayey or tenacious earth, and the clearing of ditches or other water-fed earths. The compost for strong tenacious soils should, on the other hand, be formed of hot manure, the dung of animals that do not chew the cud, such as horses and pigs. These should be mixed with light, sandy, or rubbly earth, the sides of roads, or sandy dry porous earth from rich yards or other places.

Road scrapings, being the produce of stone reduced by friction, is of a gritty sandy nature, whatever be the nature and properties of the materials of which it is composed; and from its gritty quality it forms an excellent alterative for clayey soils, and when mixed with a large portion of horse dung, it

forms an excellent compost for all clay or strong soils, as it tends to keep the soil open and porous.

In Flanders great attention is paid to manure, particularly to the urine of animals, and water that runs from the dunghill. These are collected and oil-cake dissolved in them, and they are drawn out in water carts and spread over the pasture land; or mixed with earth and formed into a compost, they become an excellent manure for turnips as well as pasture. An ox is said to make 12 cart loads of dung per annum, if fed on grass in the stall, and 1400 gallons of urine. "The urine of 44 head of cattle, with the aid of 2400 lbs. of rape cake, is sufficient to manure, in the best manner, 21 acres."

Manure should be always applied to fallows so early, as to be well mixed with the soil before the crop is sown; it then combines with it not only mechanically, but chemically, and thus increases the powers of the soil to combine with the water and air, and to decompose their substances, from which plants receive their nourishment.

The whole of the manure, however, ought yearly to be applied to the production of those crops, which furnish food for animals kept on the farm; such as turnips, cabbage, potatoes, vetches, carrots, and clover for sheep and oxen.

Meadow land should be manured soon after the

crop of hay is carried off, and before the end of August. A compost, with at least one-third of earthy matter in it, is the best manure for meadow or pasture land; and the land should be pastured the year after manuring.

Ashes from burnt peat are used largely both in Berkshire and in Hampshire, as a top dressing for young clover, and have so great effect on the crop as to increase it perhaps fully one-fifth; 50 bushels is generally the quantity used, per acre, although more will have a greater effect. Ashes are had at Newbury in Berkshire at 3d. per bushel; this costs only 12s. 6d. per acre, and a day of a waggon, besides the spreading.

In the application of manure, the nature of the soil should be considered. If the soil be a strong clay, and very tenacious, the manure should be of a light, or loose porous nature, such as stable unfermented dung; and if a compost, it should be made of a light, sandy or porous nature: but if the soil is light and porous, the dung should be of a cold nature, such as well rotten cow or cattle dung.

Compost made of cattle dung and clayey loam, or any heavy tenacious substance, is the best manure for light land; long straw, or unfermented dung, as stable dung or any substance which is loose and friable, should never be used on sandy soils.

Peat mixed with green dung and fermented, is

formed into an excellent vegetable manure: the mode of doing this, in the most perfect way, is that recommended by Lord Meadowbank.

The principal artificial manures are bone-dust, soot, rape, and oil cake; these produce wonderful results on the turnip crop.

59. On the Nature and Properties of Lime.

SIR H. DAYY says, that "quick lime (Hydrate of lime) in the pure state, is injurious to plants; that when mixed with moist fibrous vegetable matter, there is a strong action between the lime and the vegetable, and they form a kind of compost of which a part is usually soluble in water; but, that carbonate of lime is a useful ingredient in soil, that it acts upon the decomposing vegetable and animal matter in the soil, so as to render it more fitted for the purposes of vegetation, that it prevents the too rapid decomposition of substance already dissolved, but has no tendency to form soluble matter."

Quick lime is a combination of lime with onethird of its weight of water, in which state it is called Hydrate of lime; when it is exposed to the atmosphere a sufficient time, it reabsorbs from the atmosphere the carbonic acid gas which it lost during the process of burning, and, in this state, it re-assumes all the properties it had before it was burnt. This effect is soon produced after it has been slaked and spread on the land in a dry state, and it has very little time, in its caustic state of quick lime, to effect any alteration on the soil; it must therefore be in its original carbonaceous comminuted state, when intimately mixed with the soil, that it can have any effect, either on the soil, or on the decaying vegetable matter therein.

The effect which it produces on the soil must therefore be as an alterative in changing its texture, by the addition of so much carbonate of lime to it, in a very finely divided state.

Dr. Anderson and Du Hamel are of the opinion that powdered marble or powdered limestone has a good effect on grass land.

Anderson says, "that lime is no sooner slaked than it immedately begins to absorb its air, and return to its former mild state; or in other words, it becomes effete, in which state it possesses the same chemical qualities in every respect as limestone.

"If this be spread out thinly upon the surface of the earth, it absorbs its air in a very short time. A few hours in this situation are sufficient to restore a large proportion of its air; and, in a day or two at most, it becomes perfectly effete, as masons experience when they sweep together the scattered particles that have lain round their heaps of lime and attempt to use it in mortar by itself, for it is then no more coherent than sand, or moistened earth.

"Hence then it must follow, that in every case, lime is converted into the same state with limestone, in a few days after it is mixed with the soil; so that if it produces any effect at all as lime, or a saline substance, it must only be at the very first when it is applied, and must act ever afterwards merely as powdered limestone.

"But it is well known, that lime produces scarcely any sensible effect as a manure, at the beginning. Even the first year after it is applied to the soil its effects are inconsiderable, in comparison of what it produces in the second and succeeding years. From whence we must conclude, that it operates upon the soil, merely as a mild calcareous earth; and that its calcination is of no further utility in preparing it for manure, than as a cheap and efficacious method of reducing the limestone to a fine powder." chemists say that it requires exposure to the atmosphere for a considerable time to render it completely effete, or to receive its full quantity of carbonic acid gas. Kames, Young, Brown, and others say, that long experience has convinced them, that lime is as efficacious in its effete, as in its caustic state; and Kames thinks it produces little effect on vegetables, till it becomes effete; it therefore appears not only from their opinion, but also from the experience of

practical farmers, that the efficacy of lime on some land does not arise from any effect it may produce when in a caustic state, but from those qualities which it possesses in common with all other calcareous matter. It must be evident that lime, in a dry, slaked, or pulverized state, can be more easily and intimately mixed with the soil, than when it becomes wet, and in a state like mortar.

Is lime only a stimulant exerting its influence on something that is already in the soil? and if so, does its influence tend to exhaust this something? or, is it an enriching manure which gives nourishment to plants? or does it, by becoming a portion of the soil, improve its texture and composition, by making the soil more capable of supplying the food necessary for the production of vegetables? Dr. Anderson says, "Writers on agriculture have been long in the custom of dividing manure into two classes; viz. enriching manures, or those that tended directly to render the soil more prolific, however sterile it may be, among the foremost of which was reckoned dung; and exciting manures, or those that were supposed to have a tendency to render the soil more prolific, merely by acting upon those enriching manures that had been formerly in the soil, and giving them a new stimulus, so as to enable them to operate anew upon that soil, which they had formerly fertilized. In which class of stimulating manures, lime was always allowed to hold the foremost rank." "In consequence of this theory, it would follow that lime could only be of use as a manure, when applied to rich soils; and, when applied to poor soils, would produce hardly any, or even perhaps hurtful effects." "I will frankly acknowledge, that I myself was so far imposed upon by the beauty of this theory, as to be hurried along with the general current of mankind, in the firm persuasion of the truth of this observation; and, for many years, did not sufficiently advert to those facts that were daily occurring to contradict this theory. I am now, however, firmly convinced, from repeated observations, that lime and other calcareous manures. produce a much greater proportional improvement upon poor soils, than on such as are richer; and that lime alone, upon a poor soil, will, in many cases, produce a much greater or more lasting degree of fertility than dung alone.

"In direct contradiction to the theory, I must add, that I never yet met with a poor soil in its natural state, which was not benefited in a very great degree by calcareous matters, when administered in proper quantities.

"But I have met with several rich soils that were fully impregnated with dung, and therefore exactly in that state in which the theory supposes that lime would produce the greatest effect,—but upon which lime, applied in any quantities, produced not the smallest sensible effect."

And again, in another place, he says:—"I have often heard it urged, as an objection to the use of lime as a manure, that although it does indeed promote the fertility of a soil in a higher degree at first, yet, in the end, it renders it much more sterile than formerly.

"This, like many other objections to useful practices, takes its rise entirely from the avarice and unskilfulness of those who complain. It is chiefly heard of in those parts of the country, where it is not uncommon for a farmer, after once liming a poor soil, to take fifteen or sixteen crops of oats successively, without any other dressing or alteration of crops. It must be a good manure that enables these soils to produce such a number of successive scourging crops of any sort; but it would be a marvellous one indeed, if it should prevent those fields from being exhausted by them.

"But is it not well known, that in all the richest and best improved parts of the country, lime has been long employed as a manure?—yet so far are these soils from being rendered sterile by it, that it is doubtful if any art, without the assistance of lime or some calcareous matter, could ever have brought these fields to their present degree of fertility. Those, therefore, who complain of the hurtful effects of lime as a manure, proclaim what they ought to conceal, that they have had in their possession a treasure, which might have enriched their posterity, but which they have idly squandered away in their own lifetime." Although lime produces a great effect on certain poor land which has been in a state of nature, yet where lime is applied to poor worn out arable land which has been limed and exhausted by severe cropping, it has, from practical experience, no effect whatever.

If lime be a stimulant, there are roots in the soil of poor land in a state of nature for it to act upon; but, in poor worn out land, exhausted by severe cropping, there are none.

Again, such worn out land may, from the very circumstance of its worn out state, be so loosened, that an application of lime may, as an ingredient in the composition thereof, only tend to increase the evil by making it more loose and friable. Brown says, "It is sufficiently understood, that land, which has been long in grass, contains much vegetable matter; and that the trouble and expense of liming it would be amply repaid to the cultivator: but the propriety of applying lime on old arable lands has been questioned, and with much justice by the most part of practical agriculturists, and their doubts on that head are confirmed by the fullest experience.

"Were lime a manure, it would be a noble substance, for enriching, and restoring fertility to lands worn out by a succession of corn crops; but as worn out land is not restored to fertility by the application of lime, we are warranted to consider it in a different light; or, in other words, as an article to bring certain principles into action, previously possessed by the soil. This conclusion is sanctioned by experience; and experience is a far better guide than the most plausible theory.

"When lime duly operates, the whole powers of the soil are put in a state of requisition, and may be forced to act till the very soul of vegetation is extracted. It is scarcely practicable to restore fertility to land, even of the best natural quality, which has been thus abused; at least, a considerable period must elapse, before it can be restored to its original fertility; but thin moorish soils, after being exhausted by lime, are not to be restored. To lime them a second time, is not only a useless expenditure of labour and money, but also productive of serious mischief. Soils of this description, after a second liming, are apt to singe and burn the grain that is sown upon them; and, even when dunged, not to make such a return as would have been rendered under different circumstances.

"Lime has been long applied by British husbandmen, as a stimulus to the soil; and in consequence of such an application, luxuriant crops have been produced, even upon soils of apparently inferior quality, and which would have yielded crops of trifling value, had this auxiliary been withheld. In fact, the majority of soils cannot be cultivated with advantage till they are dressed with lime; and, whether considered as an alterative, or as a stimulant, or as a manure, it will be found to be the basis of good husbandry, and of more use than all the other manures put together. Wherever lime has been properly applied, it has constantly been found to prove as much superior to dung, as dung is to the rakings of the roads, or the produce of a peat mire.

"From a pretty long experience, and considerable attention to the operation of lime, we are inclined to think that it acts both as an alterative and as a stimulant; operating in the one case, as a medicine that changes the nature of the soil; and in the other, as arousing or bringing into action the vegetable powers contained in the soil, which without such an application would have remained dormant and inactive. These opinions, we know, are different from those maintained by several ingenious men, but they are supported by the result of numerous trials, undertaken to ascertain how, and in what measure, lime operated upon the soil."

It is evident that lime, when applied to land in

however small quantities, will tend to change its texture; and when there is vegetable matter in the soil, it may produce a greater decomposing disposition in it than before. In this case, it will act as a stimulant hastening the decay of vegetable matter, and thereby furnishing the elements of vegetable life. Lime also acts powerfully on any irony matter in the soil; and on the gravel sands, and clay soils, of the diluvial formation, and on the soil of the plastic clay, the new and old red sandstone, and the basaltic formation, the effect produced by the application of lime is very great. This may be owing, as we have said before, to neutralizing the pernicious effects of the sulphate of iron, and converting it into a useful soil; and every fresh application of lime may therefore convert an additional portion of sulphate or oxid of iron into an additional portion of good and useful soil. When there is a deficiency of carbonaceous matter in the soil, a fresh portion of lime must increase the productive powers of the soil

The effects which lime as an alterative has on the soil, must depend, in a great measure, on the composition of that article, and also on the composition of the soil to which it is to be applied; for the composition both of the various limestone formations, and also of the chalk and marls varies greatly. The nature of the ingredients being different, the

lime from the silicious limestone contains a considerable portion of silicious particles, and may answer best on strong clay soils, as it will furnish both silicious and calcareous matter to the clay soil; and the lime burnt for the lias limestone, which contains a considerable portion of clay, will produce the best effect on light sandy soils. But there are some soils on which lime when applied has never produced any beneficial effect. This is the case with the soil on the oolitic formation, and other calcareous soils. This is evidently owing to the superabundance of lime already in the soil, so that an addition of calcareous matter only increases the evil; but where there is no calcareous matter in the soil, and also a great quantity of iron, as is the case in the soil of the new red sandstone formation, the lime has an increased effect on every fresh application. This is so well known in the neighbourhood of Taunton in Somersetshire, and over all the soil of the new red sandstone, that the farmers lime their land every ime it comes in course of fallow for turnips, and this produces excellent crops, even without dung.

It is most astonishing that writers on agriculture have retailed an opinion, that quick lime, when mixed in a mass of earth containing the live roots and seeds of weeds, will destroy them. Any attempt of this kind will meet with a complete failure; for the roots and the seeds of weeds cannot be destroyed

by the fermentation or any heat that can be produced in such a compost. The same writers have also stated, that lime hastens the decay of vegetable matter; whereas the fact is, that it retards the process of the decomposition of vegetable matter. If straw of long dung be mixed with slaked lime, it will be preserved; while, if mixed with an equal portion of earth, the earth will hasten its decay.

60. Summary.

It has been shewn that although vegetables are composed of mucilage, starch, sugar, albumen, gluten, and various other substances, vet all of them are reducible into carbon, oxygen, and hydrogen; and that water and air are composed of these substances;-that vegetable and animal manures are decomposed into the same elements, as those of water and air; -that any of the simple minerals which compose the surface of the earth when unmixed with any other mineral, is unfit for the growth of vegetables; but that, when these simple materials are intimately mixed together, this compound, when exposed to the influence of the sun and atmosphere, produces an abundant crop; -that there is no process going on at the surface of the earth, amongst the materials which compose the cultivated soil,

which changes any of the mineral component parts of it into a new substance;—that none of the materials composing the soil, enter into the composition of the plants;—and that the application of manure, does not always cause productiveness in soils.

We therefore conclude, that to change the constituents of the soil by the admixture of mineral or other matter, and so give to it that peculiar texture which will enable it to absorb and transmit the moisture which it receives, is the best and most effective mode of permanently improving the soil, and increasing its productiveness; -that the food of plants is not so much any particular substance, or any combination of substances, as a condition of the soil; and that manure, as we have said before, may tend to give it this condition for a time, but its effects will be transitory, compared with other mineral matter applied to alter its texture. Where this peculiar condition does not exist naturally in the soil, we have shewn that it can be made so, by giving it this peculiar texture artificially.

From all that has been said, it must appear evident, that what has been called the food of plants, does not consist in any one substance, or in any combination of substances, in the nature of a specific; but in that peculiar condition of soil, which it either has naturally, or which may be given to it by artificial means, and which will enable it to im-

bibe and transmit, for the use of plants, the moisture it receives.

The reason why the food of plants has not been found out long ago is, because it has been sought for in the nature of a specific; and we feel assured that any attempt to put forth any substance or any combination of substances, such as those of which plants are composed, as the specific food of plants, will universally meet with a complete failure; for, as no crude matter can enter into the small rootlets, and the sap vessels of the plants, therefore, neither carbon, oil, mucilage, starch, sugar, albumen, gluten, nor any of the other substances, can be of any use to the growth of plants, till they are completely decomposed, and the elements of such decomposition become chemically combined with the water and air of the soil. If, however, in attempting to acquire a knowledge of what the food of plants is, we examine into the nature and constituents of the soil in which plants grow; and if, over the whole of the geological formations, we shall find some soils of a peculiar texture which are most productive, and that there are also some soils of another peculiar texture which are the least productive, on each of the geological formations, we may by a closer examination discover the reason why one is productive and the other comparatively barren; and thus we may have a greater chance of getting at the true principle of vegetable life, and we think the result of our researches will convince us, that the food of plants or the principle of vegetable life, will appear to consist more in the condition or constitution of the soil, than in any single or compound specific.

Believing this to be the true state of the question, we would advise agriculturists to pay more attention to the nature and state, or condition of the component parts of the soil; and whenever they find it too loose and light, to give it the addition of some substance that will make it more adhesive and firm; and when it is too tenacious, to apply to it some light, porous substance that will make it more friable and open; and to adopt that system of culture, which will make and keep the soil in the condition, which will best promote the absorption and transmission of moisture for the use of plants.

61. ECONOMY IN LABOUR, AND IMPROVEMENT OF SYSTEM.

WHILE every other class of the community are using all the means within their power to lessen the expense of producing the articles of their manufacture, the farmer still goes on in his old beaten track, never enquiring whether he cannot accomplish his labour with less actual, but more efficient strength of horses

and men; or whether other implements are not preferable to those he has now in use.

Thus, while the expense of all other occupations has been reduced from one half to a tenth part of what they used to be, the expenses of the farmer have, in many instances, been increased.

Most farmers limit their expenditure to the absolute necessaries required in their mode of culture, instead of laying out fresh capital in attempting to increase the productiveness of the soil. Their views have extended no farther than the next crop, a quick return being their only object, even where it would not pay the expense of production; or looking perhaps to the chapter of accidents, or waiting to see what Government will do for their relief.

This they continue to do, obtaining only a scanty crop, which is dear to the buyer, and unprofitable to the grower; instead of producing, by an outlay of additional capital on improved culture, a plentiful crop, which would be cheap to the consumer, and profitable to themselves.

But farmers in general adopt the custom of the neighbourhood in which they live, in the course of husbandry and general management of their farms; and they follow the footsteps of their fathers in this respect more pertinaciously than any other class of society; and while improvements in all other arts and manufactures are going on at so rapid a rate, that of agriculture lags far behind.

When a farmer does not improve the land he cultivates, it is evident that something is wrong in the system he adopts; it may be owing to his ignorance of the best mode of cultivating the particular soils of which his farm consists—the want of capital, or even a determination not to lay out his capital to improve another man's land, which we have often heard expressed, and by those that are reckoned intelligent and liberal farmers; although we cannot perceive the mark either of intelligence or liberality in persons who hold such sentiments.

The sands of Norfolk and Suffolk have been so much improved by the application of clay, marl, or chalk, and the alternate system of husbandry, that a crop of turnips is now produced on some land equal in value to the previous fee simple of the same soil; while the rich clay land in the vale of the White-horse in Berks, and in the vale of Gloucester, remains without any increase of its productive powers, and is still cultivated with from three to six horses in a plough.

The Norfolk system of ploughing with two horses abreast was introduced into Roxburghshire in 1762, by Mr. Dawson of Frogdon; it soon spread over the greater part of Scotland, and has been continued as the most efficient mode of cultivating every kind of soil, from the lightest sand to the strongest and most tenacious clay.

Tull's system of drilling turnips, as well as

ploughing with two horses abreast, was carried by Mr. Dawson into the Northern counties of England; but to the present day, these improvements in agriculture have made very little progress in the Southern counties. Two horses are very seldom to be seen at work abreast in a plough; we generally observe three or four at work in a plough even on the lightest soil in Berks and other counties, and these of a heavy description of animals, whose natural pace is seldom more than one mile an hour; so that it is with considerable exertion that these three or four horses with a man and a boy, and a most cumbersome plough, turn over three-fourths of an acre a day; while two light active horses plough, with the greatest ease, upwards of an acre every day, and even two acres in the fallow field.

The reason why improvement in agriculture proceeds at a much slower rate than improvements in many other sciences, is in fact owing to the very little intercourse there is amongst farmers themselves.

The English farmers in general are not readers, they therefore lose all the recorded improvements of individuals, or of agricultural societies. There is no system of education adopted in England, whereby the first principles of agriculture may be acquired; the only agricultural education, therefore, which the farmer receives, is from the practice of his father, and that of the neighbourhood in which he dwells;

and which has been handed down unadulterated and unimproved through many generations, and adhered to with an obstinacy which no reason can induce him to give up or change.

The prejudices of the farmer in favour of the mode of culture which he follows, and against all those whose modes are different, although they are performed at one-half of the expense, and produce as much or a greater return, and although only a few miles distant from him, are of the most pertinacious kind, and will never be got rid of, till some dire necessity compels him to open his eyes to see his own interest; nothing but this we are persuaded will ever induce many to change their present habits.

The produce of agriculture may be easily increased, even doubled; and in almost every instance, the expense of production may be diminished. By reducing the expense of production, we set free an additional portion of the produce, and this is just the same as if, with the original expense, we produced a greater crop; therefore none but the most efficient labour, either of man, or beast, or implements, should ever be employed.

If farmers would adopt this plan, it is evident that the greater the amount of productive and efficient labour they use, the greater will be their return: all useless expenses should be extinguished, and the most efficient mode of accomplishing any labour should be adopted.

62. System of Culture.

"In every system, it is absolutely necessary to attend to the equal distribution of labour throughout the year; so that the work, which the system requires to be performed in each month, may be easily accomplished by the means the farmer is provided with. The different operations should never be allowed to encroach on each other. If these are properly adjusted, the business of each week will be confined to the time in which it is required to be performed."

The best mode of cultivating arable land is that, which produces the greatest quantity of green food for sheep and other beasts, and which they should eat on the ground.

This prepares the land for a crop of grain or corn for the use of man. The alternate system of grain and green food for stock, is that which never should be deviated from.

It produces not only a much greater return of corn and other food for the use of man, but also a much greater quantity of green food and straw which sheep and other animals consume, and gives at the same time a proportionally greater return of vegetable and animal manure. By this means, the farmer has not only the power of reproducing the same quantity of grain, &c. but of increasing the

capability of the soil to produce an additional quantity. The production of turnips and green food for sheep, gives perhaps ten times the quantity of manure, that the old system did. Increased productiveness given to the soil, is genuine agricultural improvement.

Crops of corn, as food for man, alternating with crops of vegetables, as food for sheep or other stock, is the foundation of all good husbandry.

Such a mode of culture should be adopted as will not only increase the quantity of manure, but hasten its decomposition, and thus increase the productiveness of the soil by raising an increased quantity of food for sheep to be again consumed on the land that produced it; and when the soil is thin, poor, light sand, this may be repeated year after year, on the same land, whether it be arable or pasture. The consumption of the produce by sheep on the land is the best, the cheapest, and the most effectual means of improving pasture, as well as arable land.

Vetches, rye, clover, and buck wheat, are sometimes grown on land, and ploughed in as a manure; but if these crops were converted into a manure by passing them through the stomach of sheep, the effects produced would not only be much quicker, but of much greater value.

When the farmer is convinced that his corn crops are productive, just in proportion to the quantity of

sheep he keeps on his arable land; and when he is experienced in the best mode of cultivating the varieties of grain and vegetable which are best adapted to the soil of his farm, he may then calculate with certainty on the result of his operations.

As the weeds which grow in the land are the natural plants of the soil, they much sooner feel the influence of the weather, the manure, and the culture, than the artificial crops we cultivate, and consequently take the lead of the crop; we ought, therefore, to eradicate every weed out of the land, and when once we get it clean, to keep it so.

We should never take a crop of corn, if by taking it, we give an opportunity for the weeds to spring up in the soil; for this would be only sowing the seeds of future labour and expense, as well as incurring loss to us in preventing their increase. The repetition of corn crops in succession tends to increase the stock of weeds in the soil, without giving to the farmer either the time or the power to diminish them, and their growth necessarily retards or prevents the growth of the crop we cultivate; but the production of green crops, such as turnips, potatoes, vetches, and clover, gives to the farmer time and power to clean out any weeds that may be in the soil; and the growth of these crops prepares the land for the production of a crop of corn.

It should be remembered, however, that whenever

the weeds have got ahead of us, we must then have recourse to summer fallow to get rid of them. Whatever gives nourishment and life to weeds would, if no weeds were in the ground, give life and nourishment to cultivated plants; and that land which has a dry porous subsoil is most productive, and much easier cultivated than that which has a retentive subsoil; therefore if the land have not a porous dry subsoil naturally, one should be given to it artificially, and this the farmer should do whatever be the expense,—it will repay him with compound interest.

Different modes of culture must be adopted on different soils; for it is evident, that the same cause will have very different effects upon soils of a different nature.

The effect produced by rain on clay soils, has been shewn to be very different from the effect which it produces on sandy soils; and the effect of drought on a dry sandy soil, is equally different from the effect which it has on a wet clay soil.

Frost expands the water in the soil about onetwelfth; hence during a thaw, the water is contracted to its original bulk, leaving the soil in a loose open state, and well prepared to receive the influence of the atmosphere. Sandy soils are easily penetrated by water and air; but clay, unless well pulverized, is impenetrable to either.

The best soil for any kind of plant is that in

which it naturally grows with most luxuriance; and a quicker repetition of such plants may be made than of those to which the soil is not naturally so well adopted.

Clay soils having a proper mixture of sand and lime will produce wheat, beans, clover, and cabbages, in the greatest perfection.

Light sandy loam is best fitted for the production of barley, rye, pease, turnips, potatoes, vetches, &c.

Every different soil requires a peculiar management, and a different course of cropping.

Light sand and gravel are early soils, and should be early planted in the spring, that their growth may shut out the influence of the sun from the ground at an early period of the summer.

All succulent plants, and those that are not allowed to ripen their seed, such as clover, rye grass, vetches, turnips, cabbages, carrots, potatoes, &c. are said to receive a great part of their nourishment from the atmosphere; and therefore do less injury to the land than wheat, barley, rye, oats, pease, beans, or any of the succulent plants, when they are allowed to bring their seeds to perfection.

Vetches, pease, and beans, seem only to injure the land they grow on, when they are permitted to perfect their seed; for, if they grow so luxuriantly as to produce nothing but straw, which is sometimes the case, or if, like vetches, they be cut green, their

growth does not injure the land but is an advantage to it; we may therefore presume that it is only in ripening the seed, that the soil is injured by such crops.

When clover, vetches, turnips, cabbages, &c. are produced and consumed on the land without perfecting their seed, the soil is not at all injured by their production, and they may be repeated and consumed every year not only without the least injury being sustained by the soil, but an actual yearly increase is thereby made to its productive powers; if any one of these crops, however, be allowed to perfect its seed for two consecutive years on the same soil, the land would be injured for many years to come. The inference to be drawn from this fact is, that the soil is injured more in producing the seed, than in producing the stem and foliage, or leaves. The foliage may receive more of its nourishment from the air than the seeds; or, the seeds may receive more of their nourishment from the soil than the foliage.

The injury that land sustains from converting grass into hay is, that the production of seed, either of grass or of corn, is that which injures the land more, than the most luxuriant growth of leaves or straw.

Pasture prevents the production of seeds and encourages the growth of the roots, which are thus

promoted, and are constantly pushing out in search of nourishment all the year round; so that there is no period when they lie dormant, as is the case when seed is produced.

All perennial plants that produce seed lie dormant for several months after they have produced it; and annual plants, if prevented from yielding their seed, either by mowing or pasturing, become biennial or even triennial.

There is a great loss sustained by land from the keeping of corn in the straw for a year or two; as the farmer is thereby prevented from keeping stock to consume the straw, and of course the land sustains the loss of manure from its non-consumption.

The adoption of the best rotation of crops will not secure, at all times and under all circumstances, the improved result: no! the rotation must be accompanied with the most sedulous attention to the minute detail of all the operations, and these must be executed at the proper time to insure the result required.

63. Course of Crops.

THE philosophy of a rotation consists in a proper distribution of the various crops which are best fitted or most natural to the soil in question. On a clay soil such crops should be planted as grow best on clays; and so with calcareous soils; and so with silicious and peaty soils: but always to have one green crop at the least between two corn crops, having the crops of each kind (whether of corn or green crops), at the greatest distance apart.

The cultivation of arable land on the four field, or rather on the alternate system of corn and green crop, is by universal consent acknowledged to be the best and most profitable. The value of the alternate mode of husbandry does not rest, as some have stated, on the antipathy which annual plants have to grow the succeeding year in the same soil in which they have already lived the natural course of their existence, that is, having produced their seed and died.

The merits of this system is the great increase of green summer and winter food for stock, which gives a large supply of manure whether the stock be fed in the field or in the yard; and as it is universally acknowledged that the produce in corn increases with the increased quantity of sheep kept on the farm,—hence the system produces a great increase of both corn and animal food, at the same time the productiveness of the soil is also yearly increased.

"The course of cropping should be regulated by various circumstances. The kind and quality of the soil, and its peculiar properties, the seasons, the most profitable application of manures, and the fact that no white or corn crops should be repeated in too rapid succession, are circumstances that always govern the prudent farmer in the adoption of a system.

"But the value of every rotation depends chiefly, if not entirely, on the quantity of food that is produced during the course, for sheep and cattle, but particularly for sheep; and on its consumption on the farm, either in the fold or in the stall. "No food, no cattle; no cattle, no dung; no dung, no corn;" is a maxim that ought to be fixed in every farmer's mind.

"Turnips, vetches, rye, clover, and sainfoin, are indispensable, in every good course, as winter, spring, and summer food; and the greater the crops of these are, the greater and more productive will be those of corn. These crops, of which the turnip crop is the principal, may therefore be considered as the foundation of all good husbandry."

We have before stated that the succession of crops should be determined by the nature of the soil, the proper distribution of labour throughout the year, the greatest quantity of food for stock, particularly sheep, that can be kept, and that a crop of corn should never be succeeded by a crop of corn. The alternate system of culture ought to be rigidly adhered to, unless a repetition of green crops should be thought an advantage to the land, and produce a greater profit to the farmer in animal than vegetable

food. Keeping the above principles always in view, the rotation of crops may be changed in endless variety on deep, friable soils; but on heavy tenacious clay, they are more circumscribed.

Clover, vetches, and cabbages, are the only crops which can be raised as food for sheep or cattle on the latter; and cabbages cannot be eaten off by sheep on such land. There is more expense in the production and consumption of the crops on wet clay land, than on dry friable soil; and therefore the expense of improving such land is greater. The crops must be carted to be consumed in the yard by stock, and the dung carted again into the field; besides, the injury done to the land in wet weather, by carting off the crops, is great. Vetches and clover may, however, be folded by sheep in the summer months, on clay soils.

On good strong rich clay land, the following rotation is productive.

- 1. Clover, to be consumed on the land by sheep.
- 2. Wheat.
- 3. Beans, to be dunged on the wheat stubble.
- 4. Wheat.
- 5. Winter vetches, to be dunged on the wheat stubble and folded off by sheep.
- 6. Wheat, sown with seeds. Oats may be substituted for any of the wheat crops, and cabbages may be planted instead of the vetches or beans.

The following is an excellent rotation for a friable turnip soil, where it is necessary to guard against reducing the soil into a too loose or friable state; and it also gives food for a great stock of sheep.

- 1. Turnips, or Swedes manured with dung, bones, and rape cake; and fed off by folding sheep on the land.
 - 2. Barley, with a variety of seeds.
 - 3. Seeds, pastured by sheep or other stock.
- 4. Second year seeds, also pastured by sheep and other stock.
 - 5. Oats.
- 6. Potatoes, mangel-wurzel, beans, or winter vetches, dunged to the oat stubble.
 - 7. Wheat.

Here the different crops of corn are only once in seven years, and these we may reckon to be the most productive. The quantity of food produced by turnips, and by the two years clover, and vetches, will enable the farmer to keep and fatten a large quantity of sheep on the ground; which will, by their trampling and by the manure left on it, give to this kind of soil the best preparation for the succeeding crops of corn. We are satisfied that the land, while producing food for sheep or other stock, if the stock be properly managed, will give fully as great a return of profit to the farmer, as by producing corn, it can possibly do, without having the advantage of the results of the sheep fold.

This mode of folding sheep is the foundation of a continuance of productive crops, and also of a gradual reduction of the expense of labour, conjoined with a gradual increase of the productive powers of the soil.

64. THE EFFECTS OF CLIMATE ON VEGETATION.

The effects of climate or temperature on the productive powers of the earth must be evident to every one, who has given the least attention to the subject.

An increase of temperature hastens the growth of vegetables, brings them earlier to maturity, and renders the produce more perfect and the crop more abundant.

From the equator to either polar circle, the difference of half an hour in the length of the longest day, forms what is called a climate: and the longest day, at these circles being 24 hours, there are, therefore, 24 climates between the equator and each polar circle. Within the polar circles, however, the difference of a month in the length of the longest day, constitutes a climate; and being six in each, the climates, from pole to pole, amount to 60 in number.

At the equator, the lowest line of perpetual snow is 15,691 feet above the level of the sea; and at 19° it is 15,020, according to Humboldt. Now if we take the line of perpetual snow to be 15,000 feet above the level of the sea at 23° of latitude, and if

at 73° where the longest days and nights are three months, the line of perpetual snow becomes level with the sea, we shall have an extent of 50° of latitude with a gradual elevation of the line of perpetual snow from the level of the sea to the height of 15,000 feet. Again, if we take the average temperature of 23° of latitude to be 82° of Farenheit, we shall have a corresponding increase of one degree of temperature to a degree of latitude as we proceed towards the equator, and a loss of one degree of temperature for every 300 feet of elevation in any given latitude.

On the mountains of the torrid zone, we have every climate, and every degree of temperature as we ascend to the line of perpetual snow.

These climates follow each other as regularly as we find them do in passing from the torrid to the frigid zones, and they have the same circumstances attending them. The meaning which farmers attach to climate, is the effect produced by heat and cold, rain and drought, on the crops which they cultivate. The value of climate to the farmer may be measured by the difference of the produce of land, under similar circumstances, in two given localities; say, the one situated in the latitude of 52, and the other, in the latitude of 55 degrees.

The meaning, however, which is here given to climate, depends as much on elevation as on latitude; and we shall find by our measure that the difference

between the crop under the same circumstances in latitude 52 at the level of the sea, and the crop in the same latitude at an altitude of 900 feet, will be as great as in the case above stated.

There are many local causes which alter and modify the temperature; amongst these, we may mention the humidity of the soil and atmosphere—large tracts of pasture land—and the neighbourhood of forests, wastes, bogs, lakes, and mountains; all of which have the effect of decreasing the temperature of the place; whereas dry silicious sandy soil and subsoil—a dry atmosphere—a well drained and cultivated district—and a southern aspect, have all a tendency to increase the temperature of any locality.

The atmosphere contains aqueous vapour in quantities proportionate to its temperature, as we have before stated. If its temperature be raised, its capability of absorbing and retaining moisture is also increased; but if its temperature be lowered, it instantly parts with some of the moisture it possesses.

Humboldt calculates the proportional quantity of rain in different latitudes to be as follows:—

Latitude.	Mean annual depth of rain.
0_{o}	96 inches.
19°	80 "
45°	29 "
60°	17 "

But local causes have the effect of greatly altering this quantity. A greater quantity falls on mountains, and in their immediate neighbourhood, than on low level land; and on the sea coast, than on inland plains.

The humidity of the atmosphere decreases according to its distance from the sea.

At Keswick and Kendal in Cumberland, the quantity of rain is about 67 and 60 inches per annum; while at places in the interior, only about 24 inches fall

The greatest quantity of rain in England, generally falls in September, October, and November.

But climate may be greatly altered by agricultural improvement; such as the drainage of lakes, bogs, and morasses-the clearing away of foreststhe perfect drainage of the cultivated soil-and the conversion of pasture into arable land. In localities where such improvements have been effected, evaporation is not so great, and the atmosphere is consequently drier and warmer.

This has been particularly exemplified in the fens of Lincolnshire, since they have been drained. But the nature of the soil, and especially of the subsoil, hastens or retards the perfecting of the crops. The harvest is much earlier on silicious sandy or gravelly soils, and much later on aluminous or clay soils, than we would expect from the climate, and their elevation above the level of the sea.

The harvest is always later when the cultivation is neglected, or improperly or carelessly executed, than it is on a soil which is improved and well cultivated.

The crops are never so good or so early on cold tenacious clay soils on the gritstone formation, or on the moor lands in Yorkshire at the elevation of 500 feet, as they are on the chalk wolds in the same county at 800 feet high. This difference gives to dry, calcareous, and silicious soils, a very great advantage.

In England, land at an elevation of 1000 feet above the level of the sea, becomes unprofitable to the arable farmer; as the crops do not ripen except in very particular seasons, and therefore it ought only to be used as pasture at such an altitude.

65. ON THE VALUE OF LAND.

ALTHOUGH we have shewn that the soil, on each of the geological formations, is composed of the same materials as the subsoil on which it rests; yet we do not wish to infer from this circumstance, that the soil over the whole of each formation is of the same value.

This is by no means the case, for the quality of the soil on each, is infinitely varied; and increases in value according to the degree of culture it receives, and according to the quantity of active vegetable matter it may happen to contain. In attempting to ascertain the value of any commodity, we try all the means, and use all the tests within our power which ingenuity can devise. These tests, however, are only applicable to articles of merchandise, and cannot, properly speaking, be applied to the quality or productiveness of the soil.

The productive powers of land cannot be measured, or weighed, or tested; but can only be perceived by the results produced.

In some instances, the produce arises spontaneously from the soil; in others, it has to be drawn from it by culture.

The productiveness of land, in most cases, depends on the kind of culture which it receives; and the cultures best adapted to it can only be ascertained by a knowledge of the effects produced by particular modes of cultivation.

A knowledge of the component parts of the soil is not of so much importance, in ascertaining its productiveness, as a knowledge of its capabilities of imbibing, retaining, and transmitting moisture and air, and of decomposing those substances, which furnish the elements of plants.

The principal circumstances, to which our attention must be directed, are—the nature of the soil and subsoil; whether they are retentive or porous, dry or wet, warm or cold; the situation, whether it is exposed or sheltered, elevated or near

the level of the sea;—and the climate, whether it is dry or humid.

We may compare one soil with another, the value of which we already know; and from this comparison, draw an inference of its value, but this will be a very incorrect and fallacious way of proceeding.

The local value of land increases, in proportion to the deficiency of the supply to fill up the demand of the particular locality; and this can only be ascertained, by a knowledge of the demand and the supply of the place.

The fertility of grass lands, and, of course, their value, may be distinguished by the variety and quality of their natural grasses, and the quantity of stock per acre they will keep throughout the year. This is determined in Lincolnshire by the weight to which a field will feed an ox. "This field will only feed an ox of 60, but that will feed one of 80, or 90, or 100 stones," is the language used by the most intelligent graziers of that county.

The relative value of land, we have before said, is owing to the power it possesses of retaining and transmitting a regular supply of moisture for the use of plants; which, by being duly retentive, it affords in very dry weather, and which, by being sufficiently porous, it gives not in too great abundance, when the weather is wet.

The intrinsic value of land is in proportion to the

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yearly return which it makes, from a given quantity of labour, properly applied.

This is ascertained by a knowledge of the difference between the expense of cultivation, and the price of produce.

There is no other way by which we can determine the value of land, but by a knowledge of its yearly produce, under the system of culture best adapted to the particular soil; from which must be deducted the expense of cultivation.

The produce of agriculture is naturally divided into the price of labour, and the interest of the capital employed, which belong to the farmer who pays the labourers; and into the rent of the land, which is the difference between the price of the produce and the expense of cultivation, and this belongs to the landlord.

66. Rents.

THERE has been no period in the history of any nation, when rent has not been paid by the cultivator to the sovereign, the chief, or the proprietor; and various modes have been adopted, in satisfying the claims of those, who exercised a right to the superiority of the soil.

In the rudest state of society, rent may be defined to be that portion of the produce, which remained after maintaining the labourer and his family, during the time they were employed in producing it.

The first rent we read of, is Ryot-rent, paid to Pharaoh, King of Egypt, by the whole of the Egyptian proprietors, after the seven years of famine; and this amounted to one-fifth part of the produce.

The peasant's labour-rent in Russia amounted to from three to four days' labour per week, for the use of as much land as was sufficient to produce food for his own maintenance and that of his family.

The Metayer gave from one-half to two-thirds of the produce, as rent to his landlord, who furnished him with stock and implements to cultivate the soil.

The Ryot paid from one-fifth to three-fourths of the produce of the land to his sovereign. The cottagers in Ireland pay in money, frequently more than the money value of three-fourths of the whole produce, for their small farms, when they have, in most instances, been at all the expense of the buildings and other accommodations.

The farmer's rent is paid in money, and may be reckoned at from one-tenth to one-half of the money value of the produce, according to the kind and quality of the soil.

Arable land pays a much smaller portion of the produce than pasture or meadow land. The latter, indeed, when very productive, and in the neighbourhood of a populous district, sometimes pays more

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than three-fourths of the produce; and even then, it leaves a greater return to the farmer than that which he derives from arable land of the same quality.

The difference arises chiefly from the greater expense which arable land necessarily requires in its cultivation.

The fertile powers of the earth, aided by application and experience, yield, to the industry of the husbandman, more than is necessary for the expense of cultivation.

The portion of the produce which remains, after the expense of production is defrayed, the farmer is enabled to pay to the proprietor for the use of the land; and this overplus varies, according to the nature and fruitfulness of the soil. The amount of rent, therefore, depends on the natural fertility of the soil; but as permanent improvement has the effect of increasing the productive powers of the soil, it must also tend to increase the rent.

Rent, therefore, depends not only on the natural, but also on the artificial, and permanently improved fertility of the soil; and when these two are joined together in the highest degree, there will be the greatest difference between the value of the produce and the expense of production; or in other words, the soil will then yield the greatest rent.

Adam Smith, after asserting "that in more ancient times nearly the whole of the produce belonged to the landlord," goes on to say that, "In the present state of Europe, the share of the landlord seldom exceeds one-third, sometimes not one-fourth, of the whole produce of the land. The rent of the land, however, in all the improved parts of the country, has been tripled and quadrupled since those ancient times, and the one-third or one-fourth part of the annual produce is, it seems, three or four times greater than the whole had been before. In the progress of improvement, rent, though it has increased in proportion to the extent, diminishes in proportion to the produce."

Rents have therefore risen in England, although the proportion of the produce given originally to the landlord in the shape of rent has diminished: this increase of rent has resulted from an increase of produce, and this increase of produce has been produced by a better system of farming, by a better application of additional capital to the dormant, or latent powers of the soil, bringing forth an additional produce sufficient to cover all the expenses, besides an additional portion of the produce in the shape of rent.

The increase of rent is therefore entirely owing to the increasing improvement of agriculture, and not owing to an increase of the price of farm produce, as the political economists would have it. The industry, the activity, the mental energy of the farmers, and the judicious application of their capital, RENTS. 223

is the true source of the rent of the landlord, and of the wealth of any nation. It is this that gives to a nation all its resources, and every thing that gives a spur, and a spring to fresh energy. Every fresh application of capital gives an addition to the wealth of the landlord, and to the nation; and every thing which tends to check or paralyse these exertions, abstracts the capital of the tenant, and lowers the rental of the landlord and the resources of the nation.

The natural produce of pasture land, however poor it may be, is worth something for sheep; or young beasts will grow on such land, without any other expense than that of attendance and the original price of the stock: but land under arable culture cannot pay any rent, till the price of the produce exceeds the expense of production. Under a proper system of cultivation, however, it has been shown, that the productiveness of the soil may not only be increased, but the expense of its cultivation may be diminished; and we shall find, that the free produce is increased in nearly the same proportion, as the produce itself is increased.

Thus, if the price of 12 bushels be the expense of cultivating a particular soil, and the produce be only 12 bushels, there cannot be any rent paid in this case; but, if the produce be increased to 14 bushels without an increase of the expense of production, there will be 2 bushels of free produce, out

of which the rent may be paid; and if the productiveness of the soil is increased, so as to bring forth 20 bushels, then there will be 8 bushels of free produce, and the rent may likewise be increased to nearly the price of 8 bushels. When improvement of the soil has doubled or trebled the free produce, without any increase in the expense of cultivation, the rent may also be doubled or trebled; but if the land has undergone no improvement, the rent must fall as the price of the produce falls, or as the expense of production increases;—and, although the price of produce may fall, and the expense of production be increased, yet the rent even in this case may be increased too, if the productiveness of the soil be increased in a greater ratio.

The average price in the kingdom, of all the produce of the land in question, should be taken as the principle for fixing the money value of the free produce; and if the rent is fixed at a certain portion of the produce, and the money value of it regulated by the average price of such produce for the last five years;—this, we think, would be the best and most equitable mode of fixing the rent either of arable or pasture land.

We therefore conclude, that the rent of every quality of soil is necessarily limited by the surplus or free produce, over the expense of cultivation, which includes the interest or profit on the capital which the farmer employs.

But the price of land is kept up, by the small farmers treading on the heels of those above them; the occupiers of a hundred acres out-bid those who occupy two hundred, and these again out-bid those who occupy still more extensively, as the smaller farms are always in the greatest demand.

The rent or value of land in every situation may be illustrated by the detail of farming operations for a certain period; and the difference between the price of the produce, and the expense of culture, will shew the profits and the rent.

If landlords permanently increase the productiveness of their land, they will reap the profits arising from the improvement, by a yearly increase of rent; and if the tenant is at the expense of permanently improving the land he occupies, he is entitled to reap the fruits of his own industry, by having as many years of the increased free produce allowed him, as will repay his exertions and sunk capital with compound interest, before his landlord takes the advantage of the improvement, either by re-occupying the land, or by increasing the rent.

67. Profits of Agriculture.

PROFIT is defined to be the difference between what the article costs, and that for which it is sold. In some things, the difference is easily ascertained;

in others, it is with difficulty that we discern it. In the one case, there is merely the purchase and the sale of the commodity, and this may be done without capital; in the other, there is a complexity of accounts of expense; such as the tear and wear of machinery—wages of labour—expense of buildings—and interest of capital—all of which must be reckoned before we balance the accounts to see the amount of profit.

Profits always increase as the demand for the article increases, and according to the risk or difficulty in producing it. Where great ingenuity is required, and when there is great risk to the body or the health of the operators, there are but few individual competitors.

The necessaries of life are produced at less profit than its luxuries; and those that are engaged in enployments, which, when compared with others, that require great exertion of body and mind, may be regarded as a pleasure, are content with less profit on their capital.

But the amount of profit also depends on the number of times, which we can turn over the capital in any given period.

The merchant may do this once a month, and even oftener; and if he gains two per cent. on each transaction, this will amount to 24 per cent. per annum on his capital.

The manufacturer may be able to do this only three or four times in a year, and therefore he will require a greater profit on each transaction than the merchant; but the farmer can only bring to market once a year the goods which he produces, and therefore, from the price of these goods, must arise the whole of the profits on his capital employed.

The merchant or speculator buys the commodity at or below the market price, or what he thinks he can sell it for, or he would not make the purchase; and so does every one through whose hands any commodity passes, till it comes into the hands of the consumer; he alone buys it for consumption, he therefore not only pays the first cost price of the article, but also all the expense and all the profits of every one who has had possession of it.

It is evident that the production of any commodity must yield a fair per centage on the capital employed in producing it, or it would soon be given up; so must it be with agriculture. The reduction of the price of agricultural produce, may have the effect of reducing the rents: but the profits, or returns which the farmer receives on the capital employed, cannot fall below the average per centage of capital employed in the production of other commodities. Other trades may fail, but agriculture which supplies the first necessaries of life must continue, as its

profits and its rents are the true and genuine source of all other employments.

In cultivating the soil, labourers must be employed; and the natural value of profitable labour, is the maintenance of the labourer and his family, during the period which they are profitably engaged. "The husbandman must first eat of the fruits of the soil."

The agriculturist must also get as great a per centage on the capital he invests in the cultivation of his farm, as that which he would obtain if he employed it in any other way; to this must be added the value of his skill and abilities, which he could otherwise profitably employ. All these demands must first be satisfied, and the remainder of the produce being free, will naturally form a fund out of which the rent must be paid.

The rent, includes tithe, poor rate, church rate, road and county rate, and all parochial and parliamentary taxes on the land. The only object of the farmer is simply a profitable employment of his time and capital.

The natural qualities and powers of the soil, as we have already shown, are permanently improved by a proper application of capital; and it is susceptible of a continued improvement by every fresh application of capital judiciously employed.

The produce of any soil is in proportion to the capital and skill employed in the cultivation; but the industry of man is not alike productive.

By superior ingenuity, contrivance, and skill, one man renders his exertions much more productive than those of another man, who is not possessed of these resources; and with the addition of the results of past labour, or in other words, by money or implements, he may yet effect a still more productive application of his strength.

The cultivator, however, frequently fails in his speculations, from the want of a judicious arrangement in the rotation of his crops; from expensive or unskilful application of labour in the cultivation of the soil; from the want of economy in consuming the produce by stock; and often from a want of capital, as well as from giving too high a rent for the land he occupies.

But if the farmer has capital sufficient for his undertaking, and is possessed of skill and ability to apply it to the best advantage, the result will be profitable to himself, to his landlord, and to the community.

He will use the most effective mode of bringing the powers of the soil he cultivates into immediate action; knowing that the greater return he can make of food for man and beast at the least expense in the production, the greater will be his own profit, and the more advantageous will it be to the consumer, as this increased produce will tend to lower the price of the article; and the landlord also will have the prospect of an increase of rent, according to the increased capabilities of the soil, at the end of the farmer's lease.

The landlord should by every means encourage the perfect drainage and deepening of the subsoil, the altering and improving the texture of the soil by the application of those materials of which it is deficient, and all other permanent improvements of which the soil is capable.

This he ought to do even by a large outlay of capital, provided he has a fair prospect of getting a better return for such outlay, than he can expect to realize from any other speculation that holds out equal security, or in which there is no more risk.

Capital applied to increase permanently the productive powers of the soil, has the same effect as if we added so many acres to the breadth of the estate; it does more, indeed, for it gives us the power of cultivating this increased energy, at the same, or at a less expense than before, as highly productive land is universally cultivated at less expense per acre, than that which is poor and unproductive.

The landed proprietors of England must arouse themselves from that apathy and indifference with which they have so long regarded the permanent improvement of their estates, and endeavour to give to their land an increased power of producing a much greater return. This, we think, may be easily attained by giving to their tenantry leases of 21 years, and binding every farmer to effect at his own expense all the permanent improvements of which the soil is capable, and in such a way as shall be pointed out to him, by some skilful and experienced agriculturist capable of directing such permanent improvements.

The high state of culture which exists in the Lothians and other parts of Scotland, and in the north and east of England is, we think, entirely attributable to the leases, which the farmers have of the land they occupy, for the terms of 19 or 21 years.

That very great improvements in agriculture are going on much faster in some parts of the kingdom, and in some parts of the same county, than in others, every one who has a personal knowledge of the state of agriculture in the kingdom will admit, and if we trace out the cause of the great improvement on the one hand and of the indifference or neglect on the other, we may be led to the point which may direct us how to effect generally what is at present so very partially practised.

The tenant at will who on the good faith of his landlord lays out his capital on the improved culture

of the land he occupies, knows that he has no security that the money he may lay out in the permanent improvement of his farm will, in the case of his death or of accident which may derange his pecuniary affairs, ever be returned to him or his family, and, therefore, he limits the expenditure of his capital to the natural and yearly expense of cultivating the crops he yearly puts into the soil, and of course never expends a single shilling in attempting to permanently increase the productiveness of the soil. The farm in this case is only well cultivated land, the productive powers of the land have not increasedgood crops are produced under his management, but the soil under this good culture has not doubled the produce nor in any great measure increased the number of bushels it used to produce; the fact is the capital has only been expended to produce the yearly return-none has been laid out to permanently increase the yearly produce.

The yearly tenant is constantly in a state of uncertainty, he therefore jogs on in the beaten tracks, anxious to be able to clear his way, but never anxious to increase the productive powers of the soil he cultivates, lest his rent should be raised, or lest he should be turned out to give place to some one in greater favour with his landlord.

The tenure from year to year, being the act of the landlords, they only and solely are the cause of the listlessness and slovenliness of the tenant at will, and to the landlord alone is to be attributed the absence of permanent improvement in the agriculture of the south and west of England, for to obtain the greatest yearly return without adding anything to increase the productive powers of the soil, is the only object of the tenant at will.

Give to the English farmer, who has a sufficient capital, a certain term in the soil which he cultivates, and then he will not only be justified in laying out his capital in its improvement, but he will exert all his energy in increasing its productiveness, so as to insure the greatest return to him for his outlay. The length of term to be given should be in connection with the improvements which the land requires.

When land is let for building on, a term of 60, 80, 90, or even 999 years is granted to idemnify the speculator for the expenses of brick and mortar, and the risk he is subject to, just so should it be with the farmer when there are extensive improvements, and risk to be sustained, if the land is wet, and has to be thoroughly drained, and subsoil ploughed;—if the nature of the soil requires to be altered, so as permanently to improve its texture;—if roads have to be made;—if additional buildings for the accommodation of stock, to consume the increased produce, are necessary;—if foreign manure be required, and

a new and more perfect mode of culture be necessary, such a length of lease according to the particular circumstances of the farm should be granted, as will induce an enterprising tenant to embark his capital in the permanent improvement of his farm.

We hold it to be a principle to be acted on in all cases where the farmer either by his capital, or skill and industry, or by both, has increased the productive powers of the soil, that he should enjoy the fruits of his labour as a patent right for 14 years at the least, and that the only condition required by the landlord, which should be imperious, that this increased productive power should be left entire, and not destroyed at the end of the term; but if great outlay of capital, as in perfect drainage of the subsoil, and the deepening and altering the texture of the soil, then the patent right should extend over a period of 21 years.

It is a very weak reason to say that the lease is only binding against the landlord when the prices are high, and of no use when the prices are low, as the landlord must then either reduce the rent or take possession of the farm, for if the land be fairly rented, and if the tenant is bound to lay out his capital in the permanent improvement of the estate, the amount thus laid out will be a sufficient guarantee that the tenant will be able to pay the rent however low the prices may be, if they are caused by the

natural effects of the season. The tenant will be always able to give to the landlord the same quantity of farm produce in the shape of wheat, barley, oats, beans, beef, mutton, cheese and wool, which he at first contracted to pay in the shape of rent, but if an artificial change caused by Government lowering the prices below what natural causes would, then we think the landlord ought to suffer from these, because he ought to have protected himself and his tenant from them.

Wherever long leases have been granted with proper clauses to enforce the particular kind of permanent improvement which is necessary to increase the productive powers of the soil, there is not only an improvement in the state of culture, but a rapid augmentation to the capabilities of the soil, enabling it to produce a further increase of produce, so that the crop in the course of a 21 years lease may have been doubled and even trebled with a much less annual expense for the cultivation of the crop than was required at the beginning of the lease, when the land did not make half the return.

Improvements in the culture and management of land may take place on some estates by tenants at will; generally speaking, however, it will be effected very slowly; but any improvement for the permanent increase of the productive powers of the earth for doubling the crops will never be effected unless under a lease or by the landlord himself.

There is something more necessary than merely keeping up the fertility of the soil.—Unless the fertility of the soil be increased—permanently increased, we do not attain to that character as agriculturists which we think every farmer should strive to arrive at, and which every landed proprietor ought to make it his bounden duty to enforce as a condition in every lease he grants; indeed the principal advantage to the landlord in granting leases is the increased productiveness which the soilwill derive from the state of culture and improvement which he binds the farmer to put in force during the whole period of the lease, and which will leave the land at the end of the lease increased in its productive powers.

The first expense of the new order of things is the greatest, the most hazardous if not properly laid out by one who from his experience knows the effects which it will produce, but at the same time, it is the most profitable, in as much, as all the other operations of agriculture can be accomplished at much less expense, perhaps at three-fourths, or even one-half the previous expense, so that by the first outlay in draining, subsoil ploughing, deepening and altering the texture of the cultivated soil, one half of the

yearly expense of cultivation is saved, and a much greater certainty of crops secured than before.

Improvements in agriculture may be effected either by an increase of produce at little additional expense; or, by reducing the expense of cultivation, without diminishing the produce.

If we save a fraction of the expense of cultivation, that fraction will be as much in the nature of free produce, as if the original expense of cultivation brought forth so much additional produce. When we see the most expensive modes of cultivation adopted over a great portion of the kingdom, where a man and a boy with from three to five horses are employed in doing less work with the plough, than a man and two active horses perform in other parts, there can be no difficulty in resorting to the means of lessening the expense by reducing the number of working cattle.

Government should give the same impartial protection to the agricultural community which it gives to the manufacturing and commercial interests; and the taxes, both parochial and parliamentary, on the capital employed in agriculture, should be after the same rate as those on capital employed either in trade, manufactures, commerce, or Government security. Those too, that are now called money capitalists, a new branch of society sprung up since land, parochial, and commercial taxes were enacted, should

also be taxed in the same ratio as every other class of the community.

68. Means proposed of introducing Agricultural Improvement.

We have for many years been convinced, that very great advantage would result from a chain of example farms spread over the several Geological formations, to put into active operation the system which we have ventured to suggest for increasing the productive powers, and for permanently improving each of the several classes of soil, and to afford a practical specimen to the diligent farmer of the best mode to be adopted in its cultivation.

The situation of these farms should be on that portion of the geological formation, where the peculiarity of the soil is most evident, and, if possible, where the formation is the broadest. These farms should be so near to each other, as to give to the whole of the agricultural community, the power of a personal examination into all the details of their management.

Two or three should be situated on each of the formations, or at least on each of the soils which we have classed together, and their distance from each other should not be greater than 15 or 20 miles.

These farms should vary in extent from 200 to 300 acres, according to the nature of the soil. Those on soft sandy soil should be the largest, and those on clay the smallest; because a greater degree of attention is necessary to the details of every branch in the cultivation and management of clay than of sandy land, and more capital is also required.

As the manager too must see the various operations accomplished, and be accountable for the proper execution of each and every one of the plans laid down, a farm of larger dimensions, than that which we have stated, could not be grasped by a personal attendance upon every separate operation: and the personal attendance of the manager is absolutely necessary to insure complete success.

The buildings on these farms should be conveniently arranged, and of such an extent as would give every accommodation that is necessary. Where new ones are to be built, these ought to form specimens of farm-offices for farms of the same extent; not expensive erections, but, on the contrary, economically arranged, as well as erected. We cannot help observing that much capital has been wasted in the erection of farm-buildings, particularly of barns.

Many are the advantages which landlords, as well as farmers, would derive from the establishment of such a chain of example-farms, carried on under the most scientific and improved mode of culture, and as examples to be followed by farmers of the same kind of soils.

Such an association of example-farms over the various geological formations, we think, could be easily carried on with profit to the proprietor, and would be of the greatest advantage to all those who are occupants of such kinds of soil.

These farms would exhibit the best means of permanently improving the soil, and of increasing its productive powers;—the best and most profitable mode of cultivation;—the kind of crops best suited for each class of soils, as well as the amount of capital per acre, necessary for carrying on the ordinary operations of farmers;—the amount of extraordinary capital sunk in altering and improving the texture, for the purpose of increasing the productive powers of each class of soils; -and the reduction of the yearly expense of culture, after the texture of the soil has been changed. They would also show what portion of the produce it required to defray the expense of cultivation, what, for the interest on extraordinary capital sunk, and what, for profit and rent.

All new modes of culture which would be proved, from the practice adopted on these farms, to be the best and most profitable for any particular soil, would have the stamp of authority fixed on them, and the best, the cheapest, and the most profitable, for every soil of this character.

These example-farms being over every class of soil, the mode of culture best calculated for each would, in like manner, soon be confirmed and held up to the agriculturist, as the one which should be adopted under similar circumstances.

Every operation should be shown in the most public manner, all the details explained, and the result should be self-evident to every observer, and proved to be a well substantiated fact.

By the continuance of such a system, and by such an exhibition of its details, we may be able by the result to put to flight the unprofitable and expensive mode of culture, the customs, and the prejudices, of the farmers in the several localities.

The best mode of culture would soon be established for every particular class of soils, from having the test of the example-farm seal to it; and the landlord, or manager of estates, would have an undeniable authority for enforcing the adoption of it. Prejudice would be shamed out of her old practice, and landlords and tenants would cordially join their exertions in every plan which was thus found to be the most profitable, whether the profit was quickly returned, or obtained only after a lapse of years. The permanent improvement of the land would be gradually increased, and its productive powers would be soon

doubled and even tripled; and thus, by increasing its capabilities, the tenant would have a better chance of secure and ample profits on his outlay of capital, and the landlord of his rent.

The relative portion of the produce necessary for the interest of the natural capital, and the expense of cultivating the soil;—for the extraordinary interest on the capital sunk for its permanent improvement; -for the farmer's talent, exertion, and profit, as well as for the landlord's rent, would be clearly established, by the result of such example-farms. The proprietor, therefore, and the farmer of land of any class of soil, would have the test of experience for fixing the portion of the produce as rent; the amount of capital required for the proper cultivation of such land would also be known; and thus, the landlord would have it in his power to ascertain. whether the capital of an applicant for his estate. was sufficient for the undertaking, and he would consequently be less liable to disappointment.

In establishing these example-farms, capital to a considerable amount would be required, and although in this day of speculation and of joint-stock companies, a joint-stock agricultural society for the permanent improvement of land might be formed, with as many £100. £50. or even £5. shares, as would make up the sum required; yet we think this would not meet the view which we take of the subject:

speculative shareholders would only be a drag to such an undertaking, and it would soon fall to the ground, if the landed proprietors themselves, did not see the advantage of such a plan, and come forward, either as individuals, or as a body, and take up the matter.

An individual landlord, possessed of a considerable extent of land on any one class of soils, might himself take in hand one of his own farms, afford the necessary capital, and appoint a director to carry into active execution all that is proposed; or several landlords might join and form themselves into a society, in the several localities where they reside; and if such a number of individuals, or of such small societies, could be formed to furnish the necessary materials for setting the thing a going, even on a small scale, were it on the plastic clay formation only, we have no doubt but the plan would soon extend.

If the farms be rented, they should be on a lease for 21 years, and the occupier should pay all the expenses of permanent improvement; or if the landlord paid the amount of the money sunk, the lease might then be only for 14 years, and the occupier should then pay 5 per cent. interest, on all money sunk, beginning to pay the interest from and after the end of the second year after the outlay.

As a profitable outlay of the sunk capital, and

increased profits on the ordinary capital from the mode of culture, are the only objects, their attainment must be rendered evident by the result, or the system is of no value; and as this must depend, in a great measure, on the director, we would propose that he should be paid out of, and have a certain portion of the profits; and any fixed yearly allowance given to him, should be barely sufficient to cover his necessary expenses.

The proprietor, in choosing a person to direct and superintend all the various proceedings on these example-farms, must be satisfied that his abilities and qualifications are equal to the undertaking; as on him would devolve the direction of all the various operations, which he thought necessary to carry out the system of improvement and culture, to its full and complete extent.

The director should be accountable to the proprietor for the success of the system which he proposed, for the contemplated permanent improvement of the soil, and for the better cultivation of each of these example-farms.

The plan adopted by him, should be founded on some regular and scientific principle, and he should be required not only to give a written account of it, but to enter minutely into all the details, and to give an estimate of the expense of perfectly draining, and altering, the texture of the soil of each field, and

also to state what effect such improvement might be expected to produce after a certain period of time.*

The person appointed by the director to undertake the management should reside on the farm, be completely under his control, and accountable to him only for the proper and timely execution of all the various operations.

The director, of course, must be convinced of his fitness and qualifications for such an undertaking. His mind should be free from prejudice and open to conviction, he should be capable of adopting and executing any plan proposed, and should have a practical knowledge of the details, which are necessary on a farm of such a soil as that which he is to manage.

A daily account of all the work done in every field must be entered in the day book, which should be a record of the most minute particulars of all circumstances attending it.

The state of the weather, too, should be noticed, as favourable, or adverse, to such operations, and all the effects produced should be carefully observed and registered.

From these minutes, daily recorded, a monthly report should be drawn up by the director and manager, and read to those who attended at the monthly

* A report of Whitfield Example-Farm is appended to this work.

meetings on each farm. Such a report, should of course, enter into every minute circumstance, point out what has been effected, in what the plans have failed, and where they have succeeded.

Although the example-farms of each locality might belong to one proprietor in the neighbourhood, or to several, yet, as the objects would be to disseminate the principle of permanently improving and increasing the capabilities of the land; as well as to put forth an increased produce by adopting the best mode of culture for each class of soils; a monthly inspection of each should be offered to the public, and every farmer particularly invited to attend, and to give his opinion, on every operation, which should be taken down in writing as the inspection proceeds. This inspection should not only be of the field operations, but of the books, the state of the accounts, and the expenses.

Each separate locality would thus be interested in the proceeding of its own example-farm, and be emulous for its success; and the effects produced in its immediate neighbourhood would spread, till it met with the extended influence produced by the surrounding localities; so that the whole agriculture of the kingdom would soon feel, and be influenced by the power of such an improved system of culture. These reports should be published at least once a quarter, and embody every thing that has had, either directly or indirectly, any relation to the subject.

This publicity would court examination and enquiry; and this circumstance alone would do much in eradicating prejudice, and in begetting a spirit of improvement amongst agriculturists.

The proceedings on the whole range of these example-farms, and the reports of the inspector, would afford materials for a public agricultural journal, which would find a ready circulation over the whole range of the several localities; and afford materials for information, or discussion, on every branch of agriculture, as well as on any particular mode of executing the various details of cultivation.

An agricultural journal with such a ground work, would be sure of commanding a most extensive circulation; as the matter put forth in the reports of the various farms, would be the result of what had previously taken place in the example-farms, which had been examined, and reported on, by those who had no personal interest in them.

These example-farms, by affording the best agricultural information, would form the best school for the practical education of those, who intended to spend their life in agricultural pursuits. The manager or director might take a limited number of pupils, and educate them in every practical branch necessary to make them capable of fulfilling the duties of their station, with advantage to society, as well as profit to themselves.

If such an establishment for the education of young gentlemen, in all the branches of science indispensable or tributary to agricultural knowledge, could be formed in connexion with several of these example-farms, so as to have the advantage of a weekly or monthly examination; then, much useful and practical information might be gained, by such a liberal, judicious, and practical mode of instruction.



A PLAN

And SECTION of

WHITFIELD EXAMPLE FARM.

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APPENDIX.

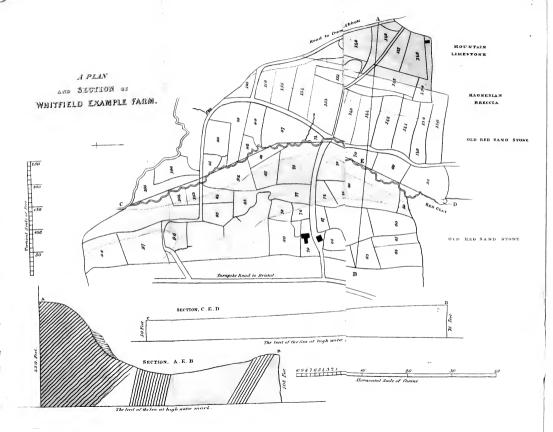
REPORT

OF

WHITFIELD EXAMPLE FARM,

BY

JOHN MORTON.







APPENDIX.

WHEN any defect exists in the conduct or operation of others, the best mode of correcting it is to show by example the superior advantages of a better plan of proceeding. If we reason with them on the foolishness of any part of their proceedings, we may be able to convince, though we should have to pierce through a host of objections raised by selfishness and prejudice; but even should we succeed so far, pride will not allow them to adopt our suggestions, because, by so doing, they would acknowledge their own inferiority. The case is, however, materially altered when their imperfections are displayed by the result of an example daily placed before their eyes; they will then insensibly fall into the plan which expediency teaches them is preferable, because they may do so without any personal acknowledgment of inferiority.

To no class of people does this remark so strictly apply as it does to farmers; for in none, generally speaking, is there such a degree of prejudice, and such a strict adherence to custom. The only way in which an improvement is to be effected in their mode of cultivation is by keeping a practical specimen of the best farming constantly under their view.

We have elsewhere stated that "a general association of example-farms over the various geological formations could not only be carried on with profit to the proprietor, but would be of the greatest advantage to all those who are occupants of each kind of soil. These farms would exhibit the best means of permanently improving the soil, and of permanently increasing its productiveness; the best and most profitable mode of cultivation; the kind of crop best suited for each class of soils; the amount of capital per acre necessary for carrying on the ordinary occupation of the farm; and the reduction of the annual expense of culture after the texture of the soil has been changed. They would also show the relative portion of the produce necessary for the interest of the natural capital, and the expense of cultivating the soil-for the interest on the extraordinary capital sunk in its permanent improvementand for the farmer's talent, exertion, and profit, as well as for the landlord's rent. Every operation would be shown in the most public manner, all the details explained, and the results would be selfevident and proved to be well-substantiated facts. The test of public opinion, which would then be stamped on each of the several operations, would be

the surest way of fixing its value; the success or failure of each would be made known to all; the valuable portion would be adopted and acted upon, and the worthless rejected."

In many cases an attempt has been made by landlords to institute farms of this kind; but their principal object has been the improvement of live stock, in which they have deservedly merited approbation and reward. The great fault, however, of these has been, that though different modes of cultivation have been compared, and, in some cases, their relative value ascertained, yet the expense and return of each operation and the general money accounts of the farms have never been kept distinct and separate. In many cases economy has not been an object, so that however excellent each operation may have been, yet the fact, so often the case, that the expensive mode in which they have been performed has rendered it a losing concern to the proprietor, affords just the strongest argument to the farmer against the adoption of any of the proposed plans, and strengthens his prejudice in favour of his old habits.

With the sanction of the Earl of Ducie, and his son Lord Moreton, an example-farm is to be formed in the parish of Cromhall; and it is intended that the above remarks, as to the general objections against those of the kind as yet formed, shall not apply to this. It is intended that every thing shall be brought

to the book, and the merits or demerits of each operation determined only by a reference to the cash account, in which the expense attending it, and the return from it, will appear. The agricultural public are invited to inspect and report their opinion on each and every operation, so that, by the whole being placed before them, it is hoped that an interest may be excited.

REPORT

On the present state of Whitfield Farm, situated in the Parish of Cromhall, in the County of Gloucester, belonging to the Right Honourable the Earl of Ducie, and the plan proposed for improving it.

This Report will consist of three parts:—1st. The present state of the farm, under the mode of management adopted by the present tenant, Mr. Thomas; 2nd. The plan which I purpose to adopt in attempting permanently to increase the productiveness of the soil; and 3rd, The system of culture which I think is best calculated for such a soil after it has been improved.

- I. The present state of the farm under the mode of management adopted by Mr. Thomas.
- 1. This farm has been in the occupation of Mr. George Thomas, as a yearly tenant, for the last twenty-one years. It consists of 232 acres, 164 of which are pasture, and 68 arable. The rent is £200. a-year; the poor-rate £28; the tithe £33; and the road-rate £4; which, including all parochial taxes, amounts to £265 per annum.
- 2. The buildings on this farm are very limited. A dwelling-house, 45 by 35 feet, consists of a kitchen,

back-kitchen, dairy, and parlour below, with four bedrooms above; a small barn, a stable for four horses, a shed with four bays, sufficient for eight cows, a house for four cows, and a calves' house, form the whole of the buildings on the estate; and these are in a very bad state of repair.

- 3. One is struck with the forest-like appearance which the pasture-land presents, when viewed from the high ground at Abbot-side. The immense number of oaks, and other trees in the hedgerows, are so crowded together as to injure the pasture greatly, by occupying the surface, preventing the circulation of the air, destroying the fences, preventing the drainage, and shading the grass, thus making it unpalatable to stock (souring it).
- 4. Mr. Thomas keeps a pack of twenty-five cows on this farm, and rears seven calves a year, which he keeps till they have calves, when three years old, to fill up the place of seven cows, which, together, in some cases, with some of the heifers and calves, are sold every year. Thus seven heifers or cows in calf being sold in the spring of the year, his live stock consists of twenty-five cows, seven heifer calves, seven year-old heifers, and seven two-year-old heifers. These, together with four working horses, a riding horse, and some pigs, are the whole of the live stock which have been kept for the last twenty-one years.
 - 5. The produce of the 164 acres of pasture-land

is wholly consumed by the above fifty head of stock. There are generally about 100 acres of it mown, and made into hav for the maintenance of the stock during the winter and spring, and the remaining 64 are pastured during the spring and summer, till the cattle can be turned into the latter-math. That portion of the grass land which is pastured, has been always pastured, and the remainder has been generally made into hay. One would naturally expect from this mode of management, a gradual improvement in the land which has always been pastured; but this is not the case, owing to the wetness of the soil, and in consequence of the land being so shaded and covered with trees. The natural result, however, of mowing land every year, and carrying off the produce, shows itself in the most evident light; unless manure is laid abundantly on, such a treatment must necessarily injure any land, and particularly this, which is so wet and spongy. The crops of hav which are produced, are sometimes not worth the expense of making, seldom averaging more than half a ton per acre; and then it is composed of anything but grasses of a good quality. The principal plants which grow in the pasture-fields-besides a mixture of the common grasses, Meadow Fescue (Festuca pratensis), Rough-stalked Meadow-grass (Poa trivialis), Rough Cock's-foot (Dactylis glomerata), and Perennial Rye-grass (Lolium perenne)-are

the common yellow Cow Wheat (Melampyrum pratensis), which, in many cases, completely yellows the pasture; the Moon-flower (Chrysanthemum leucanthemum), which, on the other hand, is frequently so luxuriant as to give it a white appearance; the Corn Marygold (Chrysanthemum segetum), the common wild Basil (Clinopodium vulgare), Rest Harrow Cammock (Ononis Arvensis), Dyer's green weed or Wood waxen (Genista tinctoria), Common Agrimony (Agrimonia Eupatoria), Corn Woundwort (Stachys arvensis), yellow Meadow Veitchling (Lathyrus Aphaca), Greater Knapweed (Frustranea Cyanus), Common Feverfew (Pyrethrum Parthenium). Besides these, there are many other plants which prefer the wetter parts of the ground, such as several species of Orchis, the Meadow Lychnis (Lychnis floscuculi), and the Water Flag (Iris Pseudocorus), which only grows where it finds standing-water, as in the bottom of ditches, &c.

- 6. There might be some manure got from the consumption of 100 acres of hay; but it is all carried to the arable land, and nothing but a little earth taken from the grips (surface or open drains), mixed with a little lime, is put on the grass land.
- 7. There never has been any underground, and very little surface draining done on this farm; the fences are, therefore, in a bad state, and most of the ditches are full of the roots of the hedgerow trees,

brambles, and rubbish. There is a prejudice existing against underground draining; "Gripping" (that is, surface draining) "will do good on this land, but underground drains never do good on this land, sir." This is a common saying, not only of Mr. Thomas and the workmen, and all those who have any connection with it, but also of some of the neighbouring tenants, without any reason being given for it. From Mr. Thomas it may be taken as an apology for his conduct. I think they might have found a good reason in the immense number of trees, the roots of which would soon stop the best and most efficient underground drainage that could be effected.

8. The mode of managing the arable land, is that which is used amongst most of the dairy farmers in the neighbourhood, potatoes and wheat for the family being the chief crops. As, however, there is a much greater proportion of arable land on this farm than is generally the case with dairy farms in this neighbourhood, Mr. Thomas sometimes has part of the land in barley and clover, and has lately had some of the poorest of it planted with teasels. At present I find fourteen acres in wheat, which may produce twelve bushels per acre; seven acres in barley, which may produce twenty bushels per acre; seven acres in teasels, worth, perhaps, 30s. per acre; eight acres in clover, which may produce eighteen cwt. of hay per acre; and twenty-four acres in potatoes, which

may produce $5\frac{1}{2}$ tons per acre. Of the potatoe land, eight acres are dunged, and let to the labourers at £7. per acre, and sixteen acres are not dunged, which are let to the labourers at £4. per acre, and the remaining acres are for the use of the family. The whole of the arable land is full of couch, thistles, and every other weed which such land is subject to.

- 9. There is no fixed system of cropping, nor is there any plan for executing the work which must be performed. No arrangement is made for the performance of any one act of husbandry; all is left to chance; if the work be done soon after his neighbour's, the farmer thinks that all is well. We need not be disappointed, therefore, at the result of such management.
- 10. The whole of the potatoe crop belonging to the labourers is of course carried off the land, and the little straw which the wheat crop produces is made into hulm, as it is called, for thatch; some of this is kept for thatching ricks, and the remainder is sold. The only part, therefore, of the produce of the arable land which is consumed on the farm is the barley straw, the hay from the clover, and the potatoes and wheat which the family consumes; all the rest is taken off the land.
- 11. The expenses attending this mode of farming are not very great. The workmen employed are two men (a cowman and ploughman), a boy, and two

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women in the house to manage the dairy. In har-
vest there are sometimes two mowers and two men
to make the hay. There may thus be four additional
men for ten or twelve weeks during the hay, corn,
and potatoe harvests. The expenses of the labourers
may, therefore, be stated as follows:—
£. s. d.
Two men by the year at 9s. each perweek;
one boy at 3s.; two women at 4s. each 75 8 0
Say four men in harvest for ten weeks at
12s. each 24 0 0
Tradesmen's bills carpenter, black-
smith, &c. house and cows doctor's
bill 15 0 0
Housekeeping—say for four at 4s. per
week each 41 12 0
Forty bushels of malt at 7s 14 0 0
£170 0 0
æ170 0 0
10. Who walve of the madues of this farm may be
12. The value of the produce of this farm may be
taken as under, which is as near as can be obtained:—
\pounds . s. d. For the last twenty-one years the cows
have not averaged $2\frac{1}{2}$ cwt. of cheese
each, which gives $62\frac{1}{2}$ cwt. for 25 cows,
which, at 50s. per cwt. is 156 5 0
Carried forward $\pounds 156$ 5 0

	£.	5.	d.
Brought forward	156	5	0
The butter of twenty-five cows at 30s.			
per cow	37	10	0
A fat pig sold for every five cows—five			
pigs at £3	15	0	0
Eighteen calves at 10s. each	9	0	0
Seven old or young heifers and calves			
at £9	63	0	0
Sold:—			
Wheat, 168 bushels at 7s	58	16	0
Barley, 80 bushels at 4s	16	0	0
Eight acres of potatoes, dunged, at £7	56	0	0
Ten acres of ditto, not dunged, at £4.	40	0	0
Eight acres of teasels at 30s	12	0	0
_			
£4	63	11	0

This estimate of the expense and of the produce is taken from Mr. Thomas's statements and my opinion of the crops.

13. The amount of capital which Mr. Thomas may have employed on this farm can only be estimated by calculating the value of his live and dead stock, and the expense of labour for one year; and it may be stated thus:—

		£.	s.	d.
Twenty-five cows at £10 each		250	0	0
Seven two-year-olds at \pounds 7		49	0	0
Seven year-olds at £4		28	0	0
Seven calves at $\pounds 2$		14	0	0
Five horses at £15		7 5	0	0
Two sows and pigs, say		10	0	0
Two waggons, two carts, two ploughs	3,			
one drag, two harrows, one rolle	r,			
harness, &c		60	0	0
Dairy and household furniture, say		70	0	0
One year's expense of labour, see §.11		170	0	0
	,			
	đ	£726	0	0
14. The profits, if any, will appear	b	y ded	luct	ing
from the value of the produce (§. 12)				
The expenses of labour (§. 11) £170				
The rent and taxes (§. 1) . £265				
	_	435	0	0
Leaving only as interest on the capit	al			
employed		28	11	0
	đ	€463	11	0

II. The plan which I purpose to adopt in attempting permanently to increase the productiveness of the soil.

- 15. In noticing the principle on which I propose to improve this estate, I would observe that, whether the land be arable, pasture, or meadow, unless it can be perfectly drained, little can be done to improve it; for of whatever kind of soil it may be, whether clay, loam, or sand, it is very much injured by a superabundance of moisture: vegetation is retarded, and when the water becomes stagnant, the plants die. It is, therefore, my intention to drain all the wet and moist land.
- 16. There being a large portion of the estate on the clay subsoil, with alternating beds of sandstone, this must be broken up, not only to give depth for the roots of plants, but to enable the surface-water to sink to the depth of sixteen or eighteen inches, before it meets with an impervious bottom, along which it may run or slip over to the underground drains, by which it will be carried off to the main-drain, and thence to the open ditches.
- 17. Before I enter into a detail of the plan which I purpose to adopt, it will be necessary to examine the nature and properties of the subsoil and of the soil resting upon it, the present state of the surface, the roads, and the buildings.
- 18. This farm is about fourteen miles from Bristol, near to, and on the right-hand side of the road from that city to Gloucester. There is a valley in the middle of it, down which a small brook runs in a

northerly direction, dividing the farm into two nearly equal parts, one of which has an eastern and the other a western exposure.

- 19. I have annexed a plan of the farm, with two sections, one across it and the other down the valley, showing the inclination of the surface and the dip and direction of the geological formations, and its elevation above the level of the sea. These will enable me to show the principle which ought to be adopted, and the mode of drainage which will be most effectual.
- 20. The geological formations of this estate are the mountain or carboniferous lime and the old red sandstone. The highest on the east side of the brook is the mountain limestone, which dips to the east at an angle of 50° to the horizon. This rock extends about eighteen chains across the farm, occupying the top of the hill on the east side, and stretching about half-way down towards the brook. The magnesian breccia overlays the lower edge of this formation, and has a breadth of about five chains. Immediately under the limestone, the old red sandstone commences, with the gritty member of it called the pudding-stone. This, we think, extends about fifteen chains down the hill and across the brook. In this pudding-stone are many fine springs of water, which are thrown out by clayer beds, which frequently alternate with the members of this formation. Under

the pudding-stone, and on the west side of the brook, the subsoil is composed of alternate beds of sand-stone and red clay, the clay being the thicker member. These dip under the pudding-stone, at nearly the same angle as that of the mountain limestone. This formation occupies nearly all the land on the west side of the brook. The water which fills up the porous reservoir between the beds of clay, keeps the whole of the surface wet, so that the whole of this part of the farm is rendered a complete puddle, by the feet of the stock in the winter and spring months. The breadth of this clayey section may be about eighteen or twenty chains.

- 21. The soil on the mountain limestone, and the magnesian breccia, is very thin, and is composed of angular fragments of the rock with some vegetable matter. It is dry and healthy for sheep, and, when the season is moist, it would produce good crops of barley and turnips, and sweet pasture. The rock is so near the surface that the soil cannot be deepened by the subsoil plough. The whole of the soil on the lime rock is under arable culture. Some of the hedges here are two or three perches in width, and are composed of thorns, hazel, and brambles, together with the stones that have been carried off the land, and thrown in among the rubbish.
- 22. The soil on the pudding-stone, immediately under the limestone, partakes of the nature of the

rock on which it rests. It is of a silicious sandy nature; from the disintegration of this stone, the soil is composed of rounded pebbles. About half of the breadth of this, on the east side of the brook, is dry, but in the other half there are many springs, some of them very large; these keep the surface for a considerable distance from the brook very wet. The dry portion of the soil on this formation is under arable culture, and would, if it were under proper management, produce good crops of wheat, barley, turnips, and grass; but that portion in which the springs are so abundant is in pasture, and the surface, in many places where it is constantly wet, is covered with bog earth. This is caused by the water being stagnant on the surface. The soil must, therefore, be perfectly drained before any means can be taken to improve it.

- 23. The soil, on that part of the estate which rests on the alternating beds of clay and sandstone, is of an adhesive clayey nature, partaking more of the clayey than the sandy members. It is a wet reddish clay soil, but, if perfectly drained, would form the most productive land on the farm. It would be strong enough for wheat or beans, not too adhesive for barley or turnips, and would answer well to be laid down in grass, or to be cultivated as an arable farm.
 - 24. The state of the fences on this farm are as

bad as can be imagined. The fields are very small, eight of them are under three acres each, eight are between three and four acres each, twenty-seven are between four and eight acres each, and only three fields are above eight acres each, so that the quantity of ditches and fences is very great for such an extent of land. The hedges, being so crowded with trees, and being frequently a perch or two in width, give to the pasture land of this estate more the appearance of a forest than that of a dairy farm. It is thus scarcely possible to keep the fences good, and the ditches in a condition to enable them to carry off the water, from the immense number of roots and leaves of the hedgerow trees. The number of trees is in some cases so great as twenty to an acre. The land is thus completely shaded on account of the smallness of the fields, and the great amount of timber growing in them and the hedgerows.

25. The roads on this farm are, as might be expected, of the very worst description. Some of them being filled with rubbish, and now forming broad hedgerows, and others being made through the fields instead of them. The length of these is the distance between the gateways, and their breadth is in many cases the width of the fields through which they pass. It is thus impossible for a load to be taken from the farm in a cart or waggon in wet weather, without the wheels sinking down to the sock. Roads

must therefore be made through the farm, requiring two or three bridges in their course, before anything can be done towards improving it.

- 26. The first step to be taken in attempting to improve this farm, is to clear it of all the trees which are so injurious to the surface, and which will prevent the perfect drainage of the soil. These we find amount to 618 oak, 662 elm, 388 ash, 63 beech, 40 alder, and a large quantity of hazel and rubbish. The value of the timber I estimate at £3200. This being accomplished, I shall then lay out the whole of the land into such a number of fields as shall be best suited for a farm of such an extent and situation, and having such a soil. Advantage will be taken of any of the existing fences whose situation will aid the perfect drainage of the land, and new ones will be made where ditches are required, or in other places where they are necessary for the conveyance of the water from the drains.
- 27. From the number of small fields of which this farm is composed, there will be a great extent of old hedgerow fences to be removed; and before the drainage and subsoil ploughing of the land can be effected, these and all the oak, elm, ash, beech, and alder trees must be grubbed up, and the ground dug to the depth of at least sixteen inches. The removal of about 3000 perches in length and at least one and half in width, of hedgerows, will thus be required to

be effected, and the ground must then be cleared of roots and dug over sixteen inches deep. The expense of this at 1s. a perch will amount to about £225. The timber to be cut, as it has caused the injury, should defray this expense. The ditches required for the perfect drainage of the land, after quicks have been planted on their edges, will do for the division of the farm into fields. The draining and fresh fencing of the whole will be effected under my superintendence. The whole may be performed at the same time, (i. e.) the forming of ditches to carry off the water from the drains to the brook, and the execution of the underground drains, to empty their water into the ditches.

28. But before these operations can be effected the brook must be deepened; and where it is necessary to effect the drainage of the lowest part of the fields which are next to it, its course must be altered. Although there be not much water in it in the summer season, yet in winter there is a considerable stream; it will, therefore, be necessary to give it the following dimensions: nine feet wide at top, two feet at bottom, and five feet deep at least.

There will thus be seventeen cubic yards in the length of every perch, which, at 3d. per cubic yard, is 4s. 3d. per perch. The length of the brook being about 300 perches, the expense of deepening, and, when necessary, altering it, will be about £65.

DRAINAGE.

- 29. We have already stated that part of the soil resting on the pudding-stone, and all the red clayey portion on the west side of the farm, is very wet and requires to be drained. The extent of this wet land may be about 160 acres, 90 of which on the red clay will require the underground drains to be about a perch or a perch and a half apart, and the remaining 70 acres of low ground, resting on the lower member of the pudding-stone, will do, we think, with one and a half, or two perches between the drains. All the rest of the farm is dry, and does not require draining.
 - 30. The ditches, to carry off the water from the underground drains, and to answer the purpose of fences, should not, we think, be less than four feet deep, six inches wide at bottom, and seven feet wide at top. There will thus be nine cubic yards in the length of every perch, and the expense of removing it, at 3d. the cubic yard, will be 2s. 3d. per perch. If the 160 acres of wet land be divided into ten-acre fields, about 640 perches of deep ditches will be required to carry off the water. The expense of this, at 2s. 3d. a perch, amounts to £74. 13s. 3d.
 - 31. The most perfect and permanent mode of underground draining, is to make parallel drains from the highest to the lowest end of the field, the distance between each being regulated by the nature of the

soil and subsoil; and at the bottom of the field, at the distance of about sixteen feet and a half from the ditch, there should be an underground main drain, into which the parallel drains empty themselves. This main drain should be large enough to take all the water from the drains, even though the field be twenty acres in size, and convey it to the ditch with which it is connected at its lower end. The principal reasons for having all the underground parallel drains to empty themselves into the main, and through that into the ditch, instead of each emptying itself into the ditch, are, that while, in the latter case, a hundred mouths would require to be kept open and clear of rubbish, in the former, only one has to be attended to; and also, that during the summer months, some of the parallel drains would become dry, and allow the entrance of moles and rats, which would soon stop them up, but that the quantity of water which always issues from a main drain would forbid their entrance, and thus hinder them from injuring it or the others.

32. The best time to drain surface or rain water from land is from September to April. The mode of proceeding should be, first, to lay out the directions of all the drains, to mark out the position of the whole, both the parallel and main drains. The digging of the main drain should then be commenced at the lowest end of the field, and it should be finished

before any of the parallel drains are touched. When the uppermost end of the main is at length arrived at, the lower end of the farthest of the parallel drains should be commenced, and the others should be completed one after another. The direction of the parallel drains should be from the top to the bottom of the field, and if there be high ridges they should lie in the furrow; they may be from one to one and a half or two perches apart, varying according to the nature of the subsoil. The fall should be as uniform as possible; it may vary from one in six to one in thirty, and it should be greatest just where it joins the main. The depth of the parallel drains should be three feet, never less than thirty inches. Their width at top should be about fifteen inches, but at bottom it must be regulated by the size of the soles for the draining tiles, and may vary from four to five Their length may be from 250 to 300 yards, but if they cross springs of water, it should never exceed 200 yards. The mode which we have adopted is to begin by putting in the tiles at the top of the highest parallel drain, and the order in which each drain is completed is exactly the reverse of that in which they were commenced, only the main drain is done as the others are completing; that is, after the first parallel drain is completed, the main is commenced, and completed as far as the second parallel,

which being finished, the main is carried on to the third, and so on till the whole is finished. A sole is put in for each tile, or rather the soles should be put close together, and each of the draining-tiles should rest on one-half of two adjacent soles, the middle of each tile being over the junction of two soles. width of the soles should be about one inch greater than that of the tiles, so that it may project half an inch on either side. The bottom sole of the parallel drain, at its junction with the main, should rest upon the top of the main draining-tile, and care should, therefore, be taken to make it sufficiently high for that purpose; a distance of an inch between the tiles of the main drain should be left at that place, so that the water from the parallel drains may fall into the main; and, as each tile rests on two soles, this opening would be covered by the projection of the last tile in the parallel drain, and no entrance would thus be allowed to earth, which would otherwise fall in.

33. The position of the main should be at the lowest part of the field to be drained; its dimension will be regulated by the size of the field and the amount of water it is expected to discharge. A fall of 1 in 200 is the least that can be advised; 1 in 140 or 1 in 100 would keep the bottom clear of sediment. A main drain for a field of ten acres should have tiles

of at least four by six inches in size, or if two tiles, side by side, be employed, they may each be about three inches by four. The soles for the former should be seven inches in width, and for the latter five. The main drain should have double the capability of carrying off water that it is expected to require. The depth of the main should be greater than that of the parallel drains by the height of the tiles used in it, so that, as was before stated, the soles of the latter may run over those of the former, and allow the water they convey to drop through an opening made for the purpose. Two tiles and two soles abreast are much preferable for the main drain to a large one of each.

34. The parallel drains should be covered by cinders or turf, or by the best soil. When the last of these is used, nothing but the very best vegetable mould should be employed. Clay or till ought never to be used for the purpose. Tiles are rather dearer than stones, but they are better when the land is nearly flat. If, however, the field has a considerable descent, stones are better and more durable. They should be broken so small that they can be passed through a two-inch ring, and then filled in to the depth of twelve inches. The course of the main drain should be directed to where it would be most convenient for watering the stock, so as to supply

two or four adjoining fields. A large cistern ought to be used for this purpose, as if the stock get access to the mouth of the drains, they would soon stop them up by trampling on them.

- 35. The depth of the drains is of the greatest importance. It has been found by experiment that a drain five feet deep will keep strong clay grass land perfectly dry to the distance of eight feet on each side of it, while one of the depth of three feet will keep it in the same condition to the distance of scarcely five feet.
- 36. The parallel drains should be at least thirty inches deep, fourteen inches wide at top, and five inches wide at bottom. There will thus be nearly 33 cubic feet of earth to be removed in the length of every perch, and the expense (there being so little room for a man to work in) may be about fourpence per perch. If stones are used instead of tiles, they should, as we have already said, be broken so as to pass through a two-inch ring, and then be filled in (without any mixture of earthy matter) to within eighteen inches of the top. They should then be covered with a turf, and the earth filled in and pressed hard down.
- 37. Drains of these dimensions would require about ten cubic feet of broken stones to fill up the length of a perch to the depth of twelve inches; so

that a cart-load, which is generally about a cubic yard, will be enough for three perches. The expenses connected with the parallel drains will, therefore, stand thus:—

		8.	d.
Digging 33 feet of cubic earth, say		0	4
Quarrying and breaking one-third of a loa	d		
of stones		0	5
Hauling stones and filling into the drain		0	$4\frac{1}{2}$
Covering with turf and filling in the earth		0	$0^{\frac{1}{2}}$

1 2

If, however, draining tiles were used, it would be $2\frac{1}{2}d$. more.

If, however, tiles were used (the expense being 1s. $4\frac{1}{2}d$.), a perch would, if the drains were $16\frac{1}{2}$ feet apart, cost £11 per acre; if they were 24 feet apart, it would amount to £8. 5s.; and, if two perches from each other, it would cost £5. 10s.

39. The main drains require to be of much larger dimensions than the parallel drains, because they convey the water from all these into the ditch; it must, therefore, be at least three feet deep, 22 inches wide at top, and eight inches wide at bottom. There are thus about 62 cubic feet of earth in the length of a single perch, which may be removed for about sevenpence. These must have either a stone-built drain, or, what is cheaper, either one large or two small tiles, which may cost 2s. a perch. The expenses will thus amount to

	3.	d.
Digging 62 cubic feet of earth	0	7
Draining tiles	2^{-}	0
Putting in draining tiles and filling in earth	0	1
	_	

Total per perch . . . 2 8

If the fields consist of ten acres each and be of a square form, the extent of the main drain will be about four perches per acre, which, at 2s. 8d. per perch, is equal to 10s. 8d. per acre. The expenses of the main drain for 160 acres will, therefore, amount to £85. 6s. 8d.

40. There are in Whitfield Farm about fifty acres of wet land, which has a considerable declivity, and in which broken stones may, therefore, be used in

the parallel drains; and they would require, I think, to be about one perch apart: so that the expense of draining this part of the farm will be £9. 6s. 8d. per acre.

- 41. There are about sixty acres of the remaining wet land which will be perfectly drained, though the distance between the drains is $24\frac{3}{4}$ feet; the inclination, however, is so small that tiles will be required. The expense of draining this will, therefore, be £8.5s. per acre.
- 42. The remaining fifty acres will do, I think, with the drains two perches or 33 ft. apart. In these, however, the tiles will be employed, as the ground is nearly level. The expense of draining this will amount to £5. 10s. per acre.
- 43. The expense of dividing the farm into fields will depend much on their size and form. This cannot be well ascertained till the plan for the perfect drainage of the whole be laid down. Supposing, however, the fields be square and averaging ten acres in extent, there would be about 2000 perches of fencing required—say 1500 of hedge and ditch, and 500 of stone wall. The deep ditches for the drainage of the land will amount in length to about 860 perches. Their dimensions may be as follows: 3 feet deep, $5\frac{1}{2}$ feet broad at top, and six inches at bottom. There will thus be $5\frac{1}{2}$ cubic yards to be removed in

the length of every perch, which, at 3d. per yard, will amount to 1s. $4\frac{1}{2}d$. per perch; and the expenses of 860 perches, at 1s. $4\frac{1}{2}d$. each, will be £59.2s.6d. There would also be required 1500 perches of hedge, which, supposing there to be two rows of quick, will require 100 plants in the perch, or in all 150,000 quicks, which, at 10s. per 1000, will amount to £75. The expense of putting them in, at say 2d. per perch, would be £12. 10s.

- 44. The 500 perches of walling, quarrying the stone, and building the wall $4\frac{1}{2}$ feet high, would cost, say 5s. per perch, or in all £125.
- 45. The next step, after the land is properly drained, is to pare and burn the surface. This is the easiest, cheapest, and most perfect plan of reducing the tough sward and getting rid of all the roots and rubbish growing and lying upon the land. This may cost 30s. an acre.
- 46. The whole of the 160 acres which require draining, having been so long in such a puddle every winter and spring, the earth has become so closely rammed together that it will require to be stirred to the depth of sixteen inches at least by Smith's subsoil plough. The expense of this will not be less than 30s. per acre.
- 47. After all these operations are completed, the whole of the 160 acres should be summer fallowed

the first year, that the surface may be well cultivated. The expense, however, of this must be paid by the farmer: it may be stated as follows:—

					£.	· 8.	d.
Three ploughings, 10s. each					1	10	0
Six turns of Finlayson's harrow	, 2s	.6d	.ea	ch	0	15	0
Four rollings, at 1s. each .					0	4	0
Eight turns of harrow, at 1s.					0	8	0
					£ 2	17	0

- 48. As the whole of the soil is greatly deficient of calcareous matter, I should, during the operation of summer fallowing, give it a good dressing of lime, which can be had near the farm. The quantity per acre which I think would be advisable for such a soil is two bushels to a perch, or 320 per acre. The expense of liming would amount to £3.10s. per acre.
- 49. Recapitulation of the expense of improving Whitfield farm:—

	£.	s.	d.
Roads (see §.25) 200 perches in length,			
at say 8s. per perch	80	0	0
Three bridges	20	0	0
Straightening and deepening the brook			
(§. 28), 300 perches, at 4s. 3d. perperch	65	0	0

Carried forward . . £165 0 0

	£.	8.	d.
Brought forward	165	0	0
The grubbing of the roots of the			
trees must be paid by the sale of			
the trees, as they have done the			
injury to the land, see §. 27.			
Drainage:—			
640 perches of deep ditching, at 2s. 3d.			
per perch (§. 30)	74	13	3
Main drains for 160 acres, at 10s. 8d.			
per acre (§. 39)	85	6	8
Parallel drains:—			
Fifty acres with stones, 1 perch apart, at			
£9. 6s. 8d. per acre (§. 40)	466	13	4
Sixtyacres of tile draining, 1½ perch apart,			
at £8.5s. per acre (§.41)	495	0	0
Fifty acres with tiles, at 2 perches apart,			
at £5. 10s. per acre (§. 42)	275	0	0
Dividing the farm into fields of ten			
acres each:—			
860 perches of ditching, at 1s. $4\frac{1}{2}d$. per			
perch (§. 43)	59	2	6
15,000 quicks, at 10s. per 1000 (§. 43)	75	0	0
Planting 1500 perches of quicks, at 2d.			
per perch (§.43)	12	10	0
Building 300 perches of wall, $4\frac{1}{2}$ feet			
high (§. 45)	125	0	0
Carried forward £	1675	3	3

£.	8.	d.
1675	3	3
,		
	0	0
560	0	0
		9
		0
	s.	d.
265	0	0
	0	0
	1675 240 560 859 3500 £. 265	240 0 560 0 859 16 3500 0 £. s. 265 0

Thus, if the whole of the £3500 is laid out the first year, the rent and taxes would be £265 for the first three years, and for the fourth year it would be increased £175 (the interest of the £3500 which is sunk in improving the estate), so that then the rent and taxes would be £440 a-year afterwards, that is, £375 the rent to the landlord, and £65 the parochial taxes.

- 51. On entering into any speculation we look forward to the result, and, if the risk be great, we must have some prospect of a large return on the capital invested; but, if there be little or no risk, and ample security, we are contented with a much smaller interest. In every case, however, it should be greater than what we receive from government securities.
- 52. In the purchase of land, we think it is a good investment when we have a clear rental, which will pay $3\frac{3}{4}$ per cent on the purchase money; land is very seldom brought to produce 4 per cent; indeed, it frequently produces only 3, and often not more than $2\frac{1}{2}$ per cent.
- 53. The only thing to be looked at in considering the propriety of investing a large sum of money in permanently improving any kind of soil, is simply what interest we expect on the money expended, and, whether the increased return will be permanent or not. If we are convinced that it will be permanent under the kind of management it is likely to receive, and that it will pay a greater interest on the capital sunk, than if, with the same amount, we had purchased an additional number of acres, then, I think, it must be evident that it is not only more prudent, but more profitable to improve the land which we have, than to buy more.
 - 54. From the above estimate, it appears that

£3500, is required to be sunk in the improvement of Whitfield farm, consisting of 232 acres. Now, if I can make it appear, that after the first two years, the increased produce of the land will enable the farmer to pay the interest of this £3500., at the rate of five per cent. for the next five years, and an increased permanent rental afterwards in addition to this, I think there will be every reason to say that the money is better employed in improving the estate, than in buying a fresh quantity.

55. Estimate of capital sunk by the farmer, before he can bring the 160 acres of land from a state of nature to a state of cultivation.

To paring and burning 160 acres at	\mathcal{L} .	8.	d.
30s. (§. 45)		0	0
To fallowing 160 acres of land one year,			
at £2. 17s. (§. 47)	476	0	0
To rent and taxes on 160 acres for one	:		
year, at £21. 10s. (§.2)	174	13	4
	£890	13	4

III. The distribution of the fields and the course of cropping, which I purpose to adopt on Whitfield example-farm.

56. The system of culture which I think is best for such a soil, after it has been improved, will necessarily embrace the rotation which I purpose to adopt; a detail of all the several operations necessary in the cultivation of each crop; the necessary expense of such cultivation, separating the yearly expense from that which is sunk, to be reaped several years after; an estimate of the capital required for dead and live stock; the return in corn, beef, mutton, and wool, and the profits of farming.

57. The principle of good farming is to adopt such a system as will produce the greatest quantity of food for stock, and, whatever be the nature of the soil, the alternate system of a seed-producing crop, and one as food for stock, should never be departed from under any circumstances, unless two or more successive green crops, as food for cattle, should be thought adviseable.

58. The repetition of any of the seed-producing crops will be regulated by the nature of the soil. That on the clayey member of the old red sandstone, is, we think, the most favourable for the production of wheat, beans, and oats; that, on the puddingstone, which is a sandy loam, or, that on the limestone, which is a very thin light rubbly soil, which is soon burned or dried up in summer by continued drought, is much more favourable for barley than either of the other two corn crops, and would produce better crops of wheat once in six, or even four years, if under proper cultivation, than of oats, which require a greater degree of adhesiveness and

moisture than the soil on this part of the farm possesses.

- 59. We have seen that the present farm consists of 232 acres; to make the farm more compact, we purpose to take in five small fields, occupied by Slade Baker, (No. 130, 139, 140, and 148,) two by J. Daniels, (No. 138 and 141). The farm will then consist of about 250 acres; 37 of which are on the limestone—this soil is full of fragments of the limestone rock; 105 acres are on the pudding-stone—a silicious sandy loam; these are good turnip and barley soils; and 108 acres on the clayey members of the old red sandstone, the soil of which is sufficiently strong for beans and wheat, without being too adhesive when drained for barley and turnips.
- 60. The rotation which I purpose to adopt is the six or eight-field course, because, in it we have a greater range than in the four-field course, and we can, therefore, put the crops two or four years further apart. This, I think, is of the greatest importance, as some soils soon get tired of the same crops—as turnips and clover for instance, when repeated at short intervals.
- 61. There being three kinds of soil on the farm, (§. 59), it will be necessary to adopt such a course of cropping on each, as will be best suited to it. I intend, therefore, to divide the clayey soil into six fields of 15 acres each, thus leaving 18 forpasture;

the sandy soil into six fields of 15 acres each, leaving 15 acres for pasture; and the soil on the limestone, into six fields of five acres each, leaving seven acres of it for pasture.

- 62. The course of cropping which we purpose to adopt for the clay soil is the following:—
- No. 1. Seven and a half acres of Swedes (manured with dung and bones). This crop to be consumed on the land by sheep. Seven and a half of mangel-wurtzel (with dung and bones). This crop to be carted off the land and consumed in the yard.
- No. 2. Seven and a half acres of wheat, after mangel-wurtzel. Seven and a half of beans, after Swedes. Clover and seeds to be sown amongst the wheat and beans.
- No. 3. Fifteen acres of clover and seeds. One half to be carted off the land and consumed in the yard; the other half to be consumed on the land by sheep.
- No. 4. Seven a and half acres of wheat, on that portion which provided the beans the previous year. Seven and a half of oats, after that which was wheat the year before.
- No. 5. Seven and a half acres of turnips, (early tankard,) after oats. Seven and a half of winter vetches, after wheat; both crops to be manured and consumed on the ground by sheep.
 - No. 6. Fifteen acres of wheat.

- 63. The course of cropping we propose for the sandy loam is as follows:—
- No. 1. Seven and a half acres of Swedes, dunged. This crop to be consumed on the ground by sheep. Seven and a half of mangel-wurtzel, dunged. This crop to be carted to, and consumed by stock in the yard.
- No. 2. Fifteen acres of barley, sown with grass, and clover seeds.
- No. 3. Fifteen acres of seeds, to be consumed on the ground by sheep.
 - No. 4. Fifteen acres of oats.
- No. 5. Seven and a half acres of cabbages, on that part where the mangel-wurtzel previously was, to be manured. This crop to be consumed on the ground by sheep. Seven and a half of potatoes, to be dunged and consumed in the yard.
 - No. 6. Fifteen acres of wheat.
- 64. The course of crops I intend for the limestone soil is as follows:—
- No. 1. Five acres of vetches and rye, to be followed by late cole seed, to be dunged. This crop to be consumed on the land by sheep.
- No. 2. Five acres of barley, with clover and grass seed.
- No. 3. Five acres of clover, to be consumed on land by sheep.
 - No. 4. Five acres of oats.

- No. 5. Five acres of globe and tankard turnips, dunged. This crop to be consumed on the land.
 - No. 6. Five acres of wheat.
- 65. If the system be strictly adhered to, we shall have $7\frac{1}{2}$ acres of cabbages, $12\frac{1}{2}$ of turnips, 15 of Swedes, 15 of mangel-wurtzel, $7\frac{1}{2}$ of vetches, 35 of clover, 5 of rye, 5 of cole, and $7\frac{1}{2}$ of potatoes, besides the 40 acres of pasture as food to be consumed by sheep and other stock. We shall also have, as seed-producing crops, 50 acres of wheat, $27\frac{1}{2}$ of oats, 20 of barley, and $7\frac{1}{2}$ of beans. The oats and beans, and part of the barley may be consumed by stock on the farm.
- 66. We shall now enter into a particular account of the mode of cultivating each crop, shewing the quantity of labour necessary, distinguishing horse from manual labour; the expense of seed and manure. We shall also give an estimate of the value of the seed producing crops, as well as of the number of sheep which the green crops will maintain, specifying the months in which each may be consumed.

67. CLAY SOILS.

The first year of the course:—Fifteen acres to be in mangel-wurtzel and Swedes, which would naturally come after wheat.

Culture.	Time when the labour should be done.	quired of of labour Expe					he labour quired of of labour Exp should be man and and of s			of labour and			
			£.	s.	d.	£.	s.	d.					
First ploughing .	Oct.or Nov.	15											
Carting 15 load of	February or		1										
dung per acre.	March	15											
Second ploughing													
ending \dots	Ditto	15											
Finlayson's harrow		5											
Second ditto .	Apr. or May	5 2 2 7											
Harrow	Ditto	2	1										
Rolling	Ditto	2											
Drilling	Ditto	7											
15 bushels of bones		1											
per acre, at 2s.6d.				_	_	1							
per bushel		1	28	2	6								
6 cwt. of rape cake		1											
per acre, at 110s.	}	1	١.		_	1							
per ton			24	15	0								
Drilling in manure		2 2				1							
and sowing seed		2											
50 lbs. at 1s. 6d.	1	1				3	15	0					
Horse-hoeing .	June	4				ĺ							
Hand-hoeing, at	1	1	١.	• •		1							
6s. per acre	T C. T		4	10	0								
Horse-hoeing .		4	1										
Pulling and storing													
mangel-wurtzel	·	l	١,	_									
at 6s. per acre		į	2	5	0								
Carting 30 ton		15	1			1							
mangel per acre	Oct. Nov.	15	_			_							
	1	93	1-0	12				0					

Taking the average of the crop of Swedes and mangel-wurtzel to be 25 ton per acre, this would give food for the keep of $12\frac{1}{2}$ sheep for six months, at 25 lbs. per day 187 sheep.

68. Second year of the course:—one-half wheat after the mangel-wurtzel, the other half beans after the Swedes; both to be sown with seeds: $7\frac{1}{2}$ acres wheat after the mangel-wurtzel.

Culture.			of manual			Ex	pen see	
			-	s.	_,	0		-1
Ploughing after the	October or		t.	s.	a.	±٠	8.	a.
mangel-wurtzel		$7\frac{1}{2}$						
Twice double-har-	Ditto	1						
rowing		_						
Drilling the seed	Ditto	1						
$18\frac{1}{2}$ bushels of seed	· ·						_	
wheat at 7s						6	9	0
	Feb. March,							
per acre · ·	or April		2	5	0			
Harvesting 7½ acres								
at 10s, per acre	August		3	15	0			
Carrying in wheat								
and stacking .	Ditto	2						
Threshing, say 30								
quarters at 2s 6d			3	15	0			
Carting to market	Dec. to May	6						
			-					
	4	$17\frac{1}{2}$	9	15	0	6	9	0

The produce, I estimate, at not less than four qrs. per acre; 30 quarters at 56s. per quarter is £84.

69. Second year of the course:— $7\frac{1}{2}$ acres of beans after the Swedes.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	manual			Expenses			
Ploughing Drilling seed	February April& May Do. or Do. September Ditto		1	s. 2 15	(4	s. 10	4	
	1	102	1.	- •	•	1			

The produce of 30 quarters of beans at 36s. is £54.

The straw would be equal to the keep of 26 sheep for six months during the winter . 26 (winter).

70. Third year of the course:—15 acres clover after the beans and wheat.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	of manual			Expenses of seed.			
10 lbs of red clover,			£.	8.	d.	£.	s.	\overline{d} .	
150 lbs. £4 p. cwt. 7 lbs. white ditto, 100, £5. per cwt.	-00					6	0	0	
						5	0	0	
7 lbs. yellow ditto, 100, £3. per cwt.		2				3	0	0	
Rolling Mowing twice for		2	_	_	•				
stock, 3s p. acre Hauling one-half			2	5	U				
of the clover, $7\frac{1}{2}$ acres home to	ĺ								
stock in the yard	ĺ	$7\frac{1}{2}$						_	
		$9\frac{1}{2}$	2	5	0	14	0	0	

71. Fourth year of the course:—one-half to be in wheat, the other half in oats:—7½ acres of wheat on that part of the field which was beans the second year of the course.

Culture.	Time when the work should be done.	quired of	of manual			Expenses of seed.		
Ploughing Double-harrowing twice Drilling the seed 18½ bush of wheat seed at 7s	September Ditto Ditto	7½ 1	£.	8.	d.	£.	<i>s</i> . 9	<i>d</i> .
Hoeing twice, at 6s. per acre. Harvesting 7 acres	Feb. March or April		2	5	0			
at 10s. per acre Carrying wheat	August		3	15	0			
and stacking. Threshing, say 30 quarters	Ditto	2	3	15	U			
Carting to market	Dec. to May	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	9	15	0	6	9	0

The produce I estimate at not less than four quarters per acre; 30 quarters at 56s. per acre is £84.

The straw, at 10 ton, $2\frac{1}{2}$ for litter and $7\frac{1}{2}$ ton for winter food (being cut into chaff) for stock, equal to eighteen sheep for six months in winter, at 5lbs. per sheep per day 18 (winter).

72. 7½ acres of oats on that part of the field which was in wheat during the second year of the course.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	manual			Expenses of seed.			
Ploughing Four double har-		71/2	£.	8.	d.	£.	8.	d.	
rowing Drilling	Feb. or Mar.	4 1							
3s		1	1	2	. 6		14	0	
Harvesting Hauling crop to the rick	September	2	3	15	0				
Threshing 52 qrs. at 2s			3	4	o				
say 52 qrs		5			_				
		$20\frac{1}{2}$	10	7	6	5	14	0	

The produce of 52 quarters of oats, at 24s. £62. 8s.

The straw equal to 15 ton, which is equal to the keep of 37 sheep for six months . . . 37 (winter)

73. The fifth year of the course:—one-half to be winter vetches and Italian rye-grass after the wheat, and the other half to be early or tankard turnips after the oats; both to be dunged and the crops fed off the land by sheep:—7½ acres of winter vetches and Italian rye-grass.

Culture.	the work	man and manual o		Expenses of seed.
Carting 10 loads of dung, per acre. Ploughing 4½ bushels of seed, at 4s Three times double harrowing Weeding, 2s. per acre	September Ditto	$\frac{5}{7\frac{1}{2}}$ 3	0 15 0 1 2 6 1 17 6	£. s. d. 6 15 0

74. The fifth year of the course: $-7\frac{1}{2}$ acres of early or tankard turnips.

Culture.		Days required of man and 2 horses.	of manual			Expenses				
First Ploughing . Second ditto Finlayson's harrow Second ditto	Feb. or Mar. A pril May April, May May		£.	8.	d.	£.	s.	d.		
Carting 10 load manure, p. acre Drilling to cover manure	Ditto	5 3 1 2	2	5	0]	5	0		
		36	2	5	0	1	5	0		

Crop equal to 25 ton per acre, and will keep 94 sheep for six months 94 (winter)

75. The sixth and last year of the course:—
15 acres of wheat.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	Expenses of seed.	
First Ploughing & Vetches Finlayson's harrow Ditto Ditto Ploughing after turnips 2½ bushels of wheat p. acre, 37 bush. at 7s Drilling wheat Hoeing, 6s. p. acre	July ? Ditto August September Ditto Feb., Mar., and April	7 \frac{1}{2} \fra	£. s. d.	£. s. d.
Harvesting,15acres at 10s Carting crop home to yard Threshing 60 qrs. at 2s. 6d Carrying to market 60 qrs	August		7 10 0	12 19 0

The produce, I estimate at four quarters per acre, 60 quarters at 56s. per quarter is £168.

76. The amount of horse-labour required to be performed, during each month, on 90 acres of clay soil.

TI	Jan.	Feb.	Ma.	Apr.	May	June	July	Au.	Sep.	Oct.	Nov.	Dec.
First Crop, 15 acres turnip &	_			_			_	_	_	_	_	
mangel-wurtzel		15	15	10	11	8	4			10	12	8
Second Crop, 7½ acres wheat.	6	}						2		3	61	
$7\frac{1}{2}$ ditto beans .	0	2		1	1		6	~	2	3	02	71
Third Crop,								_	١.,			_
15 acres clover. Fourth Crop,			2			2	2	2	$1\frac{1}{2}$			
$7\frac{1}{2}$ acres wheat .				1				2	$9\frac{1}{2}$			
$7\frac{1}{2}$ ditto oats . Fifth Crop,	$7\frac{1}{2}$		5	1			5	2				
7½ acres vetches									15½			
$7\frac{1}{2}$ turnips	1	$4\frac{1}{2}$	3	$2\frac{1}{2}$	$12\frac{1}{2}$	4	2		_		$7\frac{1}{2}$	
Sixth Crop, 15 acres wheat.	12						10	9	91			
	_	_	_		_	_	_		-	_	-	-
	$31\frac{1}{2}$	$21\frac{1}{2}$	25	$14\frac{1}{2}$	$24\frac{1}{2}$	14	29	17	38	13	26	$15\frac{1}{2}$

77. The quantity of food for stock produced from the 90 acres of clay soil sufficient to keep sheep, of 20 lbs. per quarter, in a fattening state for six months in summer, and six months in winter.

Number of sheep during	the six summer months.	the six winter months.
1st Crop 15 acres of Swedes and man-		187
gel-wurtzel		18
2nd — $7\frac{1}{2}$ ditto wheat straw, 10 tons		26
7½ ditto bean straw 15 —		1
3rd —— 15 ditto clover	210	18
4th $$ $7\frac{1}{2}$ ditto wheat straw . 10 $$		37
$7\frac{1}{2}$ ditto oat straw 15 —		
5th — $7\frac{1}{2}$ ditto vetches		
7½ ditto tankard turnips	87	94
6th — 15 ditto wheat straw . 20 —		37
•		
70 tons	297	417

78. The particulars of the cultivation of 90 acres of silicious sandy soil.

The first year of the course;—15 acres of Swedes and mangel-wurtzel.

Culture.	Time when the work should be done.				of manual		pen see	
Carting 15 load of dung, per acre . Second ploughing ending Finlayson's harrow Second ditto	Ditto Mar.or Apr. Apr. or May Ditto Ditto Ditto	15 15 15 5 5 2 2 7	£.	8.	d.	£.	8.	d.
15 bushels of bones per acre at 2s.6d. per bushel 6 cwt. of rape cake per acre, at 110s. per ton Drilling in manure Sowing seed, 50lbs. 50lbs of seed, at 1s.6d		2 2		2 15			15	0
Horse hoeing Hand hoeing at 6s. per acre Horse hoeing Pulling and storing the mangel wurtzel, at 6s. per acre Carting off the mangel wurtzel Carting manure, 25	June & July	4	2	10 5	0			
ton per acre		93	59	12	-6	3	15	0

79. The second year of the course:—15 acres of Barley.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	manual	Expenses of seed.
Ploughing after mangel-wurtzel Finlayson's harrow Hoeing 60 bushels seed, at 4s Drilling Rolling	Ditto April August Ditto	15 5 2 2 2 2 7	2 15 0 7 10 0 6 15 0	
		45	16 10 0	12 0 0

Crop $67\frac{1}{2}$ quarters barley, at 30s.—£101. 5s.

The straw may be equal to 15 tons, which (cut into chaff) would give food for the six winter months to 39 sheep, at the rate of 5 lbs. per day to each,

39 (winter).

80. The third year of the course:—15 acres of clover to be consumed on the ground by sheep.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	of manual	Expenses of seed.
10 lbs. red clover per acre, 150 lbs. £4. per cwt	March	$\begin{array}{c c} 2 & & \\ \hline & 7\frac{1}{2} & \\ \hline & 9\frac{1}{2} & \\ \end{array}$	2 5 0	£. s. d. 6 0 0 5 0 0 3 0 0

This crop will produce food for 16 sheep per acre, for six summer months 210 (summer)

81. The fourth year of the course:—15 acres of oats.

Culture.	Time when the work should be done.	quired of	m	of an	ual	Ex	Expense of seed	
Ploughing Four double har-	Jan. or Feb.	15	£.	8.	d.	£.	s.	d.
rowings Drilling 38 bushels of oats,	Ditto	8 2						
at 3s Rolling Hoeing, 3s. p. acre	April	2	2	5	0	11	8	O
Harvesting Hauling crop to the ricks Threshing 52 qrs. at 2s	September	4	10	10	0			
Hauling to market, say 52 qrs		10						
		41	20	3	O	11	8	0

Crop 7 quarters per acre, 105 quarters at 24s. \pounds 126.

The straw will be equal to 30 tons, which will keep 74 sheep for six months 74 (winter)

82. The fifth year of the course:—15 acres, one-half in cabbages after the mangel-wurtzel, and the other half in potatoes after the turnips; $7\frac{1}{2}$ acres of cabbage.

Culture.	Time when the work should be done.	quired of	of manual	Expenses of seed.
First Ploughing Second ditto Finlayson's harrow Second ditto Harrowing double Rolling Drilling for dung Carting 10 load of manure, p. acre Drilling to cover ditto Plants Planting Hoeing Horse hoeing	Feb. or Mar.		£. s. d. 1 15 0 2 5 0 4 0 0	i

83. $7\frac{1}{2}$ acres of potatoes.

First ploughing . Oct. to Jan. 7½ Carrying 10 load of dung, per acre . Jan. to Mar. 5 Ploughing Feb. to Mar. 7½ Finlayson's harrow Mar. to Apr. 2 Ditto April 2 Rolling Ditto 1 Seed, 8 sacks per acre, 5s. per sack Planting, 6s. p.acre Hoeing, 6s. do Earthing up, 8s. do. Carting do. to pits Pitting, say 8s. per	Culture.	Time when the work should be done.	Days required of man and 2 horses.	manual	Expenses of seed.
30 30 0	Carrying 10 load of dung, per acre . Ploughing Finlayson's harrow Ditto Rolling Rolling Seed, 8 sacks per acre, 5s. per sack Planting, 6s. p. acre Hoeing, 6s. do . Earthing up, 8s. do . Carting do. to pits	Jan- to Mar. Feb. to Mar. Mar. to Apr. April Ditto	5 7½ 2 2 1	2 5 0 2 5 0 3 0 0 7 10 0	15 0 0

Winter.

38

500 to be sold, and hay to be purchased with the proceeds, say at 5s. per sack, £125. which will purchase 40 ton of hay, and thus keep 90 sheep for six months during winter.

90

84. The sixth year of the course:—15 acres of wheat.

Culture.	the work							penses seed.		
Ploughing after cabbage	Sontombor	71	£.	s.	d.	£.	8.	d.		
Ploughing after potatoes	September Ditto	$\begin{array}{c c} 7\frac{1}{2} \\ 7\frac{1}{2} \\ 2 \end{array}$								
Drilling $2\frac{1}{2}$ bushels of seed, 37 bushels at 7s.	October	2				12	19	0		
Hoeing, 6s. per acre Harvesting, 15 acrs.	Feb. March, and April		4	10	0					
at 18s. per acre Carting home . Threshing 2½ qrs.	August	4	7	10	C					
at $2s$. $6d$ Carting to market	Dec.to May	12	6	11	6					
		33	18	11	e	12	19	0		

The produce of this crop may be only $3\frac{1}{2}$ quarters per acre; $52\frac{1}{2}$ quarters of wheat at 56s is £147.

The straw, equal to 20 tons, 5 for litter and 15 cut into chaff will keep 36 sheep six months . 36 (winter).

85. The amount of horse labour required to be performed during each month on the silicious sandy soil.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
First Crop,	-	-			-	_	-					-
15 acres swedes &												
mangel-wurtzel		15	15	10	10	9	4			10	12	8
Second Crop,												
lő acres barley	5			12				7			6	15
Third Crop,			ŀ									
15 acres clover			2			2	2	2	11/2			
Fourth Crop,												1
	15		10	2		6			4	4		
Fifth Crop,												
7½ acrescabbage		$7\frac{1}{2}$	7	6	6	2				7 1/2		
7½ acres potatoes		6	61	2	3				3	5	41/2	
Sixth Crop,		1	_		l	1	1				~	
15 acres wheat	4	4					ļ	4	15	2	1	4
	_	_			-			_	l —	-	-	-
	24	$32\frac{1}{2}$	40분	32	19	19	6	13	231	281	$22\frac{1}{2}$	27
		2	-02	-	1-0	1-0	1	1.0	1-02	202	12	1

86. The quantity of food for stock produced from the 90 acres of silicious sandy soil, sufficient to keep sheep of 20 lbs. per quarter in fattening state for six months in summer and six months in winter.

sheep st	he six ummer ionths.	the six winter months.
1st Crop, 15 acres of mangel-wurtzel and swedes	210	187 36 75 94 128 36
105 tons	210	556

87. The particular cultivation of the thirty acres on the limestone rock.

The first year of the course:—rye eaten off in May, afterwards sown to cole-seed or late turnip.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	of manual	Expenses of seed.		
Carting 15 load of dung per acre Ploughing	May	3 5 2 5 1 1 1 2 1 2	£. s. d.	£. s. d.		
per acre, 75 bus. at 2s. 6d Drilling seed and bones Seed, 15 lbs. at 1s. Horse-hoeing		1½ 2- 2- 25	1 10 0	0 15 0		

The rye crop may be sufficient for the keep of ten sheep per acre for 6 months in the summer 50 (summer).

The turnip crop may be sufficient for the keep of six sheep per acre during the winter six months 30 (winter).

88. The second year of the course:—five acres of barley.

Culture.	the work should be	quired of	and manual					Expenses of seed.			
Ploughing Finlayson's harrow Hoeing 20 bushels of seed Drilling Rolling Hoeing weeds, at 3s. per acre . Harvesting, 5 acres Carting home crop	March March April August	5 1 2 3 2 3 3 2 3 2 3 2 3 2 3	0	s. 15 10		£.	<i>s</i> .	<i>d</i> .			
to yard Threshing Carting to market	Ditto	$2\frac{1}{3}$	2	5	0						
		15	5	10	0	4	0	0			

The crop, say 4 quarters of barley, per acre, equal to 20 quarters at 30s. a quarter, would be £30.

The straw, say 5 ton, would keep nine sheep for six months 9 (winter).

89. The third year of the course:—five acres of clover and seeds to be consumed by sheep on the ground.

Culture,	Time when the work should be done.	quired of	of manu	al	Ex	pen see	
Red clover, 3½ lbs. per acre White ditto, 2½ lbs. Yellow ditto, 2⅓ lbs. Rolling Mowing Hauling one-half home		থত	£. s. 0 15	d. 0	2 1 1	s. 0 13 0	0

90. The fourth year of the course:—5 acres of oats.

Culture.	Time when the work should be done.	quired of	of manual	Expenses
Ploughing 4 double harrowings Drilling	Feb. or Mar. Ditto April Apr. or May September	223 233 243 243	£. s. d. 0 15 0 2 10 0 3 9 4	

Taking the produce at 4 qrs. per acre, 20 qrs. equal to $\pounds 24$.

The straw equal to the keep of 20 sheep for six months 20 (winter)

91. The fifth year of the course:—5 acres of globe turnips to be fed off the land by sheep.

Culture.	Time when the work should be done.	Days required of man and 2 horses.	manual	Expenses of seed.
First ploughing Second ditto Finlayson's harrow Second ditto Grant Harrowing double Rolling Carting manure Drilling for dung Carting manure Toitto, seed Sowing Grant Hoeing Grant Horse hoeing Grant Horse hoeing Grant Finlays Second Grant Horse hoeing Grant Horse Harrow Harro	April May Apr. or May Ditto May Ditto	$ \begin{array}{c c} 5 \\ 1\frac{2}{3} \\ 1\frac{2}{3} \end{array} $	£. s. d.	£. s. d.

This crop may keep 8 sheep per acre for six months, 40 sheep 40 (winter)

92. The sixth year of the course:—5 acres of wheat.

Culture.	should be	quired of	of manual	Expenses of seed.
Ploughing	August	2	£. s. d. 1 10 0 2 10 0 2 3 10 6 3 10	4 6 0

This crop may be equal to 3 quarters per acre, or 15 quarters at 56s.—£41. 12s. 6d.

And the straw may winter 8 sheep for six months. 8 (winter).

93. The amount of horse-labour required, during each month on the 30 acres of the limestone rock.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
First Crop,		-	_		-							
5 acres rye and												
turnips						4	$6\frac{1}{3}$	10	2			
Second Crop,							-	1	}			
5 acres barley .		$2\frac{1}{3}$	2 3	2/3		1		$2\frac{1}{3}$			4	5
Third Crop,		*		Ĭ				1		1		
5 acres clover .		l	1			1						
Fourth Crop,		i							i	1		
5 acres oats	5			7					$1\frac{1}{3}$	$3\frac{1}{3}$		
Fifth Crop,	1								ľ			
5 acres turnips		2	3	32	3	5	11			5		
Sixth Crop,							"			1		
5 acres wheat .								2	5	2	4	
	5	$4\frac{1}{3}$	$4\frac{2}{3}$	$11\frac{1}{3}$	3	9	72	$14\frac{1}{3}$	81	$10\frac{1}{3}$	8	5

94. The quantity of food for stock produced from the 30 acres of the limestone soil, sufficient to keep sheep, of 20 lbs. per quarter, in a fattening state, for six months in summer and six months in winter.

	Number dunthe six summer months.	the six
1st Crop, 5 acres rye	50	30
3rd Crop, 5 acres Swedes 4th Crop, 5 acres oats straw 5th Crop, 5 acres turnips	35	20 40
6th Crop, 5 acres wheat straw 5 —	 85	107

95. The 40 acres of pasture land may be able to keep six sheep per acre, during the summer months . . . 240 summer And two per acre, the winter ones . 80 winter.

96. Abstract of the amount of labour required, during each month, on the whole of the arable land.

											i	
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	I											
90 clay	31½	$21\frac{1}{2}$	25	$14\frac{1}{2}$	$24\frac{1}{2}$	14	29	17	38	13	26	15
90 sandy soil	24	$32\frac{1}{2}$	$40\frac{1}{3}$	32	19	19	6	13	$23\frac{1}{2}$	$28\frac{1}{2}$	$22\frac{1}{3}$	27
30 limestone	5	$4\frac{1}{3}$	4_{3}^{2}	$11\frac{1}{2}$	3	9	72/3	$14\frac{1}{3}$	$8\frac{1}{2}$	$10\frac{1}{2}$	8	5
	-	_										
210 acres	601	58½	70	58	$46\frac{1}{2}$	42	$42\frac{2}{3}$	$44\frac{1}{3}$	70	52	56‡	47

From the above table it appears that 655 days' labour, of a man and two horses, are required to be done during the year, and that the greatest quantity of labour, required in any month, is in September and March.

97. The following table will show the number of working days, in which land that is perfectly drained, will be in a proper working condition in each month in the year: and also the quantity of work which a man and two horses is capable of doing each month.

Mont	hs.		Working days.	Working hours each day.	Acres per day.	Acres ploughed per month
January . February . March April . May June . July . August . September . November .		 	14 14 18 20 20 20 20 20 20 20 20 18 16	8 8 9 10 10 10 10 10 10 10 10 10 10 8	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	14 14 20 25 25 25 25 25 25 22 28 18
			216			254

By this table it appears, that there are 216 working days in the year, and that a man and two horses can, in that time, plough 254 acres of land. From the table, § 96, it appears, that there are 70 days' work to be done in March; and, as a team commonly does 22 days' work in this month, that is, plough 22 acres, there must be four pair of horses to perform that work in proper time.

98. Abstract of the quantity of food for stock, in summer and winter.

-	Weight of Dry Food.	Summer.	Winter.
On the 90 acres of clay soil 90 sandy soil,	70 ton	297	417
Hay $\begin{cases} 65 \\ 40 \end{cases}$	105 ,,	210	556
30 limestone	17 "	85 240	10 7 80
	192	832	1160 832
		- 2	2)1992
			996 for 12 months.

99. As there are other stock to be kept on this farm besides sheep, we must determine the relative consumption of food which each of the several kinds of stock require. From various experiments which have been made, we have the following result:

A horse will consume as much food, besides

corn, as			. 8 s	sheep.
A cow	ditto	ditto	. 12	,,
A fattening ox	ditto	ditto	. 10	,,
A three-year old	l heifer	ditto	. 8	,,
A two-year	ditto	ditto	. 6	,,
A one-year	ditto	ditto	. 4	,,
A calf	ditto	ditto	. 2	,,

100. The quantity of each kind of stock which may be kept on the food produced. There must be nine horses kept to cultivate the farm, and we intend to keep ten cows, and breed ten calves, and have ten fat beasts to turn off every year, besides the flocks of sheep, so that the following stock may be kept on this farm:

9	horses	W	ll r	eqı	ure	th	e k	eep	of	72	sheep.
10	cows				dit	to				120	,,
10	calves				dit	to				20	,,
10	one-ye	ear	old		dit	to				40	,,
10	two-ye	ear	old		dit	to				60	,,
10	three-	yea	r o	ld	dit	to				80	,,
220	ewes)	
220	lambs									>550	,,
110	one-ye	ear	old	fa	tter	ing	g sh	ieep))	
								_			
										942	,,

101. An estimate of the stock and implements required to cultivate this farm of 250 acres, of which 210 acres are to be arable culture, under the sixfield course:

9 horses, say at £30 each	£270
Implements;	
4 ploughs, say at £3. 15s. each£15	
2 Finlayson's harrows 20	
4 pair of harrows 8	
4 horse hoes 12	
Carried forward ${\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{\cancel{$	£270

	Brought forward		£	355	£ 270
2	rollers			15	
l ·	turnip-sowing machine			6	
8	single-horse carts, £10 each .			80	
3	three-sparred carts for the wheel	s			
	and axles	•		24	
	Cart Harness for 8 horses, at £3.	10	s.	28	
	Plough-harness for 8 horses .	•		8	
	Saddle-horse furniture			6	
	Winnowing machine and riddlers	s .		15	
2	turnip slicers			8	
2	chaff cutters			10	
	Cake bruiser			5	
3	wheel barrows			3	
3	ladders			3	
	Weighing machine			30	
	Corn chest			2	
	Raeks, forks, axe, saw, spades, sh	0-			
	vels, grapes, hoes, &c. say,			5	
10	staddles for corn, at £4		,	40	
6	curry combs, 8 mouth bags, lanth	or	n	7	
	Riddle, sieves, bushel, load barro	w,			
	and 2 straw barrows for carr	y-			
	ing corn			5	
80	sacks (4 bushels)			12	
50	dozen hurdles, at 12s		,	30	
	dairy utensils, say			10	
			_		407
	Carried forward				£677

WHITFIELD EXAMPLE-FARM.	321
Brought forward	£677
102. Dairy Stock.	
10 cows, at £12. each 120	
10 calves, at £3. ditto 30	
10 one-year old, at £5. ditto 50	
10 two-year old, at £8. ditto 80	
10 three-year old, at £12. ditto 120	
A sow and six pigs 8	
	408
103. Stock of Sheep.	
220 ewes, at 25s. each 385	
220 lambs, at 20s. ditto 220	
110 tegs, at 30s. ditto 165	
	770
·	€ 1855
104. Abstract of the expense of labour, manur	

seed required on this farm.—Clay soil, 90 acres.

								La	ibou	ır.	Ma	nu	re.	s	eed	•
							Aeres.	£.	s.	d.	£.	8.	d.	£.	8.	d
ı.	Swedes	an	d 1	ma	$ng\epsilon$:l-										
	wurtz	el					15	6	18	0	52	17	6	3	15	0
2.	Wheat						71	9	15	0				6	19	6
	Beans						71	7	17	6				4	10	(
3.	Clover						15	2	5	0				14	0	(
4.	Wheat						71	9	15	0				6	19	(
	Oats						71	10	1	6				5	14	(
5.	Vetches	, R	ye				7 <u>î</u>	1	17	6				6	16	(
	Early T	urı	йр	s			7 <u>1</u>	2	5	0				1	5	(
6.	Wheat						15	19	10	0				12	19	(
								_				<u> </u>				
						- 1	90	70	1	-6	52	17	6	61	8	61

105. Sandy soil.

					Acres.	L	abo	ur.	M	anu	re.	1	Seed	l.
						£.	s.	d.	£.	s.	\overline{d} .	£.	8.	d.
1. Swedes ar	ıd	ma	nge	el-										
wurtzel					15	6	15	0	52	17		3	15	0
2. Barley .					15	16	10	0				12	0	0
3. Clover .					15	2	5	0				14	0	0
4. Oats .					15	20	3	0				5	14	0
5. Cabbage					$7\frac{1}{2}$	4	0	0				3	5	0
Potatoes					$7\frac{1}{2}$	18	0	0				15	0	0
6. Wheat .					15	18	11	6				12	19	0
					20	85	4	6	$\overline{52}$	17	6	 66	13	0

106. Limestone soil, 30 acres.

	Acres.	Labou	r.	Ma	nure.	s	eed.
1. Rye and Turnips .	5	£. s.	$\frac{d}{0}$		s. d.		s. d. 6 0
2. Barley	5 5	5 10	0	J	, 0	4	0 0
3. Clover	5	$\begin{array}{c c}0&15\\6&8\end{array}$	0			$\frac{4}{2}$	$\begin{array}{ccc} 12 & 0 \\ 0 & 0 \end{array}$
5. Turnips 6. Wheat	5 5	1 10 6 10	0			0 4	87 0 6 0
			_				
Limestone Soil . Landy Soil	30 90	$\begin{array}{cccccccccccccccccccccccccccccccccccc$	6	9 52	7 0 17 6		1 0 13 0
Clay soil	90				17 6		18 6
	210	178 19	0	115	2 0	149	13 0

107. Recapitulation of one year's expenditure of seed, manure, and labour:—

Seed								£149	13	0
Manure								. 115	2	0
Day lab	ου	ırer	ŝ					. 178	19	0
Car		~4	for	TTO 1	d			£113	1.4	- 0

Brought forward	£ 443	14	0
Yearly servants:—			
Superintendent	. 80	0	0
Foreman	. 39	0	0
Three ploughmen . at 10s. a wee	k 78	0	0
One shepherd 12s. —	32	0	0
One cowman 10s. —	26	0	0
Two boys 5s. —	26	0	0
One dairy maid 8s. —	20	0	0
One other maid 6s. —	15	0	0
One old man for jobs 6s. —	15	12	0
Corn for nine horses for 36 weeks, at	a		
peck a day per horse, from October	1		
till June 8, is equal to 64 bushels fo	r		
each horse-576 bushels at 3s	. 86	8	0
Tradesmen's bills:—			
Carpenter's bill 30s. per hors	e 13	10	0
Smith's 30s. —	13	10	0
Saddler's 10s. —	4	10	0
Hurdles for sheep	. 8	0	0
	<u></u>		
	£ 901	4	θ_
108. Abstract:—	£.	s.	d.
Capital required (§. 103).	1855	0	0
First year's expenses—cultivation, seed, manure	901	4	
Capital sunk in fallowing, &c. (§. 55).	890	$\frac{4}{13}$	() 4
Household furniture	100	0	ô
,	30546	1.5	
a	3746	17	4

109. Recapitulation of the capital required for Whitfield Farm, consisting of 250 acres, and the yearly expense of cultivation:—

		ital ired		Year pe atter this	nse ndir	ıg
The sunk or dormant capital (§. 55) To liquidate this sum in fifteen	£. 890			£.	s.	ď.
years, there must be charged 5 per cent. at least Working horses (§. 101)	270	0	0	44	10	6
To insure against accident, 10 per cent. Implements (\$.101)	407	0	0	27	0	0
To keep this dead stock of the same value, 10 per cent	408	0	0	40	14	0
5 per cent Sheep (§. 103)	770	0	o	20	8	0
5 per cent	149	19	0	35 149	-	0
Seeds and seed corn (§. 106)	115		0			ő
Expense for labour (§. 107)	510		0			ŏ
Horse corn (§. 107)	86	8	0	86	8	0
Tradesmen's bills (§. 107) Household furniture and expenses,	39	10	0	39	10	0
(§. 108)	100	0	0	374	14	0
	3746	16	4	1444	4	6

110. Abstract of the produce:—		
Wheat:— \mathscr{E} .	8.	d^*
$7\frac{1}{2}$ acres—30 quarters, at 56s 84	0	0
$7\frac{1}{2}$ ditto—30 ditto at 56s 84	0	0
15 ditto-60 ditto at 56s 168	0	0
15 ditto— $52\frac{1}{2}$ ditto at 56s 147	0	θ
5 ditto-15 ditto at 56s 41 1	12	6
Beans:—		
$7\frac{1}{2}$ acres -30 quarters at 36s 54	0	0
Oats:—		
$7\frac{1}{2}$ acres— 52 quarters at 24s 62	8	0
15 ditto-105 ditto at 24s 126	θ	0
5 ditto- 20 ditto at 24s 24	0	0
Barley: —		
15 acres—67 quarters at 30s 101	5	Û
5 ditto-20 ditto at 30s 30	0	0
Seed producing crops worth $\pounds922$	5	6
Return from stock:—		
For sale: 220 fat sheep at 50s 550	0	()
330 fleeces of wool, four to a tod-		
82 tods at 34s 140	0	0
Cheese, &c. from ten cows, £10 each 100	0	0
Ten fat beasts, say £20 each 200	0	0
Carried forward £1912	5	6

Brought forward £1912 5	6
Deduct—	
Expenses of cultiva-	
tion (§.109) . £1444 4 6	
Present rent and taxes 265 0 0	
5 per cent. on £3500	
sunk in permanently	
improving the land 175 0 0 1884 4	6
Clear profit £28 1	0
Besides 10 per cent. on capital employed.	
111. Of the capital employed on the	
farm, 5 per cent. is charged on the	
£890. of sunk capital, to liquidate it	
in fifteen years, which it will do if the	
annuity (£44.10s.) be invested yearly	
at 5 per cent. compound interest . £44 10	0
Ten per cent. is charged on the cost	U
•	
price $(£270)$ of the working horses to	
insure their value, which, owing to	
accident or death, is supposed to de-	
crease at this rate annually 27 0	0
Ten per cent. is charged on the value of	
the implements, so that their value is	
supposed to decrease at the rate of	
£40. 14s. yearly 40 14	0
Carried forward £112 4	0

Brought forward \mathcal{E} Five per cent. is charged on the value of	112	4	0
the dairy stock (£408) to insure against accident or death	20	8	0
Five per cent. on the sheep stock (£700)	95	0	0
to insure against accident or death .	- 		_
£	167	12	0
112. The income of the farmer will be as	follo	ows:	_
Ten per cent. on the whole capital em-	£	8.	d
ployed, £3747 (§. 109) The allowance of £80 per year to the	374	14	0
superintendent	80	0	0
Clear profit (§. 110)	2 8	1	0
£	482	15	0

113. In this report, the estimated value of the produce in animals is £70 more than the value of the produce in corn, and the estimated value of the whole is upwards of four times that of the produce of the farm for the last twenty-one years.

The labourers employed are estimated at seven men, two boys, and two women, yearly servants, besides £174.9s. paid for piece-work, which may be equal to the employment of four men, three women,

and two boys in addition throughout the year, thus giving employment throughout the year to eleven men, four boys, and five women, while at present Mr. Thomas only employs three men, two women, and one boy.

JOHN MORTON.

Chester Hill, 1839.

ALETTER

TO THE

TENANTS OF PHILIP PUSEY, ESQ. M.P.

FOR BERKSHIRE.

GENTLEMEN,

From my connexion with you and with your landlord, I have taken the liberty of presenting to your notice the substance of many conversations which I have had with you, on the necessity of agricultural improvements—on the absolute necessity of adopting the best and most efficient means of cultivating your land, and of managing all your farming operations.

It is my intention in this letter to lay before you some observations on the mode of culture which you adopt, and I wish you to go along with me, and let us enter into a thorough examination of the whole economy of your establishment—the cultivation of your arable land—and the mode you have so long practised of converting your crops into money; and see whether the system you have so long practised be

the best for such a soil, or whether there may not be a better one, that will produce a much greater return for the expense of cultivation, and a more profitable way of converting your green crops than the one which you at present adopt.

But unless we go about this examination with a desire to get at the truth, and endeavour to divest our minds of all our prejudices, and all our previously acquired opinions, and lay our minds open to conviction, we shall be sure to fail in our object.

That the most profitable system of culture is that which will produce the greatest per cent. on the money laid out in cultivation, while the land is yearly increasing in its productive powers, is a truth which none will attempt to deny: we shall therefore take this as a rule to guide us in our inquiry.

The rotation which you adopt is called the Norfolk or four-field course: the first year wheat, after one year clover made into hay; the second year is turnips after the wheat; most of your dung is laid on for this crop, but part of the field intended for turnip is sown in September, with winter vetches or rye, or white and yellow clover sown amongst the wheat, and these crops are fed off by sheep in April, May, and June, after which the land is sown to winter turnips; there is also a part sometimes sown to white peas, and when they are harvested the land is sown with turnip seed; the third year the whole is

in barley, with clover seed; and the fourth year the whole is in clover, which is made into hay: this I believe is the system of culture which you strictly adhere to.

Now, before we examine the several members of this course of cropping, let us see how the economy of your live stock goes on; they consist wholly of a flock of sheep, and these principally of breeding ewes, (I believe there are very few of you that ever fatten any of your ewes or lambs for the butcher,) and that you dispose of your lambs and old ewes in summer or autumn, and that the price you get for them, with the price of the wool from your ewes, is the amount of money you yearly receive from your sheep; this is all the return they make for the whole of the food they consume in twelve months. The only other stock you have is working horses; some of you may breed a colt to keep up his team, others have some cows for the use of the family. These remarks are not intended to apply to the dairy farms.

All your live stock may therefore be said to be your working horses and your flock of sheep, and all the return they make you is the value of your lambs, old ewes, and the wool from your ewes, besides the value of the manure from the sheep when folded on your turnips, or on your land for wheat, either before or after it is sown.

The whole of your wheat, and barley, and peas

you take to market, and the price you get for these, with what we have before mentioned as the return from your live stock, make up the total amount of return from your farm.

From this system it is evident that the several crops come around in rotation once in every four years; this quick repetition of the same crop, on the same ground, is the greatest objection to the Norfolk system. It has been found that land soon gets tired of any particular crop, when repeated in so short a period.

The first member of the course that fails is the clover, which is by no means so sure or productive a crop now as it used to be; it is very frequently a failing crop, dying when it comes up, or blighting off in the spring or early part of the summer; indeed, the land seems to be so completely tired of it, that we can scarcely ever see a good crop of clover: a remedy for this evil has been attempted on your stronger land, by dividing the clover field into two, and taking a crop of beans or peas over one half of it, and clover on the other half, so that if these crops be taken on the alternate sides of the field, that which was beans last turn comes in course for clover next turn, -so that it will be eight years before either the clover or the beans come round on the same ground: this is a great improvement, so far as the crop goes, and it will remedy the evil, and I have

no doubt but an increased crop of clover will be the result; but it must be remembered, that by this change one-fourth part of the green crop, as food for sheep, is given up, and this fourth part is added to the corn producing crop, not to be consumed on the farm, but to be sold and carried off the land. This is an evil equal in magnitude to the failure of the clover crop: thus a fourth part of the food for sheep is gone, and with it, of course, the means of returning the manure it would have produced to the soil, for the reproduction of food for stock.

That which we have already noticed as to the failure of the clover crop, also takes place with the turnip, which is of much more consequence to you: how often do we see the turnips to be a failing crop, indeed how seldom do we see a good crop of turnips on the fine turnip soil of which your farms consist.

This failure is, we think, partly owing to the same cause as that of the clover—the too frequent repetition of them on the same land. If the crops were farther apart, say six or eight years, we have no doubt that the crops would not only be more certain, but also more abundant.

About the first of this century the turnip crops in Norfolk began to fail; great complaints were heard in every quarter, that the turnips, instead of producing large bulbs as they used to do, produced roots like fingers and toes, without any bulbs; and much was written on the cause of the failure, and on the remedy; but every remedy failed, till some one, by claying a field a second time, (that is, putting on a 100 cubic yards of clay or chalk marl to the acre) found that, after this, the sandy soil, having a much greater degree of tenacity or adhesiveness than before, produced good crops of turnips, as well as good crops of clover, barley, and wheat.

When I mentioned to some of you this mode of recruiting your land which is tired of turnips, (and which is still continued in the sandy parts of Norfolk and Suffolk, of claying their land every eight years), you expressed your approval of the plan, and stated, "We have no doubt of it, for if we take any earth from the sides of the field or road, and put it on our land in course for turnips, we are sure to see turnips where the earth was laid, if there be any in the field." Now there is scarcely a field, particularly in Charney, but what has accumulations of earth at the end of the old ridges, left by the turning of the plough, and it would be an advantage to the field to have these accumulations removed; and it would be of great use if carted over the field, or if mixed with the dung, and forty or fifty cart loads of such a mixture put on the acre would be sure to secure a good crop of turnips; besides this, there are the sides of the field, the road sides, and the sides of the ditches would furnish as much matter as would give a covering to

the whole of your arable land, and there is clay within a mile I think of any field on the estate; a covering of which would produce as good an effect on the sands of Berks, as it does on those of Norfolk and Suffolk.

But in some instances there may be another cause for the complete failure of the turnip crop; indeed I have seen very good reasons for believing it.

Before we attempt the cultivation of any plant, it is quite necessary for us to be well acquainted with the nature and habits of the plant, and the mode of culture which suits it, to be able to cultivate the plant with success.

If the nature and the habits of the turnip, and the kind of culture necessary for the development of its natural character be unknown, or neglected, we shall very seldom succeed in producing good crops; but if we know something of the nature and habits of the plant, and attend strictly to the mode of culture necessary, under every circumstance, we shall seldom fail in producing good crops.

The turnip seed and the habits of the young plant are in every way like those of the wild mustard and charlock, which is to be seen growing in the spring very abundantly and luxuriantly, on land which has been pulverized or reduced to a very fine tilth, and is so injurious to early sown barley, or oats, or spring sown wheat on some soils; but these plants very

seldom grow on the same field, if the land be left in a rough, or cloddy state, not finely pulverized; here then is a key to the production of these plants, hence the necessity of having the land well pulverized in the early part of the spring, and then to keep it so for the perfect developement of the turnip plant, whose habits in the early stages of its growth, are in every respect like those of the wild mustard and charlock.

We think, therefore, to secure a good crop of turnips, the land must be early reduced to a fine tilth, and when in this fine pulverized state, it must also be kept moist; for a fine pulverized soil, recently made so by mechanical means, is dry and without moisture in it to vegetate the seed. This is universally the case with land (however light and sandy it may be) which is ploughed the first time for turnips in the spring, and we have seen the first ploughing given to turnip land in the month of May, and the result was, what was predicted, a complete failure of the whole crop of turnips.

Here let us stop for a little, and try if we can ascertain the amount of loss sustained by the failure of the turnip crop; for this is a most important question, and it is right that we should have a clear view of it, for it is universally believed by every turnip farmer, that if they get a good crop of turnips, there is no fear of good crops during the

remainder of the course, and this we believe to be the case.

But before we can ascertain what loss we sustain from not having a good crop of turnips, it will be necessary for us to know the value of such a crop: well then, a good crop of turnips may be reckoned at 20 tons of bulbs per acre, and it has been ascertained by many experiments on a large scale, that sheep, when fattening on turnips, will consume as great a weight of turnips per day as the quarter weight of their mutton; that is, if a sheep weighs 80 pounds of mutton when dead, the same sheep will have consumed about 20 pounds of turnips per day while fattening, if no other food was given to it, and if it had as many as it could eat. Fattening cattle consume about the same quantity in proportion to their weight; thus, if an ox weighs when dead 8 cwt. of beef, it will while fattening have consumed about 2 cwt. of turnips per day, if no other food was given to it, and if it had as many turnips as it could consume.

From the above facts, we find that an acre of turnips weighing 20 tons will keep in a fattening state $12\frac{1}{2}$ sheep, weighing 20 pounds per quarter, six months, from the 20th day of October till the 20th day of April; but if the sheep are kept in a store state, the same acre of turnips may keep 16 sheep for the same period.

Now, from the above facts, let us see what loss we sustain from not producing a good crop of turnips.

£. s. d.

The increased value of the $12\frac{1}{2}$ sheep which an acre of turnips will keep for 6 months, in a fattening state, we cannot reckon at less than 13s. per head, this is after the rate of 6d. per week per head, or 16 store at 10s. per head 8 2 6

There is also the loss of the manure (dung

and urine) which the sheep would have made from the consumption of 20 tons of turnips, this must be equal to 15 tons at 5s. per ton, or if we take the opinion which farmers have of the value of the fold, which is, that 200 sheep will, during the night, in a week, go over an acre, and that this is worth £1. 10s. this folding will be equal to 325 sheep for a week both night and day, instead of 200 sheep at night only, after this rate the manure would be worth . .

£12 18 6

Thus a clear loss of £12, 18s. 6d. per acre, is the result of a failure in our crop of turnips.

But although we have now come to the end of our course, with a loss of £12. 18s. 6d. per acre, during the course of four years, yet the evil does not terminate here; for it cannot be expected that the land will be in so good a state for the production of a crop of turnips now, as it would have been had a good crop of turnips been produced on it four years ago, and by their consumption on the land leaving such a quantity of manure of the most excellent kind. There is, therefore, not such a prospect of your getting a good crop of turnips now as you had four years ago when you failed. The evil is therefore perpetuated, and a diminution of the productive powers of the land is the result, -and all this evil has arisen from your failing to produce a good crop of turnips.

Most of the land you occupy is an excellent barley soil, and your mode of culture and time of sowing is, in my opinion, in every respect what it ought to be, and it almost universally ensures a good crop; by early sowing, the ground is covered with the leaves of the plants early in the spring, and this prevents the sun from having such an effect on it as it would have had if it had been sown in May. The barley crop is therefore a more certain crop than any other which you cultivate.

Wheat is always sown after your clover, and also after beans, where they are introduced into the

clover break; but some of your land is naturally so soft and loose, and in many cases weak,—I do think that wheat once in four years is too often for such soft land, although that portion of the property which is strong enough might produce a crop of wheat every other year, under good culture, without any diminution of crop or injury to the land.

The plan which you adopt to give an artificial firmness to the land sown to wheat, when there is naturally a deficiency of adhesive matter in the soil, by the press, drill, the trampling of sheep, and folding of your sheep on it, shews that you can find the means of accomplishing the end you wish, when you think it is for your interest to do so, and as it has long been considered by farmers that the wheat crop should pay the rent, no means are left untried by you to increase the quantity of wheat per acre, knowing that every bushel of it goes to the market, and is returned to you in the shape of money; but there is one part of the management of your wheat crop which I am not sure you are right in; that is, the folding of your sheep on your wheat after it is sown. I do not mean the trampling of your land by sheep to firm it, but the folding of the sheep at night; this is for the express object of leaving the dung of the fold to enrich the land, and as you think to secure a better crop, this is the object you have in view from this practice. I think the effect

produced frequently tends to give an unhealthy luxuriance to the straw without making it productive in corn: the straw gets soft and weak, and frequently falls down, not from its length nor from the weight of corn in the ear, but from the softness and weakness of the straw. My opinion is, that no animal manure should be put on your land for a corn crop; it should be in such heart as to produce a good crop of wheat from the effects of the manure put on the land to produce your turnips and other green crops, and from their consumption on the land by sheep; and if the clover were all consumed by sheep on the ground instead of being made into hay, the crops of wheat would be greatly increased, and the land would be much firmer, and the straw would be bright and much stronger.

But let us again return to the turnip crop. It is evident to you, that the increasing evil which you sustain from the loss of the turnip crop must be stopped, or there is no knowing where it will end.

I think a remedy would have been found before this if you had been in the habit of disposing of your turnips in the market, at, say 15s. a ton, (instead of consuming them by sheep,) for then the actual money value of the crop would have come into your calculation, and into your pockets in a directline from the turnip field, and not through the circuitous line, first from the wool, then from your ewes and lambs, then from your barley crop, and last from your wheat crop.

But I said that the greatest objection to the four course system is the quick repetition of the same crop on the same land. I would, therefore, endeavour to put before you a plan whereby each kind of crop of green food for sheep or other stock, shall be at a greater distance than four years, without disturbing the present arrangement of your fields, so far as they regard your barley and wheat crop.

First, then, we shall begin with the land after the crop of wheat has been harvested, which in your present course comes in for turnips. I would therefore advise you to divide the field into two equal parts, on one of these parts I would advise you to have the common globe turnip, the swedish turnip, and cabbage in equal parts, as these are all of the same class of plants, and their nature and habits are nearly the same; on the other half of this field I would advise you to plant mangel-wurtzel, potatoes and carrots, these plants being very different in their nature and habits from the turnips; when this field therefore comes round in the course of four years, these crops should be transposed: the turnips, swedes, and cabbage, should be sown on that part which produced the mangel-wurtzel, potatoes, and carrots, and these, on that part of the field which produced the turnips, swedes, and cabbage, so that by this arrangement, these crops would only come round on the same land once in eight years. All the manure that you can by any means procure should be put on the crop of turnips, &c., which follow the wheat crop, and even bone dust should not be withheld from the turnips, swedes, cabbage, and mangel-wurtzel.

As we have seen the loss which you sustain from the failure in the turnip crop, to be equal to £13 per acre, let me suggest to you a mode of culture which I think will produce a good crop, equal to what we have mentioned, if not considerably more; but it must be remembered, that all the operations of ploughing, dragging, harrowing, putting on the manure, covering it, sowing the seed, and hoeing, must be executed not only in a proper manner, but also in a proper time.

The land intended for turnips or other green crop, must be ploughed the first time in autumn, at least before Christmas, and that with a very deep furrow, and if the subsoil plough follows, loosening the bottom of the furrow to the depth of sixteen inches from the surface, so much the better; this ploughing to remain for the frost to pulverize it during the winter; in February or March it should be ploughed across, and soon afterwards dragged and harrowed to get out any weeds that may be in it, and then the

land should be left smooth to keep in the moisture. It may be gone over with the Finlayson's harrow, as often as necessary to destroy the annual weeds and keep the land loose.

All the manure you have, should be put on the land before the second ploughing, if it is long unfermented straw yard dung, as it will then get better rotted, and incorporated with the soil, but if your dung be well rotted, it should be put into drills or what you call trenches, but in doing this, much injury will be sustained if the work is not gone about quickly, so as to prevent the manure and soil from getting dry during the operation.

In making the one-bout drills (or trenches as you call them)—carting and spreading the manure in the drills,—splitting them so as to cover the manure, and sowing the seed,—all these several operations must be simultaneously performed, that is, the whole of these operations must be gone about at the same time, and all the drills that are made to receive the manure must be dunged, the dung spread and covered, and the seed sown before the evening, so as to preserve the moisture of the manure and the moisture of the soil from evaporating if left till tomorrow, which moisture it is absolutely necessary to retain to vegetate the seed, the crop frequently fails from letting the land remain for a day after it is ploughed before the seed is sown.

The advantage of bone dust in turnip husbandry which you have seen to be so great,* will naturally induce you never, to sow any without giving fifteen or twenty bushels of it per acre, even although you have dung to go over the whole breadth of your turnip break.

The advantage of sowing turnips early, is as great as that of sowing barley early, on your light sandy land. I would therefore advise you to sow your turnips much earlier than you have been in the habit of doing. Swedes should be finished by the first of May, and the common turnip by the tenth of June at farthest, if we expect a large crop; "to sow early and to drill turnips is to put in for a fair chance of doubling the worth of the crop,"—is the opinion of practical farmers. If you follow the plan which I have laid down, I think there will be less complaints of the failure of your turnip crop.

The whole of the field after these crops to be sown to barley as you do now; but after the barley, instead of sowing the whole to clover as you do at present, I would again divide the field into two equal parts, as I advised with the turnips, and on the half which was in turnips, swedes and cabbage, I would sow broad clover seed; but on the other half I would,

^{*} From experiments made by Mr. Pusey's tenants with bone-dust in 1837.

after the barley is harvested, have the land ploughed, and sow it to winter vetches, and Italian rye-grass together, which would furnish the earliest and the finest food for your stock in the spring, after the mangel, potatoes and carrots are consumed.

The clover field being thus divided, that part of it which produced clover this year, would produce winter vetches and Italian rye-grass the next time it came round, and that part which produced vetches and Italian rye-grass, would produce clover, these of course would only come round on the same land once in eight years as in the turnip field, but the barley and wheat would come round once in four years This arrangement we think would cure the evil arising from the quick succession of green crops on the same ground.

We shall now look into the mode you adopt to consume your straw. Those of you that have not dairies, have no cows, or other beasts except your working horses, a flock of sheep, and a few pigs, so that your wheat and barley straw is thrown out into the court yard to be trodden under the feet of your horses, and turned over by your pigs till it receives a certain degree of wetness, and then it is taken out into the field where it is intended to be used, and thrown up in a heap to lie till the time arrives when it is to be put on the land: this is the only preparation you give to your dung, and the only animal

manure mixed with the straw is the dung and urine of your working horses and pigs.

There is either a want of knowledge of this part of the farming business, or an apathy and indifference about the matter, out of which you should rouse yourselves.

The real value of manure to a farm seems not to have entered your head; for had you a right idea of its value, one would have thought that you would be more anxious about its increase and more careful of it, so as to prevent it from running to waste; for we have seen dung-hills on the road side with the rich liquid manure running out of them into the ditch or sinking into the rock; we have also seen them covered with docks, nettles, and every kind of weed, and we have seen a stream of water, in wet weather, from the yard, carrying off all the most valuable parts of the manure, without any attempt being made to stop it, or to mix it with the earth, &c.: this is a very common case over all the country. It would be difficult to calculate how much is lost yearly throughout the country by inattention to this subject; perhaps a quarter, if not one-third, or even a half of the value of all the dung is thus allowed to go to waste, thus exhausting the soil by negligence instead of increasing its productiveness by attention to the subject.

The old maxim that "muck is the mother of

gold," conveys a truth which you really seem to have lost sight of, but which I hope you will be more familiar with for the time to come, as it is for your own pecuniary advantage, for without manure we seldom succeed in procuring good crops of any kind, and with a liberal supply of it of a good quality, properly applied, we can produce the most luxuriant crops of every kind, you should therefore use every means in your power to increase its quantity, and improve its quality, and make every exertion to produce the largest quantity per acre of those crops which by their consumption with sheep on the land, or with stock in the house or yard, will return the greatest quantity of so valuable an article.

The manure from your straw yard, as we have before stated, is merely straw in a state of decomposition, there is little or no animal dung amongst it, but some of you have told me "that you think it is much better for your land than the dung of animals." Let us consider the point; well then, the manure which you prefer, consists wholly of rotten straw, which is a light, loose, porous substance, with no adhesiveness or tenacious property in it, to make it stick together, so that when it is dry, it is like so much chaff, and when it is mixed with the soil, it must make it more light and porous than before, and tend to make it, and keep it loose and open, for the drought to have a greater effect upon it.

The dung of horses partakes in a great measure of the same nature, it is of a dry light warm nature, in summer when it gets dry, it seems to be a mass of bruised strawy matter, you might almost from its appearance detect the kind of food of the animal which produced it, it is so light, that you might kick it about with your foot, without soiling your shoe. The dung of the ox or cow, and of all animals that chew the cud, is very different in its nature, there is no vestige of the nature of the food which the animals consume, to be seen in their dung, it is a mass of close adhesive cold excrement, in summer it drys into a hard compact substance, very unlike the dung of the horse or of rotten straw.

From the light and sandy nature of your land, we have seen that you very properly use artificial means to press it together with the press drill and the roller, and to trample it with the sheep to harden it, and to make it firmer, knowing from experience, that if this were not done, there would be much less certainty of a good crop; but a light, loose, friable substance, mixed with your light land, would have a tendency to make it more light and porous than it was before, and a tenacious adhesive substance of the nature of clay, being mixed with your light soil, would have the effect of making it more tenacious and firmer than before it was applied: your light strawy dung will therefore have the effect of making your light sandy land more light and porous, tending to let the drought into the land, when it is mixed with it; but the dung from ruminating animals well mixed with the soil has a contrary effect, it tends to make it closer and firmer, and thereby enables it to resist the drought better; you will therefore perceive that the notion which some of you have got about your rotten straw being the best sort of dung for your light land is quite erroneous, and this strawy dung may be one of the principal causes of the failure of your turnip crop, the evil effects of which we have already considered. But let it be remembered, that although long strawy unfermented dung may be of little advantage to loose soft sandy land, compared with well rotted animal manure, yet upon strong adhesive clay, such as that of Bedlam and Hanney farms, the strawy dung will be most advantageous, as it will tend to make and keep the tenacious clayey soils of these farms loose, friable, and porous.

From what has been said on this subject, I think you will see the propriety of preparing the manure for your turnip crop, so as to get it well rotten, and well mixed with some heavy earth or clayey matter. I would therefore advise that you should, every week or two, clear out all your dung from your yards, etc. and lay it in heaps either near the yard or in the field where it is to be used, and have it

mixed with earth, first making a layer of earth about six inches thick, then a layer of dung about six inches thick upon it, and repeat this four or five times, covering the edges of the dung with earth, and when it has remained in this state for some time it will ferment, but not violently, when it has been in a state of fermentation for some weeks, turn the whole over, carefully mixing the earth and the dung as perfectly as you can, and form it into a heap in the form of a potatoe pit, or like the roof of a house; after it has remained in this state for some time, it will again heat, but not so much as at first, and when it begins to cool it ought again to be turned over; this second fermentation and turning will have divided and blended the earth and the dung together, so that it will have the appearance of a dark rich earthy substance, this will form an excellent compost to put into the drills for turnips but the oftener these compost heaps are turned over, the better prepared they will be for your light sandy soil, and you will have a much greater certainty of a crop of 20 or 25 tons of turnips per acre, after a dressing of 20 or 25 loads of this compost, than you now have after 20 or 25 loads of rotten straw.

We were next to consider the state of your live stock: these we have before observed to consist of a flock of sheep besides your working horses, and this is the state of the matter on all the arable farms, except those of you who have dairy farms also. Well then, this flock of sheep is what you call a working flock, that is, in some seasons of the year they work very hard all day to get their belly full, and in the evening they are driven to a fallow field, to be in the fold all night, that they may leave the dung on the land for the next crop.

I cannot think that this is the best kind of stock, or the most profitable way of managing them on such farms as you occupy. I cannot see the advantage of forcing a flock of sheep—ewes and lambs to wander all the day long, day after day, over all the poor pasture land on your farm, to pick up what food they can get, and then to be shut up at night on some portion of the arable land, to deposit the result of their hard day's earnings, this I think is really "robbing Peter to pay Paul." The only acknowledged object of your flock of sheep is the value of the fold, to enable you to raise good crops of barley and wheat: "without the fold, sir, we cannot expect to get a crop of corn on this land." Let us see if we cannot find a better reason for having a flock of sheep, than merely to make them work hard, and live hard all day, and then force them to lie on ploughed land for ten hours at night, that they may there empty themselves to please us.

Suppose then, that instead of the hard working

sheep, you should have a flock of sheep of an improved kind of Southdown, like those of Messrs. Twynham, of Whitechurch, in Hampshire, these I am told are not only excellent feeders, but good folders: well then, let our object be not only to breed, but to fatten for the butchers all the stock that we breed, and that our flock of sheep should also be folded on our arable land, that the full value of the fold may be given for the production of our corn crops; keeping these objects in view, let us, in the first place, have always a sufficient quantity of nutritious food for them, and all the other stock which we keep, for every day in the year; we should carefully avoid giving our flock any more trouble than is necessary; we should therefore always fold them on the ground which produced the crop they are consuming, and give it to them fresh and fresh every day: thus, while they are consuming turnips, &c. in the autumn, winter, and spring, if our turnips are 20 tons or more per acre, then we should carry one-half the crop off the ground, either to be consumed by other kinds of stock in the straw yard, or by sheep on another part of the field, where the whole of the crop of mangel-wurtzel, potatoes, and carrots were taken off, so as to give the whole field the same advantage of the dung, and the trampling of sheep in the fold, but by no means to drive the sheep to be shut up at night in a field or ground

where there is no food for them, and for no other object but for them to carry their dung, to save us the trouble of carting their food to the place where we wish the advantages of the fold to be applied. The expense of carting the turnips, and of cutting them where we wish to fold the sheep, is a much more reasonable mode, and, in my opinion, a much more profitable one than the one which is at present adopted, because the sheep improves more when they are allowed to feed and rest when they like.

In spring, summer, and autumn, we should proceed in the same way with our winter vetches, Italian rye-grass, clover, &c., folding our sheep on them, giving them a fresh piece every day, and never allow them to run all over the field, but when you add the length of a hurdle of fresh food to them at one end of their fold, take off the length of a hurdle from the fold at the other end: thus they will gradually proceed over the whole field, and the end at which they began first may be ready for them again by the time they have finished at the other end. But part of the winter vetches, Italian rye-grass, and clover should be cut and carted to the cattle and other stock in the straw-yard and house.

I am fully convinced that an arable farmer cannot make the most of his crops, unless he has oxen or other beasts to consume the greatest part of his straw, and convert it into manure. I would there-

fore advise you to keep, according to the extent of your farm, some breeding cows, and to rear up so many calves, and keep them till you fatten them off at three or four years old for the butcher; you can easily do all this if you succeed in producing 20 or 25 tons of turnips, &c. per acre on the fourth part of the farm, of which I have not the least doubt, if you set about the work in right earnest; this will, ' in the winter and early part of the spring, give you at least double the quantity of such food as you have had for these many years past, of course you will be able to spare nearly half of these for your beasts in the yard, but if you should not have sufficient turnips for them, oil cake is a good substitute; and in the summer you will have another fourth part of your farm producing clover, vetches, and Italian ryegrass, and if half of this was cut and carted to your straw-yard to your beasts, there would be food for t hem in the summer months: and be assured, that the larger the quantity of food you can raise for your stock, and the greater quantity of stock you keep in the house or yard, so much the greater quantity of manure of a richer quality will be produced, and the additional quantity of manure being put on the land for green crops, will again produce an increase of these, and this increased produce will appear in every crop of the course.-Larger crops of barley and wheat of a better quality will follow as a natural consequence.

By adopting this mode, I think you would be able to get more corn to take to market, and receive a much greater return for your stock than you do at present. Indeed, I think it quite possible for you to keep as much stock on your farm as will produce as great a return as you now receive from your corn crop, without diminishing your crop of corn.

We have now come to the last thing which we have to consider, that is, the agricultural implements, and the expenses of your horse-power, which you require to use them. The kind of horses you use is the heavy, dull, slow animal, like the waggon or London dray-horse, the natural pace of these animals is about a mile in the hour. Of these heavy, powerful horses you universally put three to the plough which you use, but then such a plough: the most clumsy, lumpiest, antiquated implement in the kingdom, with two wheels, and a carriage to carry the end of the beam of the plough, which rises up at an angle of about thirty degrees to the horizon, with a wooden mould board, of from four to five feet long, and this is the plough that most of you use, with, I believe, only a single exception, and it is generally used in the Vale of the White Horse,

Such is the overpowering effect of habit and custom, that although you have had an example for many years at Buckland, within a mile of you, of a man and two active horses, with a light plough, doing more work in a day than you can with your

three heavy horses, a man, and a boy, on the same light land, yet you still drag on this unwieldy machine, without even calculating the additional expense you are at in ploughing your land, which the Buck-slowness of your horses, I have never seen them plough an acre a day, while I have seen a man and two horses, with a light plough, in Lincoln, Norfolk, and Suffolk, plough an acre and a half, with the greatest ease, daily; and in the fens of Lincolnshire two acres a day is frequently performed. But the mode in which you work your horses is not the best, in my opinion; they start to work in the morning, and finish their day's work before they come home: that is, they take eight hours at a spell, and when the man and boy are eating their dinners, the horses stand in idleness and hunger, waiting till they have finished: would it not be much better to take two spells a day, of four hours each, and make the horses go briskly while they are at work in the morning, and then come home and rest for two hours in the middle of the day, and the horses get something to eat, and then take them back and work them other four hours? This would be making it more easy for the horses, by dividing the time and doing more work per day; but these heavy horses are not so fit for doing light quick work, as active horses that have some blood in them, and it would be well for

you to form the design of gradually getting out of them, and of the plough and your heavy carts also, and to get light ploughs—swing ploughs, not wheel ploughs, and light carts, &c., so that you may be able to cultivate your land at a much less expense than you do at present; for, if it be true, that an acre and a half of your light land can be ploughed by a man and two horses in a day, while you at present are scarcely able to plough one acre a day with three horses, a man, and a boy, it is evident to me that you might, by the change which I propose, save one-half of the expense of ploughing your land, and the saving in every other work would be after the same rate.

I have placed my ideas on your mode of farming before you, that you may have it in your power, whenever you think proper, seriously to consider the value of any statement which I have made: if you are convinced that they are right, you will of course adopt them, but reject any which you believe not to be applicable to the peculiar circumstances under which you and your farms are placed.

I am, Gentlemen,

Your most obedient servant,

JOHN MORTON.

Chester Hill, January 18, 1838.

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